THE CITY OF NEW YORK

HAZARD MITIGATION PLAN UPDATE 2014

DRAFT FOR PUBLIC REVIEW

NYC Hazard Mitigation Plan 2014

THE CITY OF NEW YORK

HAZARD MITIGATION PLAN

UPDATE 2014

THE PLAN

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1) Overview

Hazard mitigation planning, the effort to reduce or eliminate the risks from hazards to people and property, is the first of the four phases of emergency management. It is followed by preparedness, response, and recovery (see Figure 1). Although the mitigation planning stage of emergency management often gets the least attention, it is one of the most important steps in creating a disaster-resistant community.

Figure 1: Phases of Emergency Management

Hazard mitigation is any action taken to reduce or eliminate risks to people and property. It has been demonstrated time after time that hazard mitigation is most effective when based on an inclusive, comprehensive, long-term plan that is developed *before* a disaster actually occurs. Although it is impossible to predict exactly when and where disasters will occur or the extent to which they will affect localities, careful planning and collaboration among public agencies, stakeholders, and citizens can minimize losses that can occur.

The 2014 New York City Hazard Mitigation Plan (HMP) update is the result of extensive planning and collaboration. The New York City Office of Emergency Management (OEM) partnered with the New York City Department of City Planning (DCP), working with the Mayor's Office of Long Term Planning and Sustainability (OLTPS), to develop the plan, which assesses hazard vulnerabilities, identifies mitigation opportunities, and secures funding for the benefit of New York City. The update differs from New York City's original HMP, published in 2009, in two important ways: It includes *non-natural* hazards along with natural hazards, and it addresses the impacts of climate change on identified natural hazards. This document is the culmination of a cooperative partnership among dozens of city, state, and federal agencies, authorities, and organizations, with input from the private sector, academic institutions, community

organizations, and citizens. The plan is a living document and will be refined and updated every five years.

a) Stafford Action and Disaster Mitigation Act of 2000

This plan meets all requirements for hazard mitigation plans under the Robert T. Stafford Act Disaster Relief and Emergency Assistance Act (Stafford Act). The Stafford Act was signed into law in 1988 and provides the authority for Federal disaster assistance activities, including not just assistance for response and recovery, but also preparedness and mitigation.

The Disaster Mitigation Act of 2000 (DMA 2000) amended the Stafford Act to reinforce the importance of mitigation planning and emphasize planning for disasters before they occur. DMA 2000 established provisions and requirements for State, local, and Indian Tribal entities to closely coordinate mitigation planning and implementation efforts. States and communities must have an approved Hazard Mitigation Plan (HMP) to be eligible to apply for and receive FEMA hazard mitigation funds. The plans must demonstrate that the proposed mitigation actions are based on a sound planning process that accounts for the risk to and the capabilities of the community. To facilitate plan development, the Federal Emergency Management Agency (FEMA) has issued guidelines under DMA 2000 regulations.

b) Benefits of Mitigation Planning

Hazard mitigation planning helps communities reduce their risk from hazards by identifying vulnerabilities and developing strategies to lessen and sometimes even eliminate the effects of the hazard. Some of the benefits of mitigation planning to New York City agencies and other stakeholders are as follows:

- **Leads to selection of risk-reduction actions.** Hazard mitigation planning is a systematic process of learning about the hazards that can affect New York City; setting clear goals; and identifying and implementing policies, programs, and actions that reduce losses from disasters.

- **Builds partnerships.** Hazard mitigation planning enhances collaboration among a broad range of stakeholders to achieve a common vision. Increased collaboration also reduces duplication of efforts among organizations with similar or overlapping goals.

- **Creates a more sustainable and disaster-resistant city.** There is an intrinsic link between the concept of sustainability and natural hazard risk reduction. An essential characteristic of a sustainable city is its resilience to disasters.

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- **Establishes funding priorities.** A mitigation plan allows New York City to better identify and articulate its needs to state and federal officials when funding becomes available, particularly after a disaster. With its HMP in place, New York City can propose projects as an integral part of an overall, agreed-upon strategy, rather than as projects that exist in isolation. Mitigation planning coordinates existing and potential mitigation actions into a unified mitigation strategy. Importantly, this plan ensures New York City's eligibility to receive FEMA's Unified Hazard Mitigation Assistance funds for mitigation projects, especially Hazard Mitigation Grant Program (HMGP) funding, also known as 404 Mitigation due to it being Section 404 of the Stafford Act.

- **Increases public awareness of natural hazards.** Mitigation planning serves to help residents better understand the threat to public health, safety, and welfare, economic vitality, and the operational capability of critical infrastructure.

The New York State Office of Emergency Management (NYS OEM) supports development of HMPs for jurisdictions within the state, including New York City, through various planning initiatives. NYS OEM, under the NYS Department of Homeland Security and Emergency Services administers select hazard mitigation grants as well.

c) Planning Phases

New York City engaged in a four-phase planning process, as recommended by FEMA guidelines and as illustrated in the figure below.

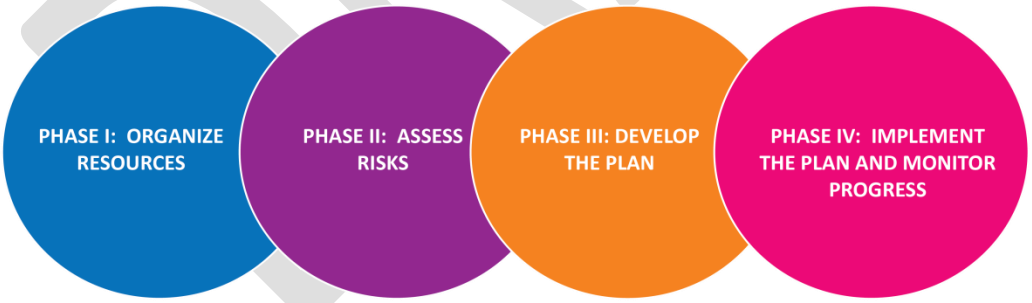

Figure 2: Four-phase Planning Process

Phase 1: Organize Resources The first phase of the process involved coordinating with agencies and organizations, integrating hazard mitigation with other planning efforts, and involving community groups and other stakeholders in the planning process.

Phase 2: Assess Risks The second phase included identifying and profiling hazards, assessing vulnerability, and estimating potential losses. This phase helped establish the scientific and technical foundation for mitigation actions.

Phase 3: Develop the Plan The third phase included developing hazard mitigation goals and objectives, conducting a capability assessment, working with planning participants to identify and analyze mitigation actions, and documenting the planning process.

Phase 4: Implement the Plan and Monitor Progress New York City is currently in this fourth phase of mitigation planning. This phase involves adopting, implementing, monitoring, and reviewing the HMP to ensure the plan's goals and objectives are met.

2) Plan Organization
New York City's HMP is organized into the following sections:

Section I: Introduction

The Introduction—the section you are now reading—provides a brief overview of the HMP's background and purpose.

Section II: Planning Process

This section outlines the manner in which New York City created the HMP. It identifies which agencies and organizations were involved in the process, how they were involved, and the methods of public participation that were employed. It also provides a detailed description of the decision-making and prioritization processes.

Section III: Risk Assessment

This analysis of the hazards and risks facing New York City contains detailed hazard profiles and loss estimates—the scientific and technical basis for mitigation actions.

Section IV: Mitigation Strategy

This section shows how New York City intends to reduce losses identified in the Risk Assessment. It includes goals and objectives to guide the selection of actions to mitigate and reduce potential losses. It contains a prioritized list of cost-effective, environmentally sound, and technically feasible mitigation actions. It identifies current and potential sources of funding and other resources needed to implement the mitigation actions. Finally, it includes a discussion of New York City's policies and programs that will serve to help administer many of the identified actions.

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Section V: Plan Adoption

As the Plan Adoption section indicates, New York City will formally adopt the HMP by executive order. This ensures comprehensive mitigation planning citywide, strong program management, and a citywide commitment to mitigation planning.

Section VI: Plan Maintenance

New York City will monitor, evaluate, and update its plan according to the process outlined in the Plan Maintenance section. The section establishes a review process and method for measuring progress during the five year time period for when FEMA requires the HMP is updated.

3) Plan Status and Contact

This report incorporates comments submitted by the Hazard Mitigation Planning Team, MPC Steering Committee, Mitigation Planning Council members, members of the public, and other stakeholders during the 30-public comment period as well as comments from NYS OEM and FEMA during the formal review process. The City formally adopted the final plan by Executive Order XXX in TO BE ADDED LATER.

If you have any questions or comments on the New York City HMP or require additional information, please contact:

Hazard Mitigation Unit
New York City Office of Emergency Management
165 Cadman Plaza East
Brooklyn, NY 11201
Email: mitigation@oem.nyc.gov
Website: nyc.gov/hazardmitigation

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1. Introduction

Effective planning efforts result in high quality and useful plans, but written plans are only one element in the process. The planning process is as important as the plan itself.

A successful planning process forges partnerships and brings together a cross-section of government agencies, the public, and other stakeholders to reach consensus on how to achieve a desired outcome or resolve a community issue. Applying an inclusive and transparent process adds validity to the plan. Those involved gain a better understanding of the problem or issue and how solutions and actions were devised. The result is a common set of community values and widespread support for directing financial, technical, and human resources to an agreed upon action.

The planning process was an integral part of the New York City Hazard Mitigation Plan (HMP) update. This section describes New York City's planning process and how the HMP update evolved over the course of eight months.

A. FEMA Requirements Addressed in this Section

New York City's mitigation planning process, which evolved over the past year, was consistent with the steps presented in the Federal Emergency Management Agency (FEMA) *How-To-Guide: Building Support for Mitigation Planning (FEMA 386-1).* The following FEMA requirements were addressed in this process:

- **Requirement §201.6(b):** The planning process ***shall*** include:
  (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
  (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
  (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.
- **Requirement §201.6(c)(1):** [The plan ***shall*** document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.
- **NYS Requirement § 1:** Counties and communities should invite (at a minimum) the following stakeholders when initiating the planning process and identifying strategies and specific projects: County Hazard Mitigation Coordinators and Floodplain Professionals, County Emergency Managers, County Planners & GIS staff, County Soil & Water Conservation Districts, Regional & Metropolitan (Transportation) Planning Organizations, Local Hazard Mitigation Coordinators and Floodplain Managers, Local Code Enforcement Officials, Local Emergency

Management (Emergency Manager, Fire & Police Chiefs), Local Planners and planning consultants, Local Engineers and engineering consultants, and Local Public Works or Highway Superintendents.

- **NYS Requirement § 7:** Draft plans should be placed on an existing county/community website, or one created for the purpose of soliciting comments, for 30 days or the time prescribed by local law, whichever is greater. The webpage should identify the name, mailing address, day phone and/or email address for the person responsible for receiving and reviewing comments on the draft hazard mitigation plan. The final plan should also be placed on an existing county/community website, or one created for the purpose of educating the public about the community's mitigation initiatives, and should contain contact information specified above for the person responsible for maintaining the plan and answering questions about it once it has been accepted.

B. Planning Process Approach

This section of the HMP, which serves as a permanent record of New York City's mitigation planning process, describes how the process unfolded and includes the following components:

- Planning Participants and organization structure
- Developing the HMP (Risk Assessment and Mitigation Strategy)
- Plan Development Meetings
- Meeting Documentation

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2. Planning Participants and Organizational Structure

A. Organizational Structure

The process for developing the update to the Hazard Mitigation Plan consisted of a four levels of engagement: Planning Team, MPC Steering Committee, the Mitigation Planning Council, and the general public (see Figure 1). The following section will further describe the role each level played in the planning process.

i. Planning Team

The Planning Team was the overall lead for developing the HMP. It was comprised of representatives of the New York City Office of Emergency Management (OEM) and the New York City Department of City Planning (DCP), working in close collaboration with the Office of Long-Term Planning and Sustainability (OLTPS). Specifically, the Planning Team consisted of four planners from the OEM Planning and Preparedness Division, one specialist from OEM's Geographic Information Systems (GIS) Unit, and five planners from DCP. OEM planners facilitated the overall plan development to ensure the HMP met the requirements of DMA 2000, and OEM's GIS specialist worked to customize and execute hazard models and create maps and data tables for the plan. DCP, which has expertise in demographic and land use analyses in addition to several agency-driven climate change initiatives, designated its planners to work on two specific sections of the HMP: New York City's Hazard Environment and the Flooding Risk Assessment profile. DCP also provided guidance on the public outreach strategy. OLTPS assisted both OEM and DCP with the "future environment" sections of the report. The Planning Team participants and their agencies are shown in Figure 2.

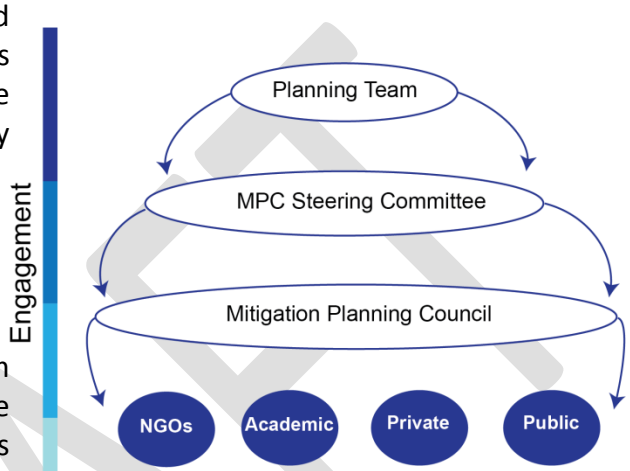

Figure 1: HMP Planning Process

1) Responsibilities

As the HMP coordinator, the Planning Team had the following responsibilities:

- Organize and guide all meetings with the Steering Committee and MPC members
- Develop and implement the community involvement process
- Guide the plan development to adhere to DMA 2000 requirements

- Manage identification, collection, and analysis of mitigation actions submitted by the MPC
- Facilitate responsibilities and provide support for all participants in the hazard mitigation planning process
- Coordinate with MPC members to identify relevant material for the HMP

2) Participants and Agency Descriptions

OEM New York City Office of Emergency Management	The New York City Office of Emergency Management (OEM) plans and prepares for emergencies, coordinates emergency response and recovery, and collects and disseminates emergency information. To accomplish this mission, OEM maintains a disciplined unit of emergency management personnel, including planners, watch commanders, and administrative and support staff, to identify and respond to various hazards.	Heather Roiter Damiano , Hazard Mitigation Program Manager Amy Post, Director Transportation and Infrastructure Melissa Umberger, Hazard Mitigation Specialist Gary Monitz, Hazard Mitigation Specialist Joshua Friedman, GIS Specialist
NYCPLANNING DEPARTMENT OF CITY PLANNING CITY OF NEW YORK	New York City Department of City Planning (DCP) is responsible for the city's physical and socioeconomic planning, including land-use and environmental review; preparation of plans and policies; providing technical assistance and planning information to government agencies, public officials, and community boards. The commissioner of the agency serves as the chair of the City Planning Commission.	Sarah Goldwyn, Planner Ralph Blessing, Planner Maryam Hariri, Planner Reza Tehranifar, GIS Specialist Thaddeus Pawlowski, Planner Jesse Levin, Project Manager
planYC	New York City's Office of Long-Term Planning and Sustainability (OLTPS) was created as part of the Mayor's Office by local law in 2006. The office coordinates with all other City agencies to develop, implement, and track the progress of PlaNYC and other issues of infrastructure and the environment which cut across multiple City departments.	Carrie Grassi, Senior Policy Advisor Erika Lindsey, GIS Specialist

Figure 2: HMP Planning Team

ii. Mitigation Planning Council Steering Committee

The MPC Steering Committee, which helped develop, manage, and implement the HMP, is a core group of 13 agencies and organizations that own or manage some of the city's largest infrastructure networks and/or engage in planning for or regulating these systems (see Figure 3). The Steering Committee includes New York City agencies and entities that were involved in the 2009 HMP and remained involved through the 2014 HMP update: OEM, DCP, and OLTPS in addition to the Department of Buildings (DOB), Department of Environmental Protection (DEP), Department of Parks & Recreation (Parks), NYC Department of Transportation (NYC DOT), Metropolitan Transportation

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Authority (MTA), and the Regional Plan Association (RPA). For the 2014 update to the HMP, the Planning Team expanded the membership of the Steering Committee to include the Department of Health and Mental Hygiene (DOHMH), the Mayor's Office for Housing Recovery (HRO), the New York City Police Department (NYPD), and the New York City Fire Department (FDNY). The Steering Committee provided subject-matter expertise in the following areas: emergency management, land use planning, building codes, housing recovery, public health, public safety, transportation, infrastructure protection, climate change, regional planning, and natural resource protection.

On July 26, 2013, the Planning Team led the first Steering Committee meeting. During this meeting Steering Committee members discussed selecting hazards for the HMP, developing goals and objectives, and identifying agency-specific capabilities for implementing mitigation actions. Following the first meeting, Steering Committee members attended two additional meetings during the planning process to facilitate the development of the HMP. During these meetings, the Steering Committee provided information for and reviewed the Risk Assessment section of the plan and evaluated mitigation actions. OEM also conducted individual meetings with Steering Committee members and maintained regular phone and email contact to develop specific ideas and identify additional resources related to the development of the plan.

1) Responsibilities

The Steering Committee's responsibilities were as follows:

- Support plan development
- Attend meetings through December 2013
- Develop HMP mission statement, goals, and objectives
- Provide subject-matter expertise
- Assist in evaluating and prioritizing mitigation actions
- Review and comment on draft HMP sections provided by the Planning Team
- Assist with maintaining the HMP

2) Participants and Agency Descriptions

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New York City Department of Buildings (DOB) ensures the safe and lawful use of more than 950,000 buildings and properties through enforcing the City's Building Code, Electrical Code, Zoning Resolution, New York State Labor Law, and New York State Multiple Dwelling Law. DOB's main activities include performing plan examinations, issuing construction permits, inspecting properties, and the maintenance of construction codes and licensing trades.

Keith Wen
Charles Shelmar
Daniel Cornwell
Juan Arias

New York City Department of City Planning (DCP) is responsible for the City's physical and socioeconomic planning, including land-use and environmental review; preparation of plans and policies; providing technical assistance and planning information to government agencies, public officials, and community boards. The commissioner of the agency serves as the chair of the City Planning Commission.

Sarah Goldwyn
Maryam Hariri
Jessie Levin
Reza Tehranifar

New York City Department of Environmental Protection (DEP) protects public health and the environment by supplying clean drinking water, collecting and treating wastewater, and reducing air, noise, and hazardous materials pollution. DEP distributes more than one billion gallons of clean drinking water each day to nine million New Yorkers and and treats the 1.3 billion gallon of wastewater that New Yorkers produce each day in a way that protects the quality of the New York Harbor.

William Morris
Alan Cohn
Gregory Anderson

New York City Department of Parks & Recreation (Parks) is responsible for maintaining the City's parks system, preserving and maintaining the ecological diversity of the City's natural areas, and furnishing recreational opportunities for City residents. The department maintains more than 17,000 parks, playgrounds, and recreation facilities across five boroughs. It is responsible for more than 1,000 playgrounds, 800 athletic fields, 550 tennis courts, 48 recreational facilities, 66 public pools, 14 miles of beaches, 13 golf courses, and 17 nature centers. Parks also cares for park flora and fauna, community gardens, historic houses, statures and monuments, and more than 2.6 million trees.

Jon Ells
Mike Dockett
Jessenia Aponte

New York City Department of Transportation (DOT) is responsible for providing safe, efficient, and environmentally responsible movement of people and goods throughout New York City. The agency's responsibilities include day-to-day maintenance of the City's 5,800 miles of streets, highways, and sidewalks. The agency's responsibilities also include the management 6,300 miles of streets and highways, over 12,000 miles of sidewalk, 781 bridge structures and six tunnels. The agency also operates the Staten Island Ferry and other ferry operations on City owned piers. DOT staff installs and maintains more than 1.3 million street signs, traffic signals at more than 12,000 signalized intersections, and over 300,000 street lights.

Alan Olmsted
Tom Maguire
Magdeline DeCamps
Sharita Hunter

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Department of Health and Mental Hygiene (DOHMH) protects and promotes the health of all New Yorkers. DOHMH is responsible for issuing birth and death certificates, providing food safety training, restaurant inspections, immunization information, and public health publications. In addition, DOHMH works to prevent, protect against, respond to, and increase NYC's ability to recover from public health threats. The agency works to build NYC Community resilience against public health emergencies through collaboration with NYC healthcare facilities and community organizations.

Kizzy Guzman
Mitchell H. Stripling
Lachelle Francis

Fire Department of New York City (FDNY) responds to fires, public safety and medical emergencies, disasters and terrorist acts, FDNY protects the lives and property of New York City residents and visitors. The Department advances public safety through its fire prevention, investigation and education programs. The timely delivery of these services enables the FDNY to make significant contributions to the safety of New York City and homeland security efforts.

Jeff Roth
Caroline Kretz
Anthony Migliore

New York City Police Department (NYPD) enhances the quality of life by working in partnership with the community and in accordance with constitutional rights to enforce the laws, preserve the peace, reduce fear and provide a safe environment. NYPD protects the lives and property of citizens and impartially enforces the law and fights crime both by preventing it and by aggressively pursuing violators of the law.

Robert Harnischfeger
James Wahlig
Victor Ferrante
Chris Matousek

The Mayor's Office of Housing Recovery (HRO) is responsible for providing information on the City's efforts to help New Yorkers recover from Hurricane Sandy; NYC Build it Back is a central tenant of HRO. This program assists homeowners, landlords, and tenants in the five boroughs whose homes and properties were damaged by Hurricane Sandy. NYC Build it Back provides several pathways to help affected residents return to permanent, sustainable housing by addressing unmet housing recovery needs in several categories.

Thaddeus Pawlowski

Regional Plan Association (RPA) is an independent, not-for-profit regional planning organization that focuses on recommendations to improve the quality of life and the economic competitiveness of the 31-county New York-New Jersey-Connecticut region through research, planning, and advocacy. RPA's mission is to help shape transportation systems, protect open spaces, and promote better community design for the region's continued growth. RPA addresses future challenges to the region and works to mobilize the region's civic, business, and government sectors to take action.

Rob Pirani
Laura Tolkoff

Metropolitan Transportation Authority serves a population of 15.1 million people in a 5,000 sq mile area spanning from New York City through Long Island, southeastern New York State and Connecticut. MTA subways, buses, and railroads provide 2.62 billion trips each year to New Yorkers. In addition, MTA brides and tunnels carry more than 280 million vehicles per year.

Judy Walker
Keyla Hamman

Figure 3: MPC Steering Committee members

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iii. Mitigation Planning Council

The Mitigation Planning Council (MPC), a multidisciplinary group of 41 stakeholders that have an interest in reducing the impact of hazards in New York City, was responsible for developing the HMP. The MPC members played an integral role in identifying existing and potential mitigation actions that will make New York City more resilient to natural and non-natural disasters. The members include 41 agencies, public authorities, and private utility providers that were involved in the 2009 HMP: the New York City Department for the Aging (DFTA), DOB, DCP, Department of Citywide Administrative Services (DCAS), Department of Corrections (DOC), Department of Design and Construction (DDC), Department of Education (DOE), DEP, DOHMH, Department of Homeless Services (DHS), Department of Information Technology and Telecommunications (DoITT), Parks, Department of Sanitation (DOS), NYC DOT, the Economic Development Corporation (EDC), FDNY, Health and Hospitals Corporation (HHC), Housing Preservation and Development (HPD), Human Resources Administration (HRA), Landmarks Preservation Commission (LPC), NYPD, OEM, OLTPS, Small Business Services (SBS), New York City Housing Authority (NYCHA), the Port Authority of New York and New Jersey (PANYNJ), RPA, the United States Army Corps of Engineers (USACE), Con Edison (Con Ed), Verizon, and the MTA (see Figure 4). For the 2014 HMP, the Planning Team expanded the MPC to include the following agencies: the Mayor's Office of Environmental Remediation (OER), the Mayor's Office for Housing Recovery (HRO), the Office of Management and Budget (OMB), and the Office of the Chief Medical Examiner (OCME).

On June 18, 2013, MPC members participated in a large-group kickoff meeting (discussed further below). The Planning Team used this meeting to introduce participants to hazard mitigation, discuss hazard mitigation funding and eligible projects, and request a list of mitigation actions from each participant. In addition, the Planning Team met with each member agency or organization individually to provide additional hazard and risk information and discuss specific mitigation actions.

1) Responsibilities

MPC members' responsibilities were as follows:

- Attend MPC meetings
- Identify, develop, and submit alternative mitigation actions for inclusion in the Mitigation Strategy section
- Review and comment on the draft HMP
- Provide ongoing monitoring of hazard mitigation efforts after plan adoption

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2) Participants and Agency Descriptions

OEM coordinated with a variety of government organizations, public authorities, and private utility providers that have a stake or interest in natural hazard mitigation. The following agencies participated in the MPC.

conEdison	Renato Derech Dennis Connelly	NEW YORK CITY DOT	Alan Olmsted Tom Maguire Magdeline DeCamps Sharita Hunter
CUNY	Howard Apsan Bernard Jones	City of New York Parks & Recreation	Jon Ells Mike Dockett Jessenia Aponte
NYC PLANNING	Sarah Goldwyn Maryam Hariri Jessie Levin Reza Tehranifar	THE CITY OF NEW YORK DEPARTMENT OF SANITATION	John Chingas Gerald Carannante
NYC Citywide Administrative Services	Kevin DePodwin Brad Zoref	NYCEDC New York City Economic Development Corporation	Rich Cote Rory Melvin
DDC NEW YORK CITY DEPARTMENT OF DESIGN + CONSTRUCTION	Eric Macfarlane Sofia Zuberbuhler-Yafer Alek Pitel	FIRE DEPARTMENT CITY OF NEW YORK	Jeff Roth Caroline R. Kretz Anthony P. Migliore
NYC Environmental Protection	William Morris Alan Cohn Gregory Anderson	HHC NEW YORK CITY HEALTH AND HOSPITALS CORPORATION	Tamiru Mammo Susan Meehan
NYC Department for the Aging	Linda Whitaker Lenny James	NYC Department of Housing Preservation & Development	Vito Mustaciuolo Ann Marie Santiago
NYC Department of Homeless Services	Fernando Miranda Thomas Vanacore Glen Panazzolo	NYC Human Resources Administration Department of Social Services	Kathryn Dyjakk Lisa Montllor Macedo
NYC Buildings	Keith Wen Charles Shelhamer Daniel Cornwell Juan Arias	NYC BUILD IT BACK Stronger & Safer	Thaddeus Pawlowski
NYC Information Technology & Telecommunications	Lisa Templeton Joseph Gallagher	LIPA Long Island Power Authority	Nick Lizanich Salvatore Iraci Ken Kane

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The New York City LANDMARKS PRESERVATION COMMISSION	Cory Herrala Edith Bellinghausen
MTA *	Keyla Hammam Judy Walker
NEW YORK CITY HOUSING AUTHORITY	Douglas McNevin Matthew Nolty
POLICE DEPARTMENT CITY OF NEW YORK	Robert Harnischfeger James Wahlig Victor Ferrante Chris Matousek
THE CITY OF NEW YORK OFFICE OF CHIEF MEDICAL EXAMINER	Donnell Harvin Frank DePaolo
OEM New York City Office of Emergency Management	Amy Post Heather Roiter Melissa Umberger Gary Monitz Joshua Friedman
NYC Office of Environmental Remediation	Daniel C. Walsch Hannah Moore
planNYC	Carrie Grassi Erika Lindsey
OMB Office of Management and Budget	Jeff Garafalo Noreen Chambers Kerry Fristoe
THE PORT AUTHORITY OF NY & NJ	Bruce Swiren
RPA	Rob Pirani Laura Tolkoff
NYC Small Business Services	Al Miller Zarines Negron
US ARMY CORPS OF ENGINEERS	John Beldin-Quinones

*MTA members include New York City Transit (NYCT), MTA Bus Company, Long Island Rail Road (LIRR), Metro-North Railroad (MNR), and Bridges and Tunnels

Figure 4: Mitigation Planning Council (MPC) members

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iv. Community Involvement

To engage the community in the hazard mitigation planning process, the Planning Team developed a comprehensive community involvement strategy. The Planning Team first compiled a list of outreach contacts based on the following intended audiences: community boards, borough president's offices, the private sector, professional organizations, non-profits, and academics (see Figure 6). The Planning Team emailed newsletters notifying the general public about the update to the HMP and guiding them to the OEM website for more information on the plan. The Planning Team also created a hazard mitigation postcard to be distributed at public outreach meetings and Ready New York events. This postcard was also attached to the newsletters that were emailed to the general public.

Figure 5: Hazard Mitigation Postcard

In addition, the Planning Team created an online survey. The purpose of this survey was to gain a better understanding of the types of hazards that members of the general public feel pose a risk to the city as well as communicate actions that local communities can take to mitigate the impact of hazards and strategies that local, state, and federal government can implement to lessen disaster losses. The survey can be found in the appendix. The survey was posted to OEM's website on October 28 and sent to the following groups: Citizen Corps, Community Emergency Response Teams (CERT) teams, Partners in Preparedness members, Special Needs Advanced Warning System (AWS) contact list, the Special Needs Task Force, Volunteer Organizations Active in Disasters

(VOAD), community boards, borough presidents' offices, and academic institutions. There were more than 200 responses to the survey. A summary of the survey findings in addition to the full list of general public contacts can be found in the appendix.

Once a draft of the HMP was complete, it was posted on the OEM website for a 30-day public comment period (December 16, 2013 to January 16, 2014) and hard copies were available. To publicize the plan and elicit feedback, OEM sent email notifications to members of New York City's CERT teams, Citizen Corps Council, Partners in Preparedness members, elected officials, borough presidents' offices, community boards, academics, and non-profit organizations. The strategy the Planning Team employed to engage the public in the planning process is detailed below.

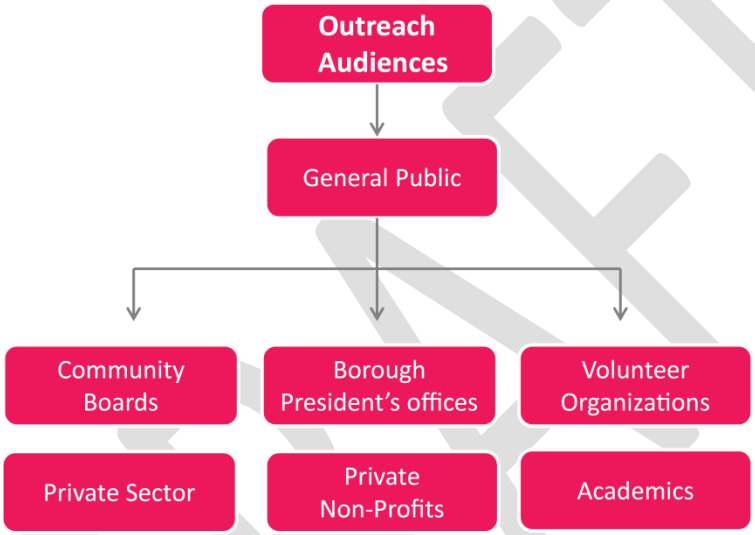

Figure 6: Hazard Mitigation Public Outreach Audiences

To engage academic, private sector, and community-based stakeholders, the Planning Team held four meetings designed to inform participants about hazard mitigation, generate discussion, and elicit feedback on the HMP. The meetings targeted New York City academic institutions, professional organizations and the private sector, community-based organizations, regional organizations, and non-profits.

1) Academic Institutions Meeting

On November 18, 2013, the Planning Team held a Hazard Mitigation Plan information session for academic institutions engaged in the fields of hazard mitigation, climate change, urban planning, architecture, and engineering. The Planning Team first

presented an overview of the HMP, which covered the planning process, the plan components, and the public review process.

The Planning Team then asked participants for feedback as well as suggestions for additional research and potential mitigation actions. Throughout the meeting, participants had the opportunity to ask questions and participate in the discussion. One topic of concern was the need to incorporate community organizations in the public outreach process and to include the mitigation strategies and projects these organizations are currently doing. The Planning Team addressed this topic, explaining that the mitigation actions of non-profits will be included in the narrative description in the Mitigation Strategy section of the plan and noting that the planning team would be coordinating a webinar for community groups in early December 2013. The Planning Team also explained that the public outreach process will continue in 2014 for an abridged version of the plan due in fall 2014. One meeting participant recommended that the city address an additional hazard: meteor crashes. To solicit additional comments and suggestions, all meeting invitees were notified when the draft HMP was available for review online.

Members from the following academic institutions attended this meeting: Columbia University (Center for Climate Systems Research/Graduate School of Architecture, Planning and Preservation/Mailman School of Public Health), CUNY Hunter College (Urban Planning), East Carolina University, Harvard University (Urban Planning), Manhattan College, New York University (NYU) (Center for Catastrophe Preparedness and Response/Polytechnic Institute/Wagner Graduate School of Public Service), Pratt Institute (City and Regional Planning), and Stevens Institute of Technology. The full invitee list is included in Appendix.

2) Private Sector and Professional Organizations Meeting

On November 13, 2013, the Planning Team held a community involvement meeting with representatives from New York City's private sector, professional organizations, and volunteer groups. This meeting was organized by OEM's Public Private Initiatives Unit, which regularly holds webinars for their Partners in Preparedness program. The Partners in Preparedness program helps organizations better prepare their employees, services, and facilities for disasters, and its members include private companies, institutions, and non-profit groups (see Appendix). At this meeting, the Planning Team provided an overview of the Hazard Mitigation Plan, covering the planning process, plan components, select hazard profile summaries, mitigation action types, and a timeline of major milestones. The presentation was followed by a question-and-answer period. Participants were asked for feedback on the work presented as well as suggestions on

how the Planning Team can help participants educate their members about hazard mitigation. The Planning Team will work with interested parties to help promote hazard mitigation through future working groups or mitigation discussions.

The following organizations RSVP'd to the webinar: Allied Rockaway Foundation for Animal Recreation and Fitness (ARF-ARF), American Red Cross, BNP Paribas, BNY Mellon, Brooklyn Bureau of Community Services, Building Owners & Managers Association of Greater NY, CIBC World Markets, CME Group, Cravath, Swaine & Moore LLP, CUNY Hunter College, Disney/ABC Television Group, Fordham University, Hippodrome, Institute for Business & Safety, Macy's, Marubeni America Corporation, Mass Mutual, Medical Reserve Corps, Neighborhood Housing Services of New York City, New York Law School, New York Life Insurance Company, NYC Amateur Radio Emergency Communication Service, NYC Clothing Bank, NYC Department Cultural Affairs (DCA), NYC DOE, NYC HHC, New York Liquidation Bureau (NYLB), NYSDEC Region 2, Orrick, Herrington & Sutcliffe, Remlu, Inc, RXR Realty, Shearman & Sterling LLP, St. Johns University, The New York Botanical Garden, The Walt Disney Company, Time Warner Cable, and Trinity Real Estate.

The full invitee list is included in the appendix. All meeting invitees were notified when the draft HMP was available for review online.

3) Non-Profit Organizations Meetings

On September 17, 2013 the Planning Team held a community involvement meeting with the New York City Citizen Corps Council. The Citizen Corps Council is part of a national initiative to bring together local leaders from community organizations, government agencies, the private sector, and volunteer programs to promote community preparedness and volunteerism. At the meeting, the Planning Team presented a brief overview of the HMP, which included a discussion of the hazards to be included in the plan and some of the mitigation actions identified by the MPC. The participants were asked for feedback as well as suggestions for improving the plan.

Several of the participants inquired about how local communities or neighborhoods can become more involved in developing mitigation practices. The Planning Team addressed this question by explaining the New York State Community Reconstruction Zone (CRZ) Program, which allows communities to identify safe, resilient, and innovative reconstruction projects based on community-driven plans that consider current damage, future threats, and the community's economic opportunities. A full list of the Citizen Corps members can be found in the appendix.

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On December 11, 2013, the Planning Team held a webinar with representatives of a variety of New York City community-based non-profit organizations and regional organizations. These organizations are a valuable resource for educating the public about hazard mitigation and actions the community can engage in to make New York City more disaster-resilient. After the presentation participants were given the opportunity to ask questions.

The following organizations were invited to the webinar event: Association for the Advancement of Blind and Retarded (AABR), Arch Care (health ministry of the Archdiocese of New York), Birch Family Services, Inc, Broad Channel Volunteer Fire Department and Ambulance Corps, Brookdale Hospital Medical Care, CARES, Inc., Central Family Life Center, Inc., Cerebral Palsy Association of NYS, Continuum Health Partners, Guild for Exceptional Children, Hamaspik of Kings County, Hebrew Academy for Special Children, Intrepid Museum, Jamaica Hospital Medical Center, Jewish Community Council of Greater Coney Island, Inc, Jewish Institute of Queens, Lutheran Medical Center, Mercy Home for Children, National Society Hebrew Day Schools, New York Hospital Queens, New York Presbyterian Hospital, NY eHealth Collaborative, NY Sandy Hook Pilots, Ohel Children's Home and Family Services, Providence Rest, Queens Borough Public Library, Regional Catastrophic Planning Grant Team, Rogosin Institute, Services for the Underserved, St John's University, Unique People Services, Womens League, Wyckoff Heights Medical Center, and YAI Network. For more information on these organizations please see the Appendix. All meeting invitees were notified when the draft HMP was available for review online.

4) Public Review

To engage the public in the planning and development of the HMP, the Planning Team posted the draft of the plan on the OEM website for a 30-day comment period beginning December 16, 2013 and concluding January 16, 2014. The website provided an online comment form for people to provide feedback.

The Planning Team coordinated with the New York City Citizens Corps Council to help publicize the plan and solicit feedback. The Citizen Corps newsletter made note of the HMP, and an email sent to Citizen Corps members introduced the plan and solicited comments. The Planning Team also notified local elected officials, including members of the New York City Council and the borough presidents, when the plan was available for comment.

The Planning Team documented and reviewed comments received during the official comment period for inclusion in the 2014 HMP. Comments received after the 30-day

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period will be discussed at annual mitigation planning meetings and considered for inclusion in the next update of the HMP.

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3. Hazard Mitigation Plan Development

The HMP consists of two major sections, Risk Assessment and Mitigation Strategy. These sections were developed by following the purposeful process described here.

A. Review and Incorporation of Existing Plans and Studies

The Planning Team members reviewed various plans, studies, and guides to begin developing the HMP. These plans included New York City's 2009 HMP along with comparable plans from surrounding jurisdictions and other cities; FEMA guidance documents; emergency-services documents; contingency plans; climate change studies; community plans; and federal, local, and state regulations and ordinances (see Table 4).

Figure 7: Plans, Studies, and guides that aided the development of the HMP

Plans/Studies/Guides	Author
VISION 2020 New York City Comprehensive Waterfront Plan	DCP
Urban Waterfront Adaptive Strategies	DCP
Designing for Flood Risk	DCP
New York City Zoning Resolution	DCP
Planning Population: Projecting the Future	DCP
History of New York City's Water Supply System	DEP
NYC Green Infrastructure Plan	DEP
Drought Management Contingency Plan 2012	DEP
Downstream Flooding Reduction Program	DEP
Reservoir Release Notification Plan	DEP
New York City Construction Code	DOB
Pandemic Influenza: Preparedness and Response Plan	DOHMH
Vital Signs: Deaths Associated with Heat Waves in 2006	DOHMH
FEMA's How-to-Guide(Series 386-1, 2, 3, 4 and 5)	FEMA
Hazard Mitigation Planning	FEMA
Integrating Manmade Hazards Into Mitigation Planning 2003	FEMA
Local Mitigation Handbook	FEMA
National Flood Insurance Program	FEMA
NFIP Community Rating System	FEMA
Local Mitigation Planning Handbook	FEMA
Post-Sandy Housing Reconstruction Analysis	FEMA/HRO
NYC Build it Back	HRO
Nassau County Hazard Mitigation Plan	Nassau County OEM

Plans/Studies/Guides	Author
State of New Jersey 2011 Hazard Mitigation Plan	New Jersey OEM
Waterfront Action Agenda (WAVES)	NYC EDC
Flood Mitigation Taskforce Stormwater Mitigation Study Area Report	New York City Mayor's Office
Hurricane Sandy After Action: Report and Recommendations to Mayor Michael R. Bloomberg	New York City Mayor's Office
2014 New York State Multi-Hazard Mitigation Plan (Draft)	NYS OEM
New York City Urban Area: Materials and Background Information for the Threat and Hazard Identification and Risk Assessment (THIRA)	NYC Urban Area Working Group: NYC, Westchester, Nassau, Suffolk, Port Authority, MTA, Yonkers
New York State Coastal Erosion Act	NYSDEC
New York State Coastal Erosion Map	NYSDEC
Citywide Interagency Management System (CIMS) Protocol	OEM
Coastal Storm Plan	OEM
Flash Flood Plan	OEM
Heat Emergency Plan	OEM
H1N1 Playbook	OEM
Power Disruption	OEM
Radiological Response and Recovery Plan (RRRP)	OEM
Winter Weather Emergency Plan (WWEP)	OEM
Cyber Incident Response Protocol	OEM
PlaNYC: A Greener, Greater New York	OLTPS
NYC Special Initiative for Rebuilding and Resiliency (SIRR)	OLTPS, EDC
Parks Department Parkland Plan	DPR
Local Waterfront Revitalization Plans - Consistency Review	DPR
Commonwealth of Pennsylvania 2010 Standard All-Hazard Mitigation Plan	Pennsylvania
Sandy Regional Assembly Recovery Agenda	Sandy Regional Assembly
Suffolk County Multi-Jurisdictional Multi-Hazard Mitigation Plan October 2008	Suffolk County, NY
Flooding and Land Use Planning: A Guidance Document for Municipal Officials and Planners	Westchester County Department of Planning
Westchester County Comprehensive Emergency Management Plan	Westchester County, NY
Threat and Hazard Identification and Risk Assessment Guide 2012	US DHS

Table 1: Existing Plans and Studies Relevant to Hazard Mitigation in New York City

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B. Development of the Risk Assessment Section of the HMP

To develop the Risk Assessment section of the plan, the Planning Team followed these steps:

i. Identifying Hazards

To determine which hazards to profile in the HMP update, the Planning Team reviewed the 2009 HMP and examined the hazards profiled in the draft 2014 New York State Standard Multi-Hazard Mitigation Plan (NYS HMP). With this preliminary review as a starting point, the Planning Team researched numerous natural hazard resources to determine the hazards that have the potential to occur in New York City.

To gain a better understanding of the non-natural hazards that may pose a threat to the city, the Planning Team reviewed plans that profile non-natural hazards; these include plans for New Jersey, San Francisco, Pennsylvania, and Seattle. In addition, the Planning Team also consulted the New York City Urban Area Working Group's *Threat and Hazard Identification and Risk Assessment* (THIRA) report. The Planning Team also conducted its own research on non-natural hazards that affect New York City. Specifically, OEM worked with the Watch Command Unit to identify non-natural hazards that have impacted New York City in the past 11 years by reviewing Notify NYC messaging and Emergency Operations Center (EOC) activations.

The Planning Team then distributed a hazard selection worksheet to Steering Committee members to determine which hazards may affect their facilities or operations and gain consensus on the hazards to be included in the 2014 HMP. The Planning Team eliminated some hazards addressed in the draft 2014 NYS HMP because they were either outside the scope of the plan or do not impact New York City. The final list of natural hazards chosen to be included in the New York City HMP are: coastal erosion; coastal storms; disease outbreaks; drought; earthquakes; extreme temperatures; flooding; severe weather; wildfires; and winter storms. The non-natural hazards are chemical biological, radiological, and nuclear releases; cyber threats; and infrastructure failures.

ii. Profiling Hazards

In the report, the hazard profiles are divided into two main components: hazard description and vulnerability assessment. The hazard description provides a general description of the hazard as well as an analysis of the severity, probability of occurrence, location, and historical occurrences. The vulnerability assessment examines how the hazard impacts the social, built, natural, and future environments. For most of the hazards, climate change will play a significant role in determining future vulnerability.

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To ensure the Risk Assessment section contains the most accurate information, the Planning Team reviewed local and state hazard mitigation plans and natural and non-natural hazard-related publications, and it also consulted with hazard-specific experts.

iii. Estimating Potential Losses

The Risk Assessment section includes potential loss estimates for New York City for each hazard. HAZUS-MH, a nationally applicable standardized methodology and software program, generated potential loss estimates for earthquakes, coastal storms, and floods. OEM GIS specialists and the Planning Team employed a variety of methods to generate loss estimates for the remaining hazards, like estimating exposure, identifying vulnerable populations, frequency of past occurrences, and mapping infrastructure. The Risk Assessment section details the methodology and potential loss estimates for the hazards.

C. Development of the Mitigation Strategy section of the HMP

Developing the Mitigation Strategy section of the HMP involved the following steps:

i. Establishing Goals and Objectives

Using information from the draft 2014 NYS HMP, hazard profiles, and community meetings, the Planning Team drafted a set of goals and objectives that represent New York City's long-term vision for reducing the impact of natural and non-natural hazards on the built environment and the city's population. The Planning Team distributed the draft goals and objectives to the Steering Committee for review and comments. Mitigation goals were also presented at community involvement meetings. Based on feedback, the Planning Team produced a final set of five goals (see all 28 objectives in the Mitigation Strategy section of the report).

Figure 8: Hazard Mitigation Goals

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ii. Identifying Preliminary Mitigation Actions

The MPC was the designated entity for identifying preliminary mitigation actions. At its kickoff meeting, Commissioner Joseph Bruno (OEM) and Commissioner Amanda Burden (DCP) made opening remarks concerning the importance of mitigation planning and OEM and DCP's collaboration in the report. Marc Ricks of the Special Initiative for Rebuilding and Resiliency (SIRR) described the findings and recommendations from *PlanNYC: A Stronger, More Resilient New York*, which provide underpinnings for the HMP. Heather Roiter Damiano (OEM) presented on the components of the HMP and the expectations for MPC members, and Thaddeus Pawlowski (DCP) presented on the Flood Resiliency Design Manual and DCP's role in the HMP update. At the conclusion of the meeting, the MPC members were given mitigation action worksheets to take back to their agencies to identify current and potential projects that aim to reduce the impact of natural and non-natural hazards.

Mitigation Action Worksheets

MPC members were asked to use the following criteria to identify mitigation actions for the mitigation action worksheets: mitigates against one or more of the 13 natural or non-natural hazards profiled in the HMP and falls under one of the six FEMA mitigation categories (prevention, property protection, public education and awareness, natural resource protection, emergency services, and structural projects), and achieves one or more of the five hazard mitigation goals and 28 objectives. For each mitigation action, agencies identified: the lead agency; "existing" or "potential" projects (existing projects are those with funding in place and ongoing strategies, whereas potential actions are projects agencies would like to implement and for which they are seeking funding); relevant hazard(s); project type; and project description. Agencies were also asked to use the mitigation action worksheets to report on the status of actions that were the result of the 2009 HMP.

Agency One-on-One Meetings

After receiving the completed mitigation actions worksheets from the MPC agencies, the Planning Team cross-referenced the actions with ongoing city resiliency initiatives. These initiatives included *PlaNYC: A Stronger, More Resilient New York* recommendations and Hazard Mitigation Grant Program (HMGP) applications. The Planning Team then scheduled one-on-one meetings with each agency to review actions and recommend including any additional actions identified in the city's ongoing resiliency initiatives.

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These meetings were a valuable opportunity for each agency to ask specific questions and gain a better understanding of how their operations relate to hazard mitigation. The Planning Team also gained a better understanding of the mitigation actions proposed by the agencies. During each meeting, the participants determined what, if any, modifications were necessary to the text and/or content of the worksheet and if there were additional mitigation actions the agency could undertake in the future. Agencies were then tasked with re-submitting the mitigation actions to include support agencies, timeline, project costs, funding, and action progress status (for actions from the HMP 2009). In total, the Planning Team conducted 32 one-on-one meetings.

Following the meetings, agencies reviewed their submissions, made appropriate corrections and additions, and resubmitted a revised list of mitigation actions for incorporation into the HMP.

iii. Finalizing Mitigation Actions

Upon receiving the revised mitigation action worksheets from the MPC agencies, the Planning Team compiled a list of 293 existing mitigation actions and 333 potential actions based on consistency with mitigation funding guidelines and relevancy to natural and non-natural hazard mitigation.

iv. Evaluating Mitigation Actions

The Planning Team and Steering Committee performed a qualitative analysis of the potential 333 mitigation actions. The Planning Team and Steering Committee used FEMA's Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) analysis to understand the opportunities and constraints for implementing the potential mitigation actions. See the Mitigation Strategy section for the full results of the STAPLEE analysis.

v. Prioritizing Mitigation Actions

In accordance with the FEMA requirements, the Planning Team prioritized mitigation actions to maximize benefits with consideration for potential costs. The Planning Team devised a prioritization methodology using the seven STAPLEE criteria as well as the number of objectives each action addressed, project cost, and project timeframe. Based on these criteria, the potential mitigation actions received a numerical ranking that translated to a high, medium, or low priority (see the Mitigation Strategy section for a detailed explanation of the prioritization process). The prioritization rankings generated by the methodology are dynamic and can change because of funding availability, revisions to the mitigation actions, or changing city conditions. The Steering Committee will work closely with New York State Office of Emergency Management (NYS OEM) and

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FEMA to secure funding for mitigation actions that are in accordance with the goals and objectives of this plan.

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3. Plan Development Meetings

Due to Hurricane Sandy, the planning process for updating the HMP was delayed for several months. Therefore, the Planning Team initiated the 2014 New York City HMP development in January 2013 and concluded the process into December 2013. During this timeframe, the Planning Team coordinated and participated in 79 plan development meetings and discussions with agencies and public stakeholders, held one-on-one meetings with nearly all MPC members, devised and implemented a community involvement strategy, and drafted the sections of the HMP. The Planning Team held bi-weekly meetings, and met numerous times throughout the planning process on specific planning issues.

In addition, the Planning Team and MPC members worked on many Sandy-related resiliency recovery initiatives throughout this plan development process.

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4. Meeting Documentation

The table below documents the meetings that took place during the planning process of the HMP (with the exception of the weekly plan development meetings). It includes the date meetings occurred, the purposes for the meetings, participants, any outcomes generated from the meetings, and the appropriate section of the plan to which the meeting relates.

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Meeting Documentation

Section II: Planning Process

Meeting #	Date	Meeting Purpose	Participants	Notes	Relevant Plan Section
1	1/9/2013	Planning Team	NYC DCP, NYC OEM, Mayor's Office of Housing Recovery, OLTPS	●Discuss new federal and state requirements ●Discuss planning for steering committee and mitigation planning council	Planning Process
2	2/6/2013	Planning Team	NYC DCP, NYC OEM, Mayor's Office of Housing Recovery, OLTPS	●Discuss new federal and state requirements ●Discuss planning for steering committee and mitigation planning council ●Discuss Hazard Selection ●Discuss work plan	All
3	3/13/2013	Planning Team	NYC DCP, NYC OEM, Mayor's Office of Housing Recovery, OLTPS	●Discuss planning for steering committee and mitigation planning council ●Discuss Hazard Selection ●Discuss work plan	All
4	3/20/2013	Planning Team	NYC DCP, NYC OEM, Mayor's Office of Housing Recovery, OLTPS	●Discuss new federal and state requirements ●Discuss planning for steering committee and mitigation planning council ●Discuss Hazard Selection ●Discuss how city resiliency initiatives can be integrated in the HMP	All
5	5/17/2013	Planning Team	NYC DCP, NYC OEM, Mayor's Office of Housing Recovery, OLTPS	●Discussed FEMA and NYS OEM requirements for updating the Mitigation Plan ●Discussed Steering Committee and draft letter from Commissioners from OEM and DCP	All
6	5/23/3013	Planning Team	NYC DCP, NYC OEM, Mayor's Office of Housing Recovery, OLTPS	●Discuss work plan schedule ●Letter from Commissioners and MPC Meeting Logistics ●Annex Coastal Construction Design Guidelines	All

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Section II: Planning Process

Meeting #	Date	Meeting Purpose	Participants	Notes	Relevant Plan Section
7	6/5/2013	Planning Team	NYC DCP, NYC OEM, Mayor's Office of Housing Recovery, OLTPS	●Hazard Mitigation logo/branding ●HMP 1 Pager ●MPC Kickoff (6/18) agenda, presentation/messaging/DCP tasks ●MPCSC Kick Off: when to schedule and goal of the meeting	Section 1: Planning Process
8	6/12/2013	Planning Team	NYC DCP, NYC OEM, Mayor's Office of Housing Recovery, OLTPS	●MPC Kickoff Presentation ●HMGP Grants ●Logo and Branding	Section 1: Planning Process
9	6/17/2013	Planning Team	NYC DCP, NYC OEM	●MPC Kickoff Presentation	Section 1: Planning Process
10	6/18/2013	MPC Kickoff	MPC	●SIRR Presentation ●HMP Planning Process/Role of MPC ●Mitigation Actions Worksheet Homework	All
11	6/26/2013	Planning Team	NYC DCP, NYC OEM	●MPC Mitigation Actions Homework ●MPC SC Meeting ●Risk Profile Outline/Deadline	All
12	6/28/2013	Planning Team	NYC OEM, OLTPS	●OLTPS Deliverables ●Timeline	All
13	7/19/2013	Planning Team	OEM, DCP, OLTPS	●MPC SC Meeting Agenda ●Goals & Objectives ●Capabilities Assessment	Section 1: Planning Process
14	7/24/2013	GIS/Planning Team	OEM & DCP	●Mapping Template Design ●Data Consistency ●HAZUS-MH methodology	Section 3: Risk Assessment
15	7/25/2013	CUNY's Mitigation Actions	OEM & CUNY	●Discussion CUNY's Mitigation Actions ●Potential Mitigation Actions	Section 4: Mitigation Strategy
16	7/26/2013	MPC Steering Committee Kickoff Meeting	MPCSC	●Select Hazards ●Establish Goals and Objectives ●Discuss current capabilities	Section 3: Risk Assessment Section 4: Mitigation Strategy

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Meeting Documentation

Section II: Planning Process

Meeting #	Date	Meeting Purpose	Participants	Notes	Relevant Plan Section
17	7/26/2013	Flood Risk Assessment	OEM, DCP, OLTPS	●Discuss Flood Risk Assessment Approach ●Divide Tasks ●Review NYS Requirements	Section 3: Risk Assessment
18	8/6/2013	DOHMH Mitigation Actions/Risk Assessment	OEM, DOHMH	●Discuss Mitigation Actions ●Discuss DOHMH resources for Risk Assessment	Section 3: Risk Assessment Section 4: Mitigation Strategy
19	8/8/2013	MTA MNR Mitigation Actions	OEM, MTA MNR	●Discuss Mitigation Actions	Section 4: Mitigation Strategy
20	8/9/2013	MTA B&T Mitigation Actions	OEM, MTA Bridge and Tunnels	●Discuss Mitigation Actions	Section 4: Mitigation Strategy
21	8/9/2013	DEP Mitigation Actions	DEP & OEM	●Discuss Mitigation Actions	Section 4: Mitigation Strategy
22	8/12/2013	RPA Public Outreach	OEM, DCP, RPA	●Discuss public outreach strategies ●Determine ways to leverage RPA's contacts and initiatives	Section 1: Planning Process
23	8/12/2013	DPR Mitigation Actions	DPR & OEM	●Discuss Mitigation Actions ●Discuss Risk Assessment for Wild Fires (occurrences and location)	Section 3: Risk Assessment Section 4: Mitigation Strategy
24	8/16/2013	DOC Mitigation Actions	DOC & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
25	8/16/2013	USACE Mitigation Actions	USACE & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
26	8/21/2013	DOB Mitigation Actions	DOB & OEM	●Discuss Mitigation Actions and next steps ●Discuss Risk Assessment Severe Weather and Earthquakes on the Built Environment	Section 3: Risk Assessment Section 4: Mitigation Strategy
27	8/21/2013	Planning Team	OEM, DCP, OLTPS	●Updates on Risk Profiles ●Public Outreach Strategy	Section 1: Planning Process Section 3: Risk Assessment
28	8/21/2013	FDNY Mitigation Actions	FDNY & OEM	●Discuss Mitigation Actions ●Discuss Risk Assessment for Wild Fires (occurrences and location)	Section 3: Risk Assessment Section 4: Mitigation Strategy

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Meeting #	Date	Meeting Purpose	Participants	Notes	Relevant Plan Section
29	8/22/2013	DoITT Mitigation Actions	DoITT & OEM	●Discuss Mitigation Actions ●Discuss Risk Assessment for Cyber Threats	Section 3: Risk Assessment Section 4: Mitigation Strategy
30	8/22/2013	NYCHA Mitigation Actions	NYCHA & OEM	●Discuss Mitigation Actions ●Discuss Vulnerability Assessment for Power Failures and Coastal Storms and Flooding	Section 3: Risk Assessment Section 4: Mitigation Strategy
31	8/22/2013	NYCEDC Mitigation Actions	NYCEDC & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
32	8/26/2013	HRA Mitigation Actions	HRA & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
33	8/26/2013	PANYNJ Mitigation Actions	PANYNJ & OEM	●Discuss Mitigation Actions ●Discuss Risk Assessment for Infrastructure Failures	Section 3: Risk Assessment Section 4: Mitigation Strategy
34	8/27/2013	NYC DOT Mitigation Actions	NYC DOT & OEM	●Discuss Mitigation Actions ●Discuss Risk Assessment for Infrastructure Failures	Section 3: Risk Assessment Section 4: Mitigation Strategy
35	8/27/2013	Con Edison Mitigation Actions	Con Ed & OEM	●Discuss Mitigation Actions ●Discuss Risk Assessment for Utility Disruptions	Section 3: Risk Assessment Section 4: Mitigation Strategy
36	8/28/2013	LPC Mitigation Actions	LPC & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
37	8/28/2013	HHC Mitigation Actions	HHC & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
38	8/28/2013	DFTA Mitigation Actions	DFTA & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
39	8/29/2013	DCAS Mitigation Actions	DCAS & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
40	8/29/2013	DDC Mitigation Actions	DDC & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
41	8/30/2013	SBS Mitigation Actions	SBS & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy
42	9/9/2013	DHS Mitigation Actions	DHS & OEM	●Discuss Mitigation Actions and next steps	Section 4: Mitigation Strategy

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Meeting Documentation

Section II: Planning Process

Meeting #	Date	Meeting Purpose	Participants	Notes	Relevant Plan Section
43	9/10/2013	Public Outreach to private sector	OEM (T&I) and OEM (Public Private)	●Discuss strategies for public engagement with private sector (webinars and eblasts)	Section 1: Planning Process
44	9/10/2013	Public Outreach to Neighborhood Groups	OEM (T&I) and OEM (CERT)	●Discuss strategies for public engagement with CERT Teams (Awareness Training and RNY Events)	Section 1: Planning Process
45	9/10/2013	Mitigation Strategies OEM Human Services	OEM (T&I) and OEM (Human Services)	●Discuss state's requirements and OEM's strategies for evacuation of special needs communities, pets, and sheltering (ADA compliant)	Section 3: Mitigation Actions
46	9/11/2013	OER Mitigation Actions	OER & OEM	●Discuss Mitigation Actions ●Discuss Risk Assessment for Hazardous Waste Release	Section 3: Risk Assessment Section 4: Mitigation Strategy
47	9/11/2013	Mitigation Strategies OEM External Affairs	OEM (T&I) and OEM (External Affairs)	●Discuss External Affairs Mitigation Actions	Section 4: Mitigation Strategy
48	9/11/2013	Bi-weekly check in with Planning Team	OEM, OLTPS, and DCP	●Discuss public outreach ●Discuss Risk Assessment ●Discuss next Steering Committee Meeting	All
49	9/11/2013	Mitigation Actions OEM Watch Command	OEM (T&I) and OEM (Watch Command)	●Discuss Watch Command Mitigation Actions ●Discuss Hazardous waste release historic occurrence data	Section 3: Risk Assessment Section 4: Mitigation Strategy
50	9/12/2013	Mitigation Actions MTA Buses	OEM and MTA (buses)	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions
51	9/12/2013	Mitigation Actions OEM Strategic Data	OEM (T&I) and OEM (Strategic Data)	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions
52	9/13/2013	LIRR Mitigation Actions	OEM and MTA (LIRR)	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions
53	9/13/2013	Mitigation Actions OEM Technology	OEM (T&I) and OEM (Technology)	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions
54	9/16/2013	Mitigation Actions DCP	OEM and DCP	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions

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Meeting #	Date	Meeting Purpose	Participants	Notes	Relevant Plan Section
55	9/16/2013	Housing Requirement OEM (Housing Unit)	OEM (T&I) and OEM (Housing)	●Discuss NYS Requirement 3a and 3b (identify sites for temporary housing and potential sites for relocating housing)	Section 3: Mitigation Actions
56	9/17/2013	Mitigation Actions OEM (Operations)	OEM (T&I) and OEM (Operations)	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions
57	9/17/2013	Mitigation Actions OLTPS	OEM & OLTPS	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions
58	9/17/2013	HMP Checkin FEMA	OEM/OLTPS/FEMA	●Provide updates on the HMP Plan	All Sections
59	9/17/2013	Public Outreach to Citizen Corps on Mitigation	OEM/Citizen Corps	●Provide an overview of the Hazard Mitigation Plan Process	All Sections
60	9/18/2013	MTA - Subways Mitigation Actions	OEM/MTA (Subways) (HQ)	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions
61	9/18/2013	Interagency check-in with the Commissioner (OEM)	OEM Mitigation Team/T&I Director/Commissioner Bruno	●Provide updates on the HMP Plan	All Sections
62	9/18/2013	Planning Team Check-in on the NYC Hazard Environment and Risk Assessment Chapter	OEM/DCP	●Check in for consistency on content for this section	Section 2: Risk Assessment
63	9/18/2013	OCME Discussion on participating in the HMP Update	OCME/OEM	●Provided an overview of the plan ●Discussed participation ●Discussed Next Steps	All Sections
64	9/19/2013	OEM Special Needs Task Force	Special Needs Task Force/OEM	●Provided an overview of the plan ●Requested any information they may have on the impact of hazards on special needs populations for the risk assessment section	All Sections
65	9/23/2013	HPD Mitigation Actions	OEM/HPD	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions
66	9/24/2013	LIPA Mitigation Actions	LIPA/OEM	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions

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Meeting Documentation

Section II: Planning Process

Meeting #	Date	Meeting Purpose	Participants	Notes	Relevant Plan Section
67	9/30/2013	DSNY Mitigation Actions	DSNY/OEM	●Discuss Mitigation Actions and next steps	Section 3: Mitigation Actions
68	10/2/2013	Bi-weekly check in with Planning Team	OLTPS/OEM/DCP	●Go over MPC SC presentation ●Go over MPC SC Risk Assessment Review Process ●Public Outreach	Section 1: Planning Process Section 2: Risk Assessment
69	10/3/2013	MPC SC Meeting 2	MPCSC	• Review Goals and Objectives of the Hazard Mitigation Plan • Discuss final Hazard Selection • Overview of Hazard Profiles: Highlights of selected hazards • Discuss next steps for reviewing hazard profiles	Section 2: Risk Assessment
70	10/16/2013	Planning Team	OLTPS/OEM/DCP	●Review HMP timeline ●Discuss Mitigation Actions ●Overview of STAPLEE ●Discuss Prioritization of Mitigation Actions ●Discuss Upcoming Meeting	Section 3: Mitigation Actions
71	11/1/2013	Planning Team	OLTPS/OEM/DCP	●Review HMP timeline ●MPC SC meeting prep ●Private Sector and Academic prep	All
72	11/6/2013	MPC SC Meeting 3	MPCSC	●Mitigation Strategy ●Analyzing and Prioritizing Mitigation Actions	Section 3: Mitigation Strategy
73	11/12/2013	Planning Team	OLTPS/OEM/DCP	●Review HMP timeline ●Private Sector and Academic prep	All
74	11/13/2013	Private Sector Webinar	OEM Partners in Preparedness	●Overview of the HMP ●Risk Profiles - Summary of select hazards ●Mitigation Action Types ●Timeline - Public Review	All

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Meeting #	Date	Meeting Purpose	Participants	Notes	Relevant Plan Section
75	11/18/2013	Academic Outreach	Columbia, Pratt, NYU, Hunter, Stony Brook etc.	●Overview of the HMP ●Risk Profiles ●Mitigation Action Types ●Timeline - Public Review	All
76	12/4/2013	Planning Team	OLTPS/OEM/DCP	●Review HMP timeline ●MPC Closeout Prep ●PNP Closeout Prep ●Public Review	All
77	12/9/2013	MPC Close Out	MPC	●HMP Overview ●Hazard Profile Summary ●Mitigation Strategy Findings ●Public Review	All
78	12/11/2013	PNP Webinar	Private Non Profits	●Overview of the HMP ●Risk Profiles - Summary of select hazards ●Mitigation Action Types ●Timeline - Public Review	All

Table 2: Hazard Mitigation Plan Meeting Tracker

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SECTION III: HAZARD RISK ASSESSMENT

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Section III: Hazard Risk Assessment

1. **Introduction to the Risk Assessment**
2. **Hazard Identification**
3. **Hazard Risk Assessment Organization**
4. **New York City's Hazard Environment**
5. **Coastal Erosion**
6. **Coastal Storms**
7. **Disease Outbreaks**
8. **Drought**
9. **Earthquake**
10. **Extreme Temperatures**
11. **Flooding**
12. **Hurricane Sandy Retrospective Analysis**
13. **Severe Weather: Thunderstorms, Tornadoes, and Windstorms**
14. **Wild Fires**
15. **Winter Storms**
16. **Chemical, Biological, Radiological, and Nuclear (CBRN)**
17. **Cyber Threats**
18. **Infrastructure Failures**

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Section III: Hazard Risk Assessment

1. Introduction

What would happen if a hazard event occurred in New York City? That is the fundamental question that fuels the hazard mitigation planning process—and it is also the question that this section of the report begins to address. The first step in planning for hazards is to assess the risks from them. This risk assessment involves evaluating the vulnerability of people, buildings, and infrastructure to estimate the potential loss of life, personal injury, economic losses, and property damage that may result.

A. The Risk Assessment process

To meet Federal Emergency Management Agency (FEMA) and New York State Office of Emergency Management (NYS OEM) requirements, the Hazard Mitigation Planning Team (Planning Team), composed of representatives of the New York City Office of Emergency Management (OEM), Department of City Planning (DCP), and Mayor's Office of Long-Term Planning and Sustainability (OLTPS), used a risk assessment process consistent with the procedures and steps presented in FEMA's How-To-Guide "Understanding Your Risks: Identifying Hazards and Estimating Losses." The four steps in the risk assessment process are:

- Determine which hazards pose a serious risk to New York City
- Describe what these hazards can do to physical, social, and economic assets of New York City
- Identify which areas of New York City are most vulnerable to damage from these hazards
- Determine damages that may result from the identified hazards

The Planning Team's four-step risk assessment process is shown in Figure 1.

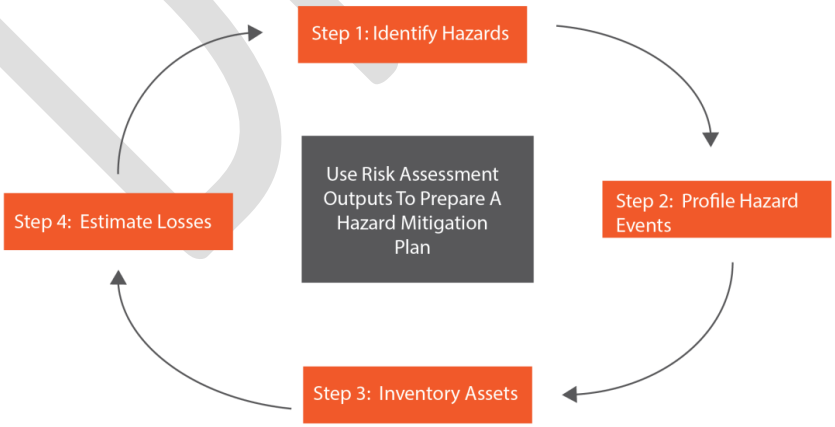

Figure 1: Risk Assessment Process

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B. FEMA and NYS OEM Requirements Addressed in this Section

The following FEMA requirements are addressed in this section:

- **FEMA Requirement §201.6(c)(2)(i):** [The risk assessment ***shall*** include a] description of the type… of all natural hazards that can affect the jurisdiction.

  [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan ***shall*** include information on previous occurrences of hazard events and the probability of future hazard events.

- **FEMA Requirement §201.6(c)(2)(ii):** [The risk assessment ***shall*** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph §201.6(c)(2)(i). This description ***shall*** include an overall summary of each hazard and its impact on the community.

  [The risk assessment] ***must*** also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.

- **FEMA Requirement §201.6(c)(2)(ii)(A)**: [The plan ***should*** describe vulnerability in terms of types and numbers of] existing and future buildings, infrastructure, and critical facilities located in the identified hazard area….

- **FEMA Requirement §201.6(c)(2)(ii)(B):** [The plan ***should*** describe vulnerability in terms of types and numbers of an] estimate of the potential dollar losses to vulnerable structures identified in §201.6(c)(2)(ii)(A) of this description the methodology used to prepare the estimate….

- **FEMA Requirement §201.6(c)(2)(ii)(C)**: [The plan ***should*** describe vulnerability in terms of types and numbers of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

The following NYS OEM requirements are addressed in this section:

- **NYS OEM Requirement §2:** The plan ***should*** identify any critical facility that has ever sustained flooding, even if it is not located in the 100-year floodplain on a current (adopted) or draft FEMA Flood Insurance Rate Map (FIRM). The plan should also analyze and document:

  1. The original problem and the estimated annual damages.

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- **NYS OEM Requirement §6:** The plan ***should*** take into account how climate change may affect their vulnerability to the following hazards, specifically the increased frequency or occurrence and/or severity for: Flooding, Wildfire, Drought and Extreme Temperatures.

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2. Hazard Identification

The first step in the risk assessment process is to identify hazards to include in the plan. To initiate this determination, the Planning Team, with input from the Mitigation Planning Council Steering Committee (Steering Committee), identified an initial list of hazards that could potentially impact the city and then selected the hazards of greatest concern for further profiling and analysis.

A. Potential Hazards

Since New York is such a large and dynamic city, it faces a broad spectrum of hazards, many of which are also caused or exacerbated by human activities. During the hazard identification process for the 2009 Natural Hazard Mitigation Plan (HMP), the Planning Team considered the full range of natural hazards identified in the 2008 New York State Multi-Hazard Mitigation Plan (NYS HMP) and made a few minor alterations, which included wording and organization, to produce a comprehensive natural hazard list. For this 2014 plan update, the Planning Team decided to expand upon this list, adding "non-natural" hazards to the required natural hazards.

To identify a preliminary list of non-natural hazards, as well as develop and refine its working list of natural hazards, the Planning Team reviewed existing plans from other local, regional, and national jurisdictions. The Planning Team also reviewed historic activations of the OEM Emergency Operations Center (EOC). Table 1 lists the full range of natural hazards that the Planning Team considered for inclusion in the HMP, and Table 2**: Non-natural Hazards Considered for Inclusion in the 2014 HMP, with Descriptions**

lists the full range of non-natural hazards.

Hazard	Description
Coastal erosion	Loss or displacement of land along the coastline due to the action of wind, waves, currents, tides, runoff of surface waters, or groundwater seepage
Coastal storms	Includes tropical cyclones (tropical storms and hurricanes) and nor'easters.
Dam failure	An uncontrolled release of impounded water resulting in downstream flooding.
Disease outbreaks	When disease cases exceed what would normally be expected in a defined community, geographic area, or season.
Drought	A prolonged period with below average precipitation.

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2. Hazard Identification

Section III: Hazard Risk Assessment

Hazard	Description
Earthquake	A sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface.
Extreme temperatures	*Extreme Heat:* Summertime temperatures that are well above average, usually combined with high levels of humidity. A heat wave is defined as three or more days with temperatures at or above 90°F. *Extreme Cold:* Wintertime temperatures that drop well below normal in an area.
Floods	A general and temporary condition of partial or complete inundation on normally dry land.
Hailstorms	Shower-like precipitation in the form of irregularly shaped ice pellets falling from a thunderstorm.
Landslides	The downward and outward movement of slope-forming materials reacting to the force of gravity.
Land subsidence	Depressions, cracks, and sinkholes in the earth's surface, which can threaten people and property.
Tornadoes/windstorms	Tornadoes are local atmospheric storms, generally of short duration, formed by winds rotating at very high speeds, usually in a counterclockwise direction, with vortices visible to the observer as whirlpool-like columns of winds rotating about a hollow cavity or funnel. Windstorms are non-rotating, straight-line winds which can knock down trees and power lines and cause damage to structures.
Wildfires	Uncontrolled burning in grasslands, brush, or woodlands, which can eventually spread to the built environment.
Winter storms	Ice storms, heavy snow, and blizzards, often accompanied by extreme cold. Heavy snow generally means snowfall accumulating to 6 inches or more in depth in 12 hours or less, or snowfall accumulating to 8 inches or more in depth in 24 hours or less. A blizzard has winds of 35 miles per hour or more with snow and blowing snow, reducing visibility to less than 1/4 mile for at least three hours.

Table 1: Natural Hazards Considered for Inclusion in the 2014 HMP, with Descriptions

Hazard	Description
Air contamination	Poor air quality resulting from a high concentration of primarily industrial pollutants (including particulate matter and ozone) near the ground.
Aviation incidents	Accidents involving aircraft departing from or arriving at the either Kennedy or LaGuardia Airports, which cause or have the potential to cause injury or loss of life.
Building collapses/fires/explosions	Damage to or destruction of a building resulting from collapse, fire, or explosion.

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2. Hazard Identification

Section III: Hazard Risk Assessment

Hazard	Description
Civil unrest	A public crisis that occurs without warning and may adversely impact a significant portion of the population.
Cyber threats	An adverse event in an information system or network in which the digital infrastructure of a person or organization is compromised.
Release of chemical, biological, radiological, or nuclear materials (CBRN)	A situation in which hazardous materials are released into the environment, causing a threat to human health and safety.
Infrastructure failure	Failure of the infrastructure systems—including transportation, water, and wastewater—to perform their intended functions.
Utility disruptions	Disruptions to essential utilities, including energy (electric, gas and steam) and communications.

Table 2: Non-natural Hazards Considered for Inclusion in the 2014 HMP, with Descriptions

B. Hazard Selection Process

i) Existing Plans and Procedures

When considering which hazards to include in the HMP, the Planning Team identified the City's existing emergency plans and procedures that address both natural and non-natural hazards. OEM and other City agencies have plans and procedures in place for many natural hazards, including coastal storms, drought, extreme temperatures, floods, tornadoes/windstorms, and winter storms. There are also plans in place for non-natural hazards, including various types of hazardous materials releases (chemical, biological, and radiological) and power disruptions. In addition, OEM is currently drafting an emergency plan for cyber threats. It was evident that all of these hazards can significantly affect New York City and should be included in the HMP.

ii) Hazard Selection Worksheet

The Steering Committee supported the hazard identification process by completing a hazard selection worksheet. The hazard selection worksheet asked members of the Steering Committee to indicate which hazards would affect their agencies' operations, policies, and/or physical infrastructure. Agencies were asked to indicate "Yes" if they felt strongly that the hazard posed a significant threat and "No" if they felt strongly that the hazard did not pose a significant threat. If they did not feel strongly one way or the other, they left the field blank. Since the Planning Team (OEM, DCP, and OLTPS) was involved in the initial hazard selection, these agencies did not fill out hazard selection worksheets. Table 3 summarizes the results of the worksheets.

Hazard	DEP	DOT	FDNY	MTA	DOHMH	DPR	RPA	DOB	NYPD	TOTAL (Yes/No)

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2. Hazard Identification

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Hazard	DEP	DOT	FDNY	MTA	DOHMH	DPR	RPA	DOB	NYPD	TOTAL (Yes/No)	
Coastal erosion	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	8	0
Coastal storms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	0
Dam failure	No	No						No	No	0	4
Drought	Yes	No	Yes	Yes		Yes	Yes	Yes	Yes	7	1
Earthquakes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	8	0
Extreme temperatures	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	0
Floods	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	0
Hailstorms	No	No	Yes				Yes	No	No	2	4
Landslides	No	Yes	No					Yes	Yes	3	2
Tornadoes and windstorms	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	8	0
Land subsidence	Yes	Yes	No					Yes	No	3	2
Wildfires	Yes	No	Yes			Yes		No	Yes	4	2
Winter storms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	0
Air contamination	Yes	No	Yes		Yes		Yes			4	1
Aviation incident	No	Yes	Yes					No	Yes	3	2
Building collapses/ fires/explosions	Yes	Yes	Yes	Yes			Yes	Yes	Yes	7	0
Civil unrest	No	Yes	Yes					Yes	Yes	4	1
Cyber threats	No	No	Yes	Yes			Yes			3	2
Disease outbreaks	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	8	0

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2. Hazard Identification

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Hazard	DEP	DOT	FDNY	MTA	DOHMH	DPR	RPA	DOB	NYPD	TOTAL (Yes/No)	
Hazardous materials release (CBRN)	Yes	No	Yes	Yes			Yes	Yes		5	1
Utility disruption	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	8	0
Infrastructure failure*											

*This hazard was added after the selection worksheet was distributed to the Steering Committee

Table 3: New York City Hazard Selection Worksheet Results

A majority of Steering Committee members checked the following hazards: coastal erosion, coastal storms, drought, earthquakes, extreme temperatures, floods, tornadoes/windstorms, winter storms, diseases outbreaks, building collapses/fires/explosions, CBRN, and utility disruptions. The other hazards listed required additional research to determine whether they should be included in the HMP. The Planning Team collected and analyzed additional data on dam failure, hailstorms, landslides, subsidence, wildfires, air contamination, aviation incidents, civil unrest, and cyber threats from newspapers, City records, and the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service (NWS), and FEMA databases.

After further consideration, the Planning Team decided to also include wildfires and cyber threats in the final list. In addition, several new categories were created to consolidate multiple hazards from the original list; severe weather (incorporates hail and tornadoes/windstorms) and infrastructure failures (incorporates utility disruptions and damage to other types of infrastructure). Air contamination was incorporated into the extreme temperatures and CBRN hazards.

C. Eliminated Hazards

The Planning Team chose to address only the most prevalent hazards affecting New York City for this plan submission, and hazards for which sufficient data was available to develop a full profile. After conducting additional research, the Planning Team completely eliminated dam failure, landslides, land subsidence, aviation incidents, and civil unrest from the HMP. Although building collapses/fires/explosions received a majority vote, it was determined at a later point in the process that these types of events are generally caused by other types of hazards (both natural and non-natural) and that the building collapses/fires/explosions themselves were generally the result of some other trigger event. Although a draft of a profile was written for this hazard, the Planning Team decided later to incorporate this information into other hazard profiles and omit this as a separate section.

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D. Final List of New York City Hazards

At the end of the hazard identification process, the Planning Team retained 10 natural hazards and three non-natural hazards for profiling and analysis in the HMP. They are as follows:

Natural hazards:

(1) Coastal erosion
(2) Coastal storms
(3) Disease outbreaks
(4) Drought
(5) Earthquakes
(6) Extreme temperatures
(7) Flooding
(8) Severe weather
(9) Wildfires
(10)Winter Storms

Non-natural hazards:

(1) CBRN
(2) Cyber threats
(3) Infrastructure failures

Since this plan was written shortly following Hurricane Sandy, the worst natural disaster in New York City's history, the Planning Team decided to include a retrospective analysis of this particular storm and what the City learned moving forward. This section was independent from the coastal storms profile.

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3. Hazard Risk Assessment Organization

The risk assessments for each hazard are divided into two primary components. The first section, the "Hazard Profile," is a description of the hazard itself and the City's physical risk. The second section, the "Vulnerability Assessment," is an analysis of how susceptible the city's social environment (population), built environment, natural environment, and future environment are to each hazard. The one exception to this organizational structure is the section on Hurricane Sandy because it is a description of a historic event rather than an assessment of risk to a potential hazard.

A. Hazard Profile

The Hazard Profile is intended to characterize each hazard and its risk of occurrence in New York City. This section is divided into five subsections, as follows:

1) **Hazard Description**: a general description of the natural or non-natural hazard that can affect New York City
2) **Severity**: a description of the strength or magnitude of the hazard, how it is measured, and the range of impacts it can have
3) **Probability**: a description of the likelihood of the hazard occurring in New York City
4) **Location**: the identification of the geographic areas within New York City that may be most significantly affected by the hazard
5) **Historic Occurrences**: a descriptive list of any previous occurrences of this type of event in New York City

This organization structure is in accordance with the requirements from FEMA, and most hazards fit these categories at least fairly well. However, complete information was not always available for every category of every hazard profile (for example, probability is generally not quantifiable for coastal erosion and most non-natural hazards).

B. Vulnerability Assessment

The Vulnerability Assessment is intended to characterize the hazard's potential impacts on different sectors and identify vulnerabilities within New York City. This section is divided into four subsections, as follows:

1) **Social Environment**: a description of the hazard's impact on the general public, including public health impacts and potential fatalities, with an emphasis on vulnerable and special needs populations
2) **Built Environment**: a description of structural vulnerabilities of the city's building stock and infrastructure. For flooding, coastal storms, and earthquakes, this

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section also includes a quantitative calculation of loss estimates (see Section i: Vulnerability Assessment Methodology, below)

3) **Natural Environment**: a description of the hazard's impact on the natural environment, resources, ecosystems, and recreational areas
4) **Future Environment**: a description of how trends such as climate change, population growth, aging infrastructure, and new technology may change the risk and/or impacts of hazards in the future

i. Vulnerability Assessment Methodology

To conduct the vulnerability assessment, address the requirements of the Disaster Mitigation Act of 2000, and better understand the potential vulnerability and losses associated with hazards of concern, New York City used standardized tools including the HAZUS-MH modeling software, combined with local, state, and federal data.

HAZUS-MH Methodology

HAZUS-MH is a nationally applicable standardized methodology and software program, developed by FEMA and under contract with the National Institute of Building Sciences. The program estimates potential losses from earthquakes, hurricane winds, and floods. In HAZUS-MH, current scientific and engineering knowledge is coupled with Geographic Information Systems (GIS) technology to produce estimates of hazard-related damage before or after a disaster occurs.

Potential loss estimates analyzed in HAZUS-MH include:

- **Physical damage** to residential and commercial buildings, schools, critical facilities, and infrastructure
- **Economic loss**, including lost jobs, business interruptions, and repair and reconstruction costs

HAZUS-MH is designed to generate estimates of hazard-related damage to a city or a region from a hypothetical "hazard event" of a fixed severity and location (that is, an earthquake, hurricane, or flood), also known as a "deterministic" event. This type of analysis can also be used to estimate damages from a historic event. Another type of analysis models the damage caused by an event that is likely to occur over a given period of time (return period), also known as a "probabilistic" event." For example, HAZUS-MH can estimate the damage caused by an earthquake that is likely to occur once every 500 years (which has a 1 in 500 or 0.2% chance of occurring in a given year).

HAZUS-MH uses demographic and general building stock (GBS) data to estimate hazard-related damage. The GBS data input into HAZUS-MH is a summary of building counts, values, construction types, and uses by census block or tract. The default GBS data provided with HAZUS-MH did not adequately reflect actual conditions. To refine the default GBS dataset, OEM provided an updated set of building data to Applied Research Associates, Inc. (ARA). This dataset consisted of Property Land Use Tax lot Output

(MapPLUTO) from the Department of City Planning (DCP) and mass appraisal data from the Department of Finance (DOF). ARA converted this dataset to a format that was usable by HAZUS-MH, which was further refined by FEMA to format with HAZUS-MH version 2.1. The resulting census block-based dataset provided a much more accurate starting point for subsequent analyses.

While the results of the HAZUS-MH analysis provide a good starting point for loss and damage estimation, they are approximate predictions. There is uncertainty inherent in any predictive model, and HAZUS-MH is no exception. This software is not meant for site-specific damage analysis. However, the use of HAZUS-MH as a tool for macro-level citywide analysis can provide a good overall view of potential exposure to various hazards based on the best available local data.

Methodology for Assessing Hazards Not Covered by HAZUS-MH

Non-HAZUS-MH hazards included in this report are coastal erosion, drought, extreme temperatures, severe weather, wildfires, winter storms, CBRN, cyber threats, and infrastructure failures. Vulnerable populations and infrastructure were evaluated using the best available data to assess vulnerability to these hazards and to help identify appropriate mitigation efforts.

While this risk assessment relies on the best available data and methodologies, uncertainties are inherent in any loss-estimation methodology. These uncertainties arise in part from incomplete scientific knowledge concerning hazards and their effects on the social, built, natural, or future environment. They can also result from the unique nature, geographic extent, and severity of each hazard. Therefore, potential exposure and loss estimates should be considered approximate

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Introduction

With more than 8.2 million residents, New York City is the most populous city in the United States. It is also one of the most densely populated urban centers in the country, with an area of 305 square miles.

New York is not only prominent among U.S. cities. Ranking among the largest urban centers in the world, New York City has for more than a century been a global center for commerce, finance, politics, foreign affairs, media, and the arts. Many of the city's neighborhoods and landmarks are famous around the world. To support its population and maintain international prominence, New York City has developed interconnected networks of infrastructure and services.

However, these defining characteristics—density, international stature, and complex infrastructure—also increase the potential significance of hazards, making New York more susceptible to their effects than many other cities.

1. The Natural Environment

A. Geography

New York City is located in the southeastern part of New York State, at the confluence of the Hudson River and the Atlantic Ocean. Much of the city is built on three islands: Manhattan, Staten Island, and Long Island (part of the city occupies the western tip of Long Island). New York City not only abuts the Hudson River and the Atlantic Ocean, it also contains or borders numerous bays, rivers, and tidal straights including New York Harbor, Long Island Sound, East River, Jamaica Bay, and the Harlem River.

The city is comprised of five boroughs (see Figure 1), each of which is a county. If the boroughs were independent cities, four of them (the Bronx, Brooklyn, Manhattan, and Queens) would be among the 10 most populous cities in the United States.

- The Bronx (Bronx County, 2010 population 1,385,108) is the city's northernmost borough and the only borough attached to the United States mainland.
- Brooklyn (Kings County, 2010 population 2,504,700), the city's most populous borough, is situated on the southwestern part of Long Island and is bounded by Queens to the east and north.
- Manhattan (New York County, 2010 population 1,585,873), the most densely populated of the boroughs, is an island southwest of the Bronx, bordered on the west by the Hudson River and on the east by the East River.
- Queens (Queens County, 2010 population 2,230,722) is geographically the largest borough. Like Brooklyn, with which it shares a border, it is part of Long Island.

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- Staten Island (Richmond County, 2010 population 468,730), as its name indicates, is an island. Southwest of Manhattan, it is connected by bridges to both Brooklyn and New Jersey and is accessible to Manhattan by ferry.

Figure 1: The Five Boroughs of New York City

B. Current Climate

New York City has a humid, continental climate with cold winters and hot, moist summers. The temperature has ranged from -15° F (on February 9, 1934) to 106° F (July 9, 1936), with an average annual temperature of 55° F, an average January temperature of 33° F, and an average July temperature of 77° F. The city's average annual precipitation, which is spread throughout the year, is 55 inches. Its average annual snowfall is 26.7 inches.

Much of New York City's weather moves in from the west off the interior continent due to the prevailing winds. This results in hotter summers and colder winters than coastal locations at similar latitudes where prevailing winds are off the water (such as northern California). In addition, the concentration of buildings and pavement in New York City raises temperatures relative to surrounding areas due to a phenomenon known as the "urban heat island effect."

However, the ocean still has some influence over the city's climate. Wind coming off the ocean often moderates afternoon heat, though less so farther away from the immediate shoreline. In winter, the warmth of the ocean relative to the land keeps the central city slightly warmer than inland suburbs and delays winter snows; in spring, the water, which drops in temperature over the winter, keeps air temperatures cooler longer into the season.

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C. Topography

Elevation generally ranges from less than 50 feet for most of Manhattan, Brooklyn, and Queens to nearly 300 feet in northern Manhattan and the Bronx. Figure 2 shows New York City's topography and the highest point for each borough. The highest point in New York City is Todt Hill on Staten Island at 412 feet above sea level.

Figure 2: New York City Topography, including the Highest Points for Each Borough

Human intervention and land reclamation along the waterfronts has altered the city's topography. Reclamation is most notable in Lower Manhattan, with developments such as Battery Park City built entirely on fill.

D. Geomorphology

Geomorphology, the study of coastal features and landforms and the processes that shape them over time, is relevant to understanding New York City's coastal hazard vulnerability. The land the city occupies was shaped to a large extent by the Wisconsin Ice Sheet, a giant glacier that stretched from Canada to what is now New York City. This glacier reached the New York City area about 20,500 years ago then began its retreat about 18,000 years ago. It ground up rock as it traveled south and carried chunks of gravel, pebbles, and sand with it.

When the glacier began to melt, this rock debris was deposited at its southernmost end, forming the "terminal moraine," the hilly area of the city that stretches through Staten Island and central Brooklyn/Queens. Streams from the melting glacier carried deposits of sand, silt, and clay, which formed today's "outwash plains," the low-lying areas on Staten Island's East Shore and along southern Brooklyn and Queens. While other areas of the city are generally higher in elevation, due to the presence of bedrock closer to the earth's surface, these low-lying areas are generally more vulnerable to storm surge and gradual sea level rise (see Figure 3).

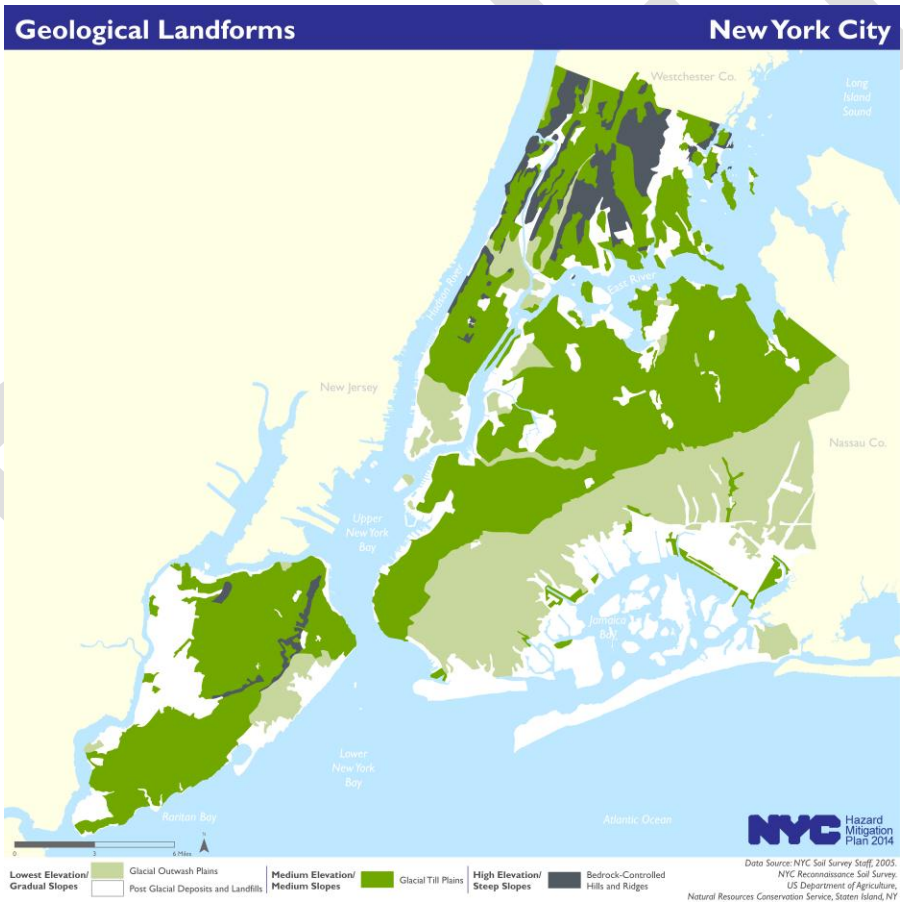

Figure 3 : Geological Landforms of New York City

E. Parks, Open Space, and Natural Areas

New York City boasts some of the most magnificent public parks in the nation. From wild to manicured, shoreline to inland, large to small, these parks run the gamut. The city's parks include playgrounds, waterfront esplanades, wetlands, hiking trails, dog runs, boating and kayaking areas, athletic courts and fields, beaches and swimming pools, monuments and historic buildings. The system of parks and open spaces managed by the New York City Department of Parks & Recreation (DPR) spans over 29,000 acres, covering 14% of the city and encompassing 1,942 sites across all five boroughs. Additionally, the city's wetlands, streams, forests, and other natural areas offer substantial sustainability and resiliency benefits, playing a critical role in managing runoff and reducing the impacts of extreme weather events (see Figure 4).

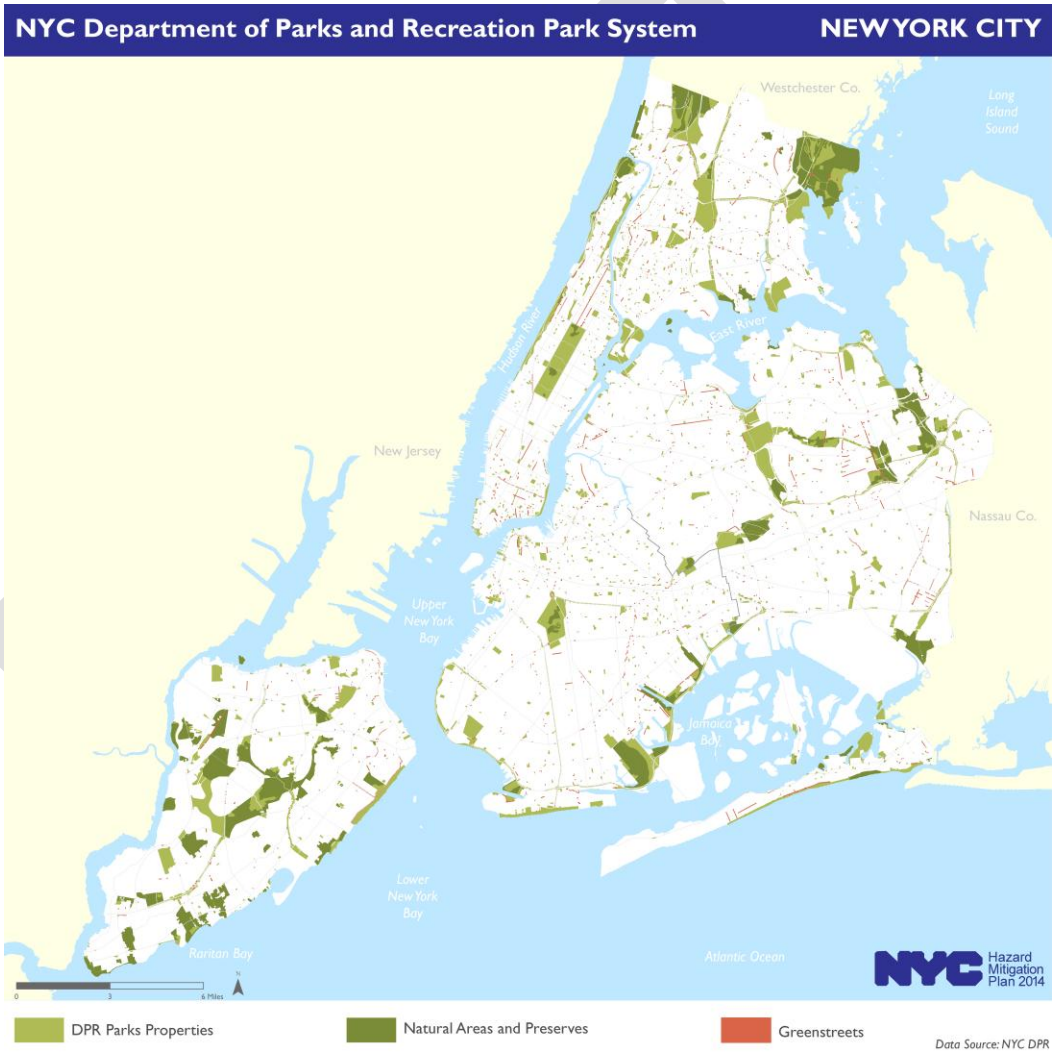

Figure 4: New York City Department of Parks & Recreation Park System

The properties in the City's parks system can be categorized according to four main types: beaches and waterfront parks, inland parks, natural areas and preserves, and tree infrastructure.

a) Beaches and Waterfront Parks

Among DPR's assets, its beaches, boardwalks, and waterfront parks constitute by far its most expansive category, covering over 7,300 acres or 30% of its total land area, and found along 150 miles—or almost 30%—of the city's total coastline. This parkland connects millions of city residents and visitors to the water. In fact, in 2012 alone, the city's beaches welcomed over 21 million people, providing them with a wide range of recreational amenities and opportunities. Especially in recent years, the city's waterfront parks also have spurred the development of residences and businesses along their peripheries. Waterfront parks include Rockaway Beach in Queens, Coney Island in Brooklyn, Orchard Beach in the Bronx, Battery and Riverside Parks in Manhattan, and Midland Beach in Staten Island.

b) Inland Parks

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

c) *Natural Areas and Preserves*

The city's 9,900 acres of natural areas—representing over a third of the acreage in DPR's system—include forests, grasslands, and wetlands. Natural areas provide many benefits, including air quality improvements, carbon sequestration, enhanced wildlife habitats, stormwater retention, shoreline protection, and native plant life preservation. The city's wetlands (see Table 1), for example, not only shelter a wide variety of plants and animals, but also protect the quality of waterways by absorbing nutrients and filtering sediment and contaminants, help manage stormwater runoff, and buffer coastal areas from the impacts of flooding through wave attenuation.

Freshwater streams play an important role in New York City's ecosystem as well as manage stormwater runoff. Today, however, there are few natural streams remaining in New York City, with many now piped underground. For example, Tibbetts Brook in the Bronx is connected to the City's combined sewer infrastructure and flows directly into the local wastewater treatment plant.

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Wetlands	Borough	Acres
Seagirt Avenue wetlands	Queens	5.32
Broad Channel wetlands	Queens	37.95
South Beach wetlands	Staten Island	4.79
Richmond Terrace wetlands	Staten Island	11.19
City Island wetlands	Bronx	8.01
Jamaica Bay wetlands	Queens	149.54

Table 1: Selected Wetlands in the New York City Region

Case Study: Jamaica Bay *Jamaica Bay is an 18,000-acre wetland estuary surrounded by the Rockaway Peninsula to the south, Brooklyn to the west, and Queens to the east. Covering an area almost equal to the size of Manhattan, it encompasses approximately 10,000 acres of parkland managed by the National Park Service and DPR as an urban national park. The bay consists of numerous islands, a labyrinth of waterways, meadowlands, and two freshwater ponds. The wetlands provide a unique environment for both wildlife preservation and urban recreation. Protected from the Atlantic Ocean by the Rockaway Peninsula, the region currently hosts over 325 species of birds, 50 species of butterflies, and 100 species of finfish. A favorite stop for migratory waterfowl, the area is an integral part of the larger regional ecosystem.*

Though Hurricane Sandy flooded over 3,000 acres of natural areas in October 2012, New York City's wetlands fared relatively well. For example, the salt marshes located in Jamaica Bay and its tributary systems remained largely clear of floating debris, with much of their vegetation surviving.

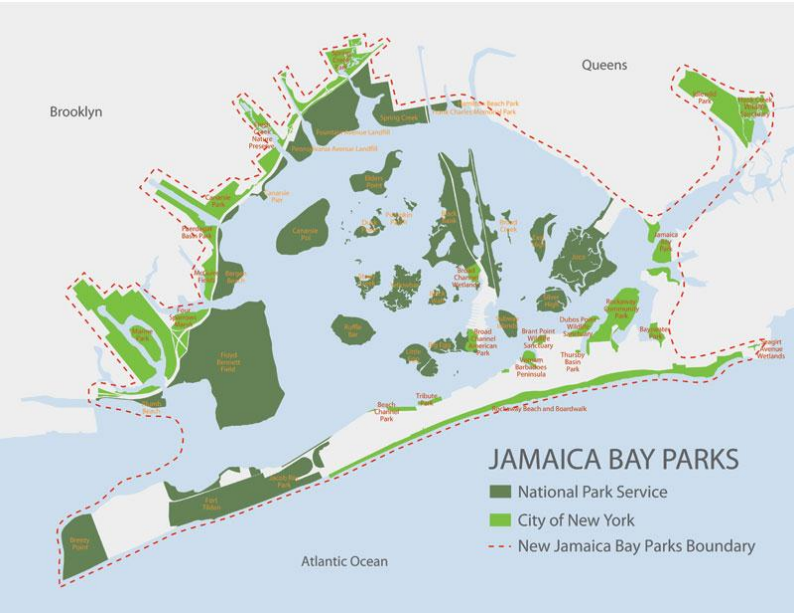

Figure 5: Parks in Jamaica Bay

d) Trees

Also found in the city—in inland parks, along waterfront parks and beaches, and dotting streets—are trees, many of which are managed by DPR. These trees moderate temperatures, remove carbon dioxide and pollutants from the air, enhance sidewalk environments and other settings, and protect waterways by reducing stormwater runoff. DPR's trees range from large canopy trees to street trees, and its staff manages this urban forest by planting new trees and pruning existing trees to remove dead branches and increase light and air penetration. Since it was announced in PlaNYC in 2007, the City has planted nearly 760,000 trees as part of the MillionTreesNYC initiative.

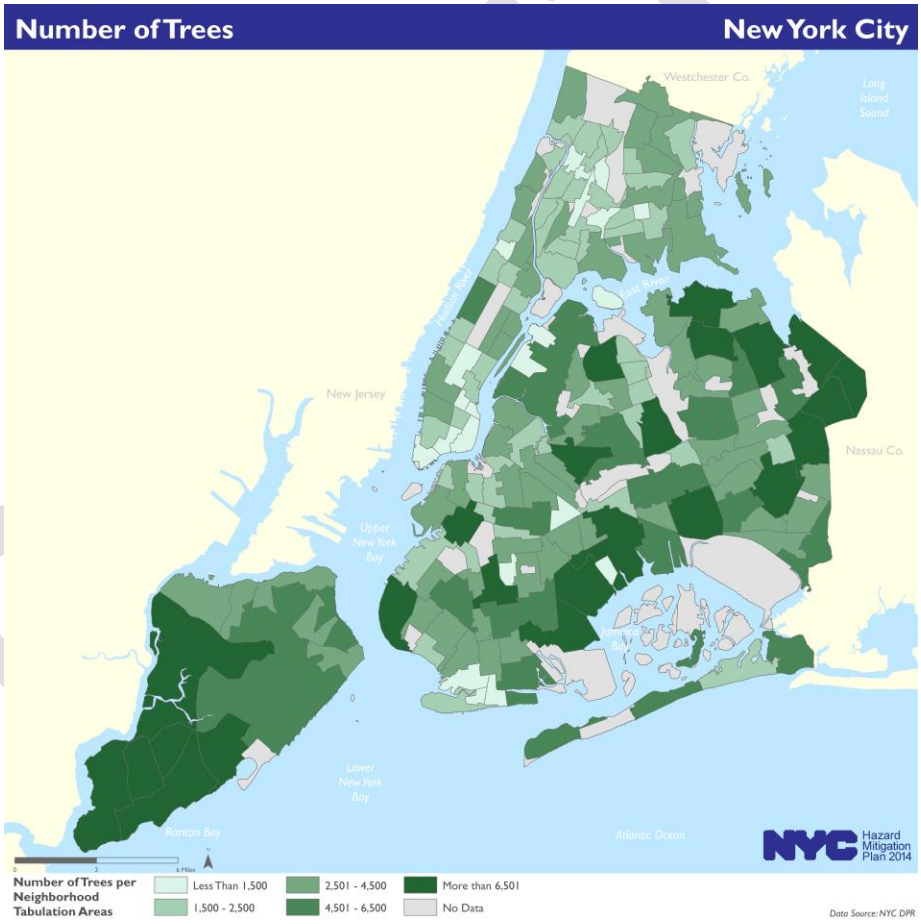

Figure 6: New York City Street Tree Density

F. Barrier Islands

A barrier island is a long offshore deposit of sand parallel to the coastline. Generally barrier islands are made up of beach, dunes, barrier flat, and salt marsh, separated from the mainland by a shallow sound, bay, or lagoon. Barrier Islands act as a buffer against storms by absorbing the most severe impacts of waves and storm surges.

Long Island, which stretches for almost 100 miles, is bordered by five barrier islands, including Coney Island in Brooklyn, and two spits, including the Rockaway Peninsula in Queens. Tidal inlets separate the barriers and connect the bays with the ocean. All of the inlets are artificially stabilized with structures and are dredged to allow for navigation by commercial and recreational boats.

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2. The Social Environment

New York City's social environment–its distinct history and culture, diverse communities and neighborhoods, and dynamic economy and resources–plays a critical role in how New Yorkers are impacted by, plan for, and respond to disasters. Each of New York City's historic neighborhoods, as well as those that have been newly developed, have unique and vibrant features. Data on population growth and density, neighborhoods, and the economy can provide powerful context for understanding New York City's social environment.

A. Demographics

Density

More people live, work, and play in New York City today than at any other time in the city's history. According to the 2011 American Community Survey (ACS), more than 8.2 million people reside in the 305 square miles that make up New York City. With an approximate density of 42 people per acre, New York City is by far the most populous, densest city in the nation. In fact, it has more than double the population of the second largest city in the country, Los Angeles.

Within New York City, Manhattan remains the densest borough, with more than 109 people per acre, while Staten Island continues to be the least dense borough, with approximately 12 people per acre (see Table 2).

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New York City		Bronx		Brooklyn		Manhattan		Queens		Staten Island	
Count	**Person/ Acre**	**Count**	**Person/ Acre**	**Count**	**Person/ Acre**	**Count**	**Person/ Acre**	**Count**	**Person/ Acre**	**Count**	**Person/ Acre**
8,244,910	42.47	1,392,002	51.09	2,532,645	56.30	1,601,948	109.64	2,247,848	32.11	470,467	12.62

Table 2: New York City Population Density by Borough (Source: U.S. Census, American Community Survey 2011)

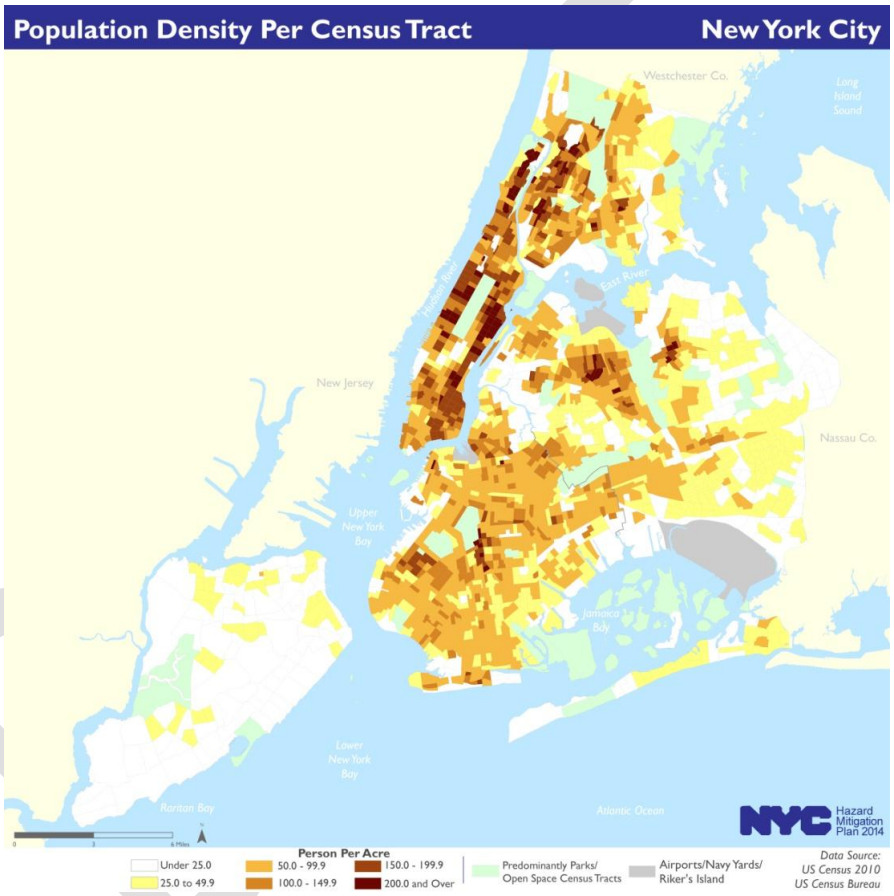

Figure 7: New York City Population Density by Census Tract

Age

Seniors
The last 30 years have seen a large increase in the number of older New Yorkers. According to the 2011 U.S. Census, over 12% of New York City's population—roughly one million residents—is over the age of 65. This trend is largely due to the fact that the first cohort of people born during the baby boomer era is now reaching senior status. This population has been growing much more rapidly (12.4% since 2000) than the city's overall population (2.1% since 2000). According to the New York City Department for the Aging (DFTA), the highest percentage of elderly people reside in Brooklyn and Queens, each accounting for about 29% of the city's population aged 65 and over. This is followed by Manhattan (21%), the Bronx (15%), and Staten Island (6%). Given growth trends over the last decade, it is expected that the city's older adult population will continue to increase in the coming decade.

Growth is not uniform across all seniors, however. Women over 65 continue to outlive men in the same age bracket, though the gender gap among the city's older adult population is slowly narrowing. Also, immigrant seniors are one of the fastest-growing demographic groups in the city. From 2000 to 2010, the number of immigrants in the city aged 65 and up increased by about 30%. According to the 2010 U.S. Census, almost 50% of New York City's older residents are foreign-born. According to the Center for Urban Futures, immigrant seniors often earn lower wages than native-born seniors, and they also have less in retirement savings and receive fewer benefits from traditional entitlement programs like Social Security and Medicare.

In addition to being one of the fastest-growing demographic groups in New York City, seniors are also among the more vulnerable populations during emergencies. Older adults who have chronic health conditions or disabilities, live alone and experience isolation, or have limited access to emergency assistance services face higher risks from a hazard. According to the 2010 U.S. Census, approximately 300,000 seniors—or roughly 10% of all New York City households—live alone. Isolation can be more acute among immigrant seniors, nearly two-thirds of whom have limited English proficiency and therefore might not be informed of warnings and evacuation orders or know about critical city services and resources during an emergency.

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	New York City	Bronx	Brooklyn	Manhattan	Queens	Staten Island
Under 5	534,400	106,190	183,027	80,126	136,797	28,260
Under 18	1,775,171.00	368,276.00	598,160.00	237,292.00	463,568.00	107,875.00
Over 65	1,011,996	149,110	291,892	218,875	290,927	61,192

Table 3: New York City Population by Age and Borough (Source: U.S. Census, American Community Survey 2011)

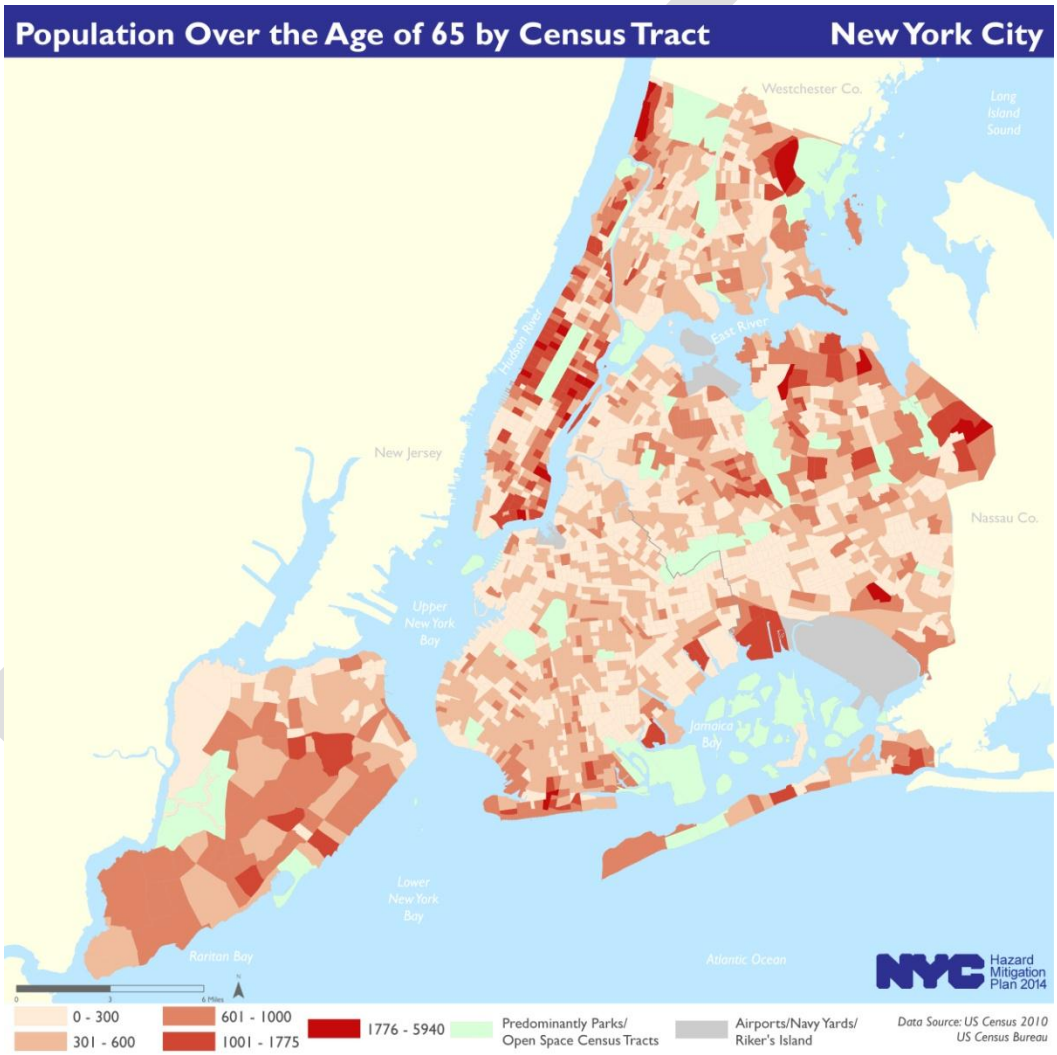

Figure 8: New York City Population over the Age of 65 by Census Tract

Children

Just as the city's older population has grown, so, too, has its group of younger inhabitants. New York City has seen a steady increase in its youth population over the last decade, with the latest U.S. Census data showing that just under 23% of the city's population is under the age of 18, and 6%, or over half a million, is under the age of 5. In fact, over 30% of all households in New York City have children under the age of 18. In addition, according to ACS data from 2011, more than 10% of the city's school-aged population is enrolled in nursery school, preschool, or kindergarten. Though Manhattan has seen some of highest growth rates in its population of children since the 1960s, Brooklyn remains the borough with the greatest number of children under the age of 5, at approximately 180,000.

According to the Federal Emergency Management Agency (FEMA), children are particularly vulnerable to natural disasters. The reason: they are disproportionately dependent on others, such as parents or adult caretakers, for shelter, transportation, and general guidance. The stress that follows a natural disaster may linger longer in children than in adults, according to FEMA's mental health experts.

Socioeconomic and pre-existing health considerations place some children at even greater risk from hazards. In New York City, approximately 30% of those 18 years of age and under (over 500,000) live below the federal poverty level (see Income and Poverty, below), and over 100,000 of these children are under the age of 5. Additionally, the 2011 ACS showed that more than 54,000 children under the age of 18—roughly 3% of the city's population—have some form of disability, which may make them more vulnerable during a hazard event.

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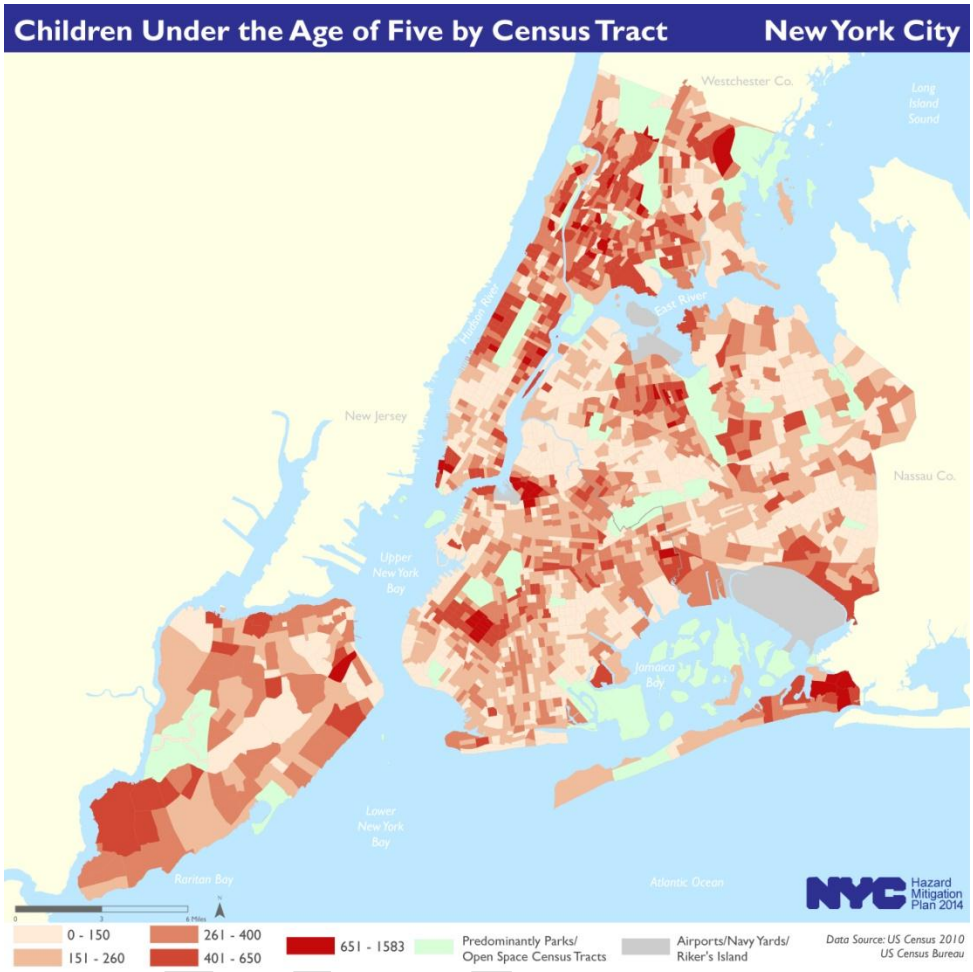

Figure 9: New York City Population under the Age of 5 by Census Tract

Income and Poverty

Federal poverty status is determined by annual income and therefore influenced by larger economic trends. The recent recession and subsequent period of sluggish employment growth have had lingering effects on income and quality of life for many New Yorkers. According to the 2011 ACS, the percentage of the city's working-age population (defined as 18 to 64 years of age) that had employment between 2008 and 2010 shrank compared to the previous two-year period, with an all-time-high unemployment rate of 10% in 2010. However, starting in 2011, the upturn in the national and local economy resulted in a drop in New York City's unemployment rate. The latest ACS data (July 2013) show an unemployment rate of approximately 8% in New York City.

Despite employment growth, some New Yorkers continue to struggle economically. According to the 2011 ACS, almost 21% of the city's population, or approximately 1,700,000, live below the federal poverty line. (In 2011, the U.S. Census set the poverty threshold at $11,484 for a one-person household and $23,021 for a four-person household. The official poverty measure's definition of family resources is pre-tax cash. This includes income from all sources such as earnings, interest, and government transfer payments that take the form of cash, with Social Security benefits included in this measure but in-kind benefits, such as Food Stamps or tax credits, such as Earned Income Tax Credit, excluded.) Of those people living below poverty, almost 30% are children under the age of 18, and just under 20% are older adults over the age of 65 (see Table 4).

More than 600,000 lower-income New Yorkers are served by New York Housing Authority (NYCHA) public housing and Section 8 programs. Based on the 2010 U.S. Census, NYCHA public housing represents 8.2% of the city's rental apartments and is home to 4.9% of the city's population. Almost half (47.5%) of the families enrolled in NYCHA are working families, with an average family income of $22,994, whereas the median household income in New York City is close to $50,000 according to the 2011 ACS.

Renters make up a significant percentage of low-income households in New York City, a fact that is relevant in a post-disaster context. Investment in post-disaster repairs is typically made by property owners, not renters, leaving most renters with little control over the quality and duration of the repairs. With the high-cost of housing in New York City, finding alternative housing, even temporarily during an evacuation or immediately following a disaster, can pose a serious challenge. As a consequence, many low-income individuals and families choose to continue to occupy their damaged homes to avoid a greater allocation of income towards rent, or even homelessness.

However, occupying damaged residences can increase their vulnerability in other ways, including increasing exposure to hazardous materials. Health problems, in turn, can result in lost wages or even loss of employment, further increasing economic vulnerability. As a group, low-income individuals have fewer resources to prepare for and recover from disasters and therefore face higher health and safety risks along with economic hardships post-disaster.

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	New York City		Bronx		Brooklyn		Manhattan		Queens		Staten Island	
	Estimate	%	Estimate	%	Estimate	%	Estimate	%	Estimate	%	Estimate	%
All	1,695,088	20.9%	412,139	30.4%	592,789	23.6%	284,572	18.3%	351,223	15.8%	54,365	11.7%
Under 18	520,799	29.8%	147,402	40.9%	198,874	33.6%	59,796	25.6%	95,880	21.1%	18,847	17.5%
Over 65	186,006	19.0%	34,239	24.7%	66,439	23.2%	37,892	17.8%	42,273	15.1%	5,163	8.7%

Table 4: New York City Population below Federal Poverty Level by Age (Source: U.S. Census, American Community Survey 2011)

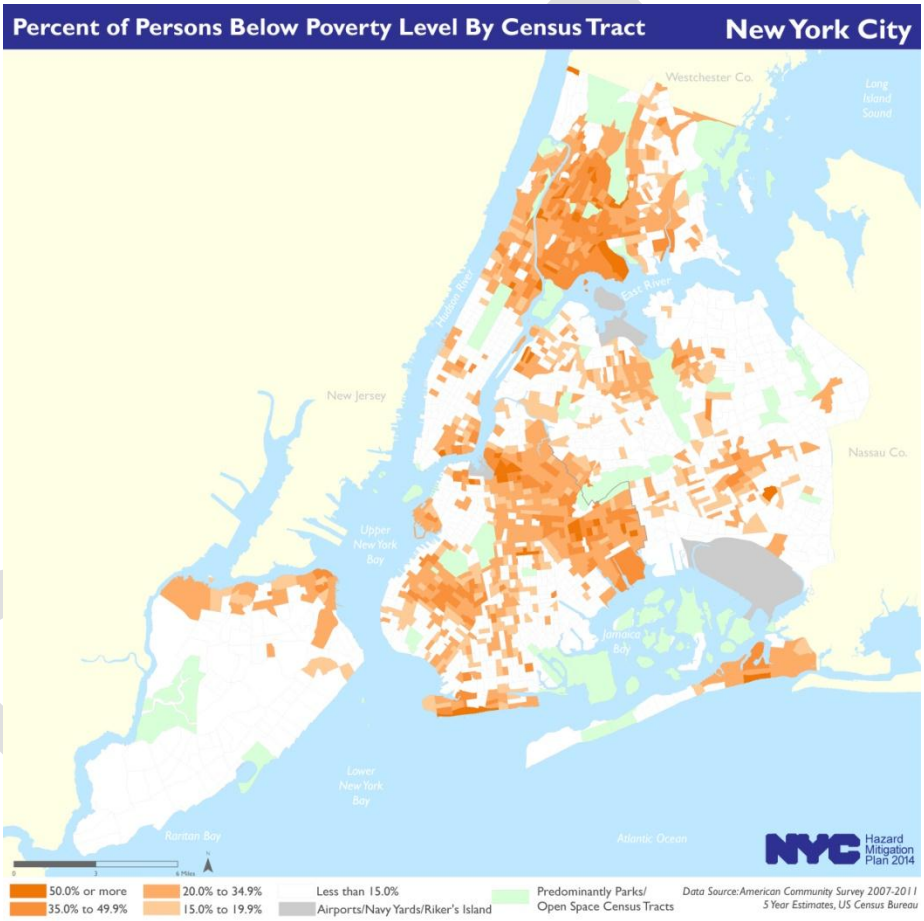

Figure 10: Percentage of New York City Population below the Federal Poverty Level by Census Tract

Linguistic Isolation

New York City is exceptionally diverse and has been a major point of entry for immigrants throughout its history. The city's 2011 foreign-born population of 3.07 million was an all-time high and represented 37% of the city's overall population. Given that New Yorkers hail from all over the world, it is no surprise that over 200 different languages and dialects are spoken in New York City. For some of the city's foreign born population, English proficiency continues to be a challenge. People who do not speak English very well are of special concern during an emergency as they might not be aware of warnings and evacuation orders or know about critical city services and resources during an emergency. According to the 2011 ACS, an estimated 23% of the city's population is "linguistically isolated."

	New York City		Bronx		Brooklyn		Manhattan		Queens		Staten Island	
	Estimate	%	Estimate	%	Estimate	%	Estimate	%	Estimate	%	Estimate	%
Speak English less than "very well"	1,795,678	23.3%	336,583	26.2%	559,161	23.8%	251,218	16.5%	602,667	28.5%	46,049	10.4%
Spanish/Speak English less than "very well"	899,769	11.7%	275,381	21.4%	186,476	7.9%	161,418	10.6%	262,078	12.4%	14,416	3.3%
Other Indo-European/Speak English less than "very well"	433,675	5.6%	30,141	2.3%	213,666	9.1%	23,834	1.6%	147,087	7.0%	18,947	4.3%
Asian/Pacific Islander/Speak English less than "very well"	394,990	5.1%	11,539	0.9%	132,247	5.6%	60,915	4.0%	180,856	8.6%	9,433	2.1%
Other/Speak English less than "very well"	67,244	0.9%	19,522	1.5%	26,772	1.1%	5,051	0.3%	12,646	0.6%	3,253	0.7%

Table 5: New Yorkers Who Speak English "Less than Very Well" by Borough (Source: U.S. Census, American Community Survey 2011)

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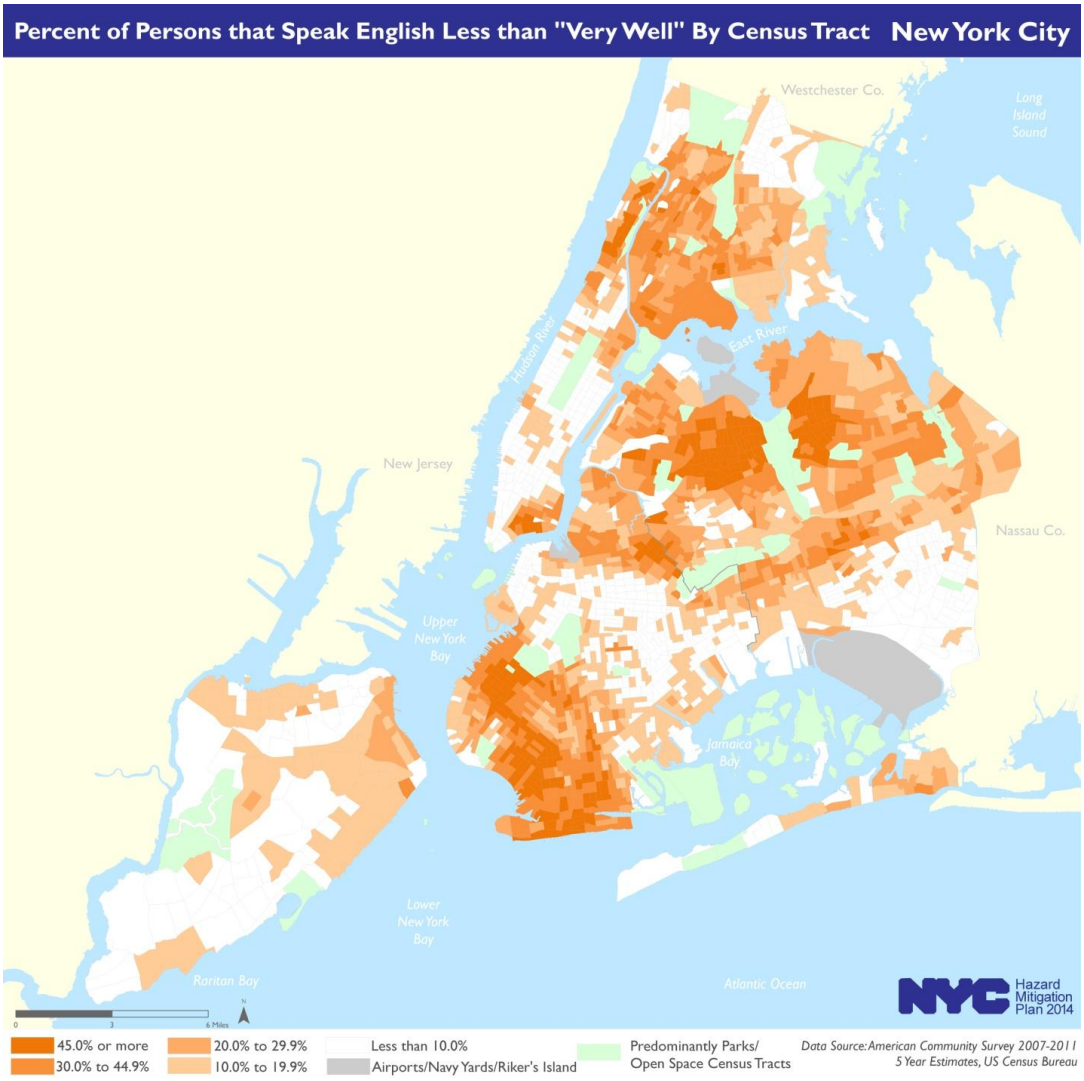

Figure 11: Concentrations of Linguistically Isolated New Yorkers by Census Tract

Disability

According to the U.S. Census, there are four major categories of disabilities. Sensory disabilities include blindness, deafness, or a severe vision or hearing impairment. Physical disabilities are long-lasting conditions that substantially limit one or more basic physical activities, such as walking, climbing stairs, reaching, lifting, or carrying. Self-care disabilities are conditions lasting six or more months that make dressing, bathing, or getting around inside the home challenging. "Go-outside-the-home" disabilities are conditions lasting six or more months that make it difficult to shop or visit a doctor's office on one's own.

	New York City		Bronx		Brooklyn		Manhattan		Queens		Staten Island	
	Estimate	%	Estimate	%	Estimate	%	Estimate	%	Estimate	%	Estimate	%
All	842,477	10.3%	189,467	13.8%	235,372	9.3%	157,324	9.9%	214,530	9.6%	45,784	9.8%
Under 18	54,189	3.1%	18,773	5.1%	12,185	2.0%	6,849	2.9%	13,678	3.0%	2,704	2.5%
Over 65	362,507	37.1%	60,000	43.3%	112,983	39.5%	69,633	32.7%	100,333	35.7%	19,558	33.0%

Table 6: New Yorkers with Disabilities by Age and Borough (Source: U.S. Census, American Community Survey 2011)

Please Note: A map is not provided for disability because this dataset does not exist at the Census Tract level. This indicator is no longer part of the Decennial Census and is instead part of the ACS. The ACS now provides these estimates alongside a margin of error. If the margin of error for an indicator is too large, the ACS does not publish its estimates. Currently, there is no updated information for persons with disabilities at the Census Tract or the PUMA (Public Use Microdata Areas) level (approximately equivalent to a Community District level). The only available data is at the borough level, which doesn't make a compelling thematic map. A table is sufficient for the purposes of this report.)

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B. Neighborhoods

New York City is a City of Neighborhoods. It encompasses five boroughs, 59 community districts (CD), and hundreds of neighborhoods. Each neighborhood has unique physical and social characteristics. The geographic boundaries and names of neighborhoods are dynamic and change as populations move and development occurs. Figure 12 through Figure 16 show the diverse neighborhoods throughout New York City.

There are twelve Community Districts in the Bronx. The northernmost borough of New York City, the Bronx is home to the New York's largest food distribution center in Hunts Point Cooperative Market, Yankee Stadium, The Bronx Zoo, and New York Botanical Garden.

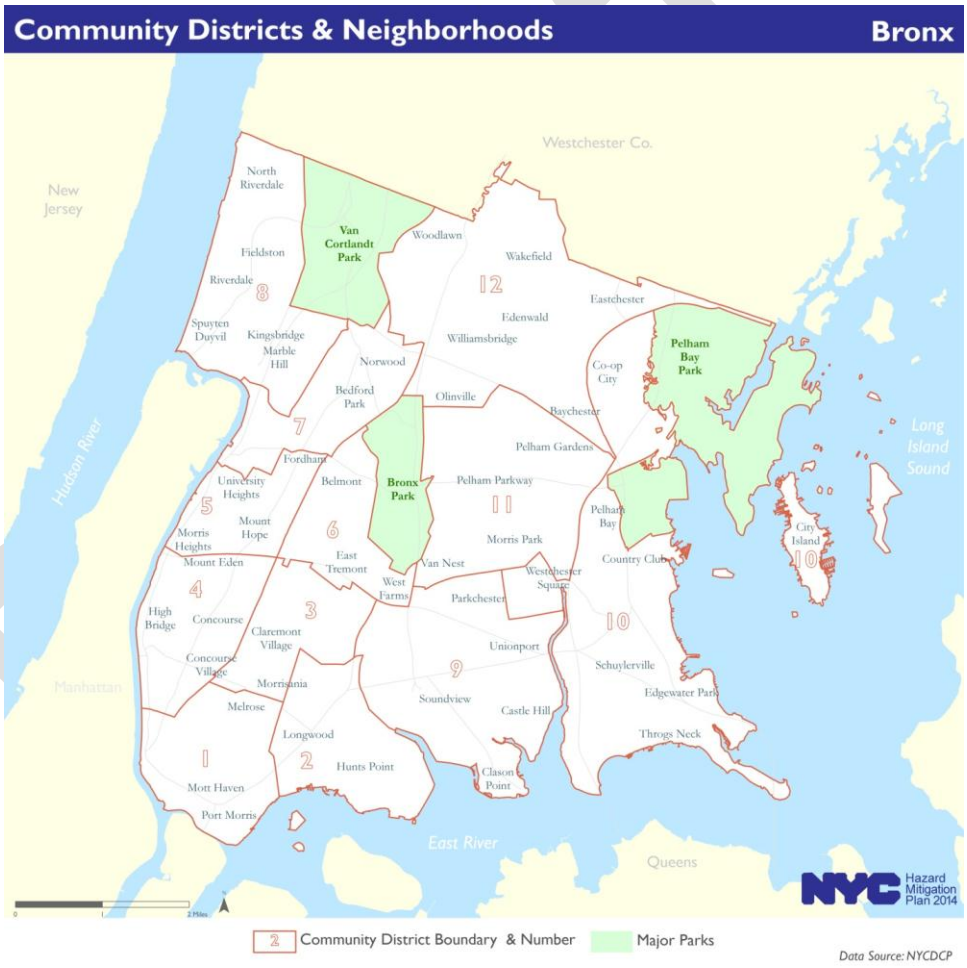

Figure 12: Bronx Community Districts and Neighborhoods

Brooklyn consists of 18 Community Districts, the most by any of the five boroughs. It is known for its brownstone architecture, Coney Island's sandy beach and amusement park, historic waterfront, and Prospect Park.

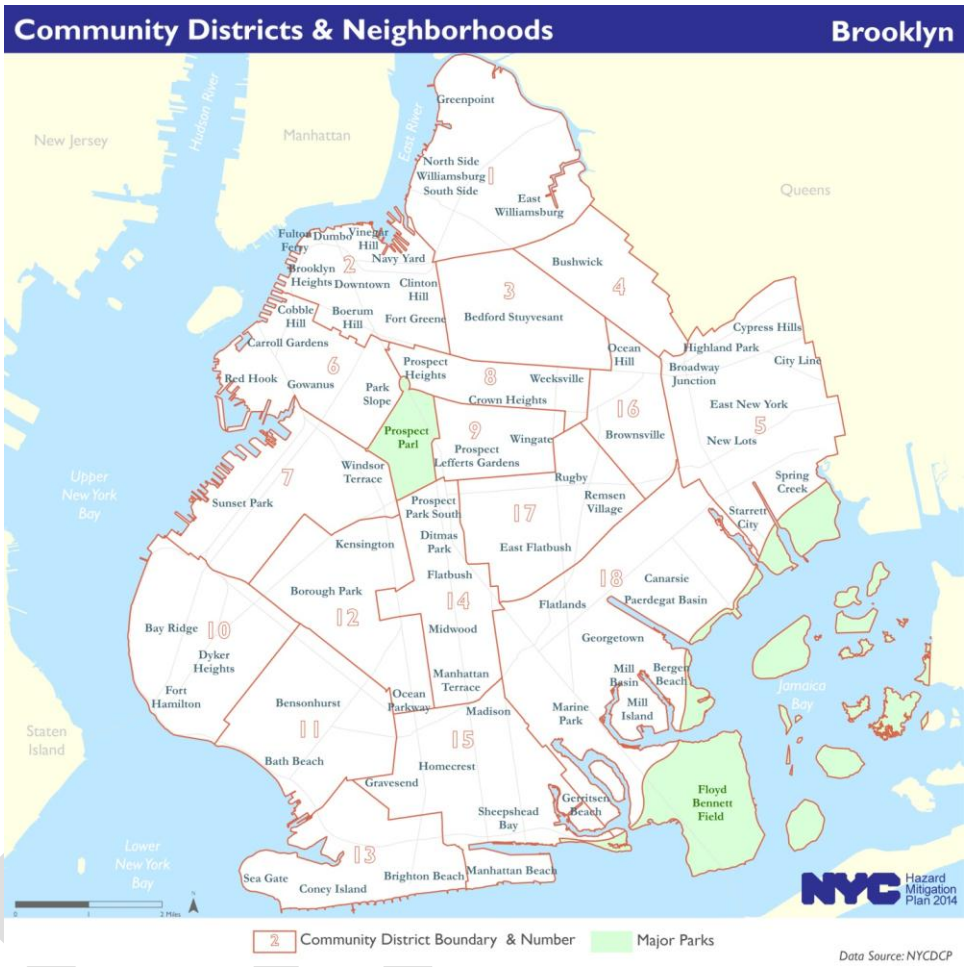

Figure 13: Brooklyn Community Districts and Neighborhoods

Manhattan, the smallest borough in geography, comprises of twelve Community Districts. It is home to Wall Street and its financial institutions, the Theatre District, Central Park, and famous museums and cultural centers such as Lincoln Center for the Performing Arts, amongst others.

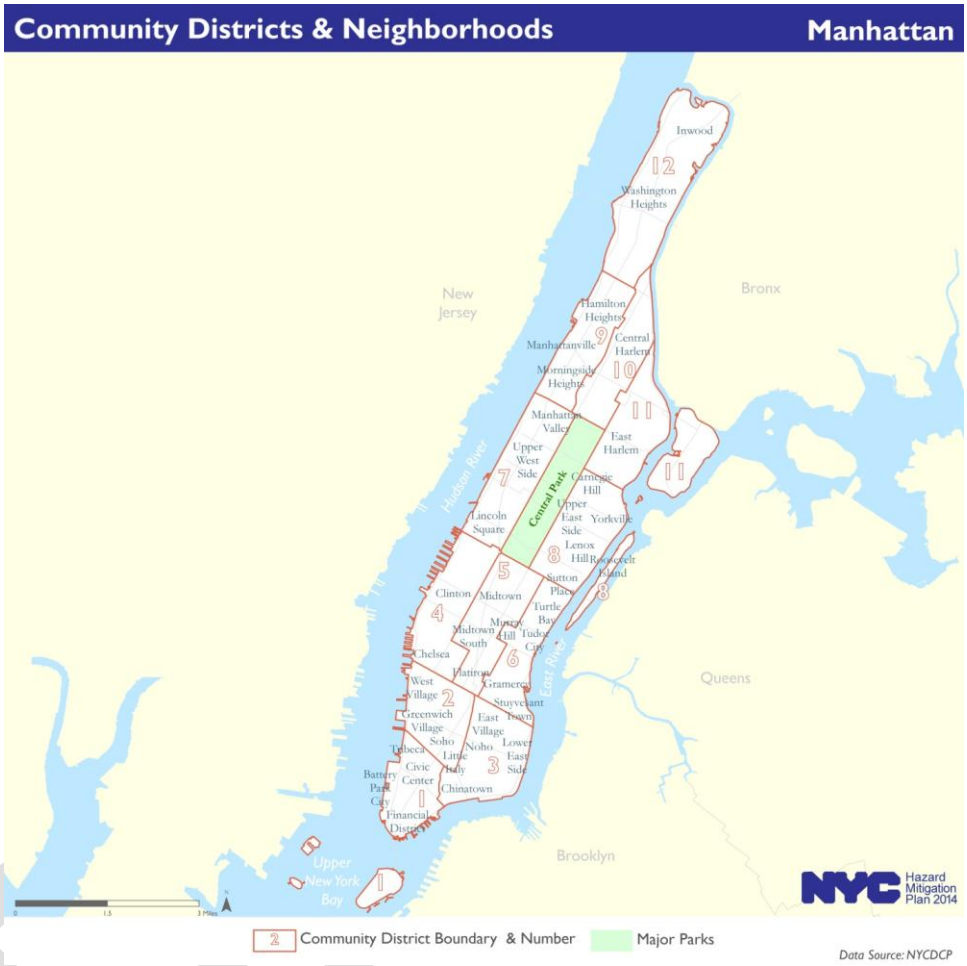

Figure 14: Manhattan Community Districts and Neighborhoods

Queens is the largest borough in size and is made up of 14 Community Districts. Both major New York City airports, LaGuardia Airport and John F. Kennedy International Airport, are located in Queens. Every year it hosts US Open Tennis in Flushing Meadows/Corona Park.

Figure 15: Queens Community Districts and Neighborhoods

Staten Island has three Community Districts. It is the least populated, but has been the fastest growing borough in terms of population over the three decades.

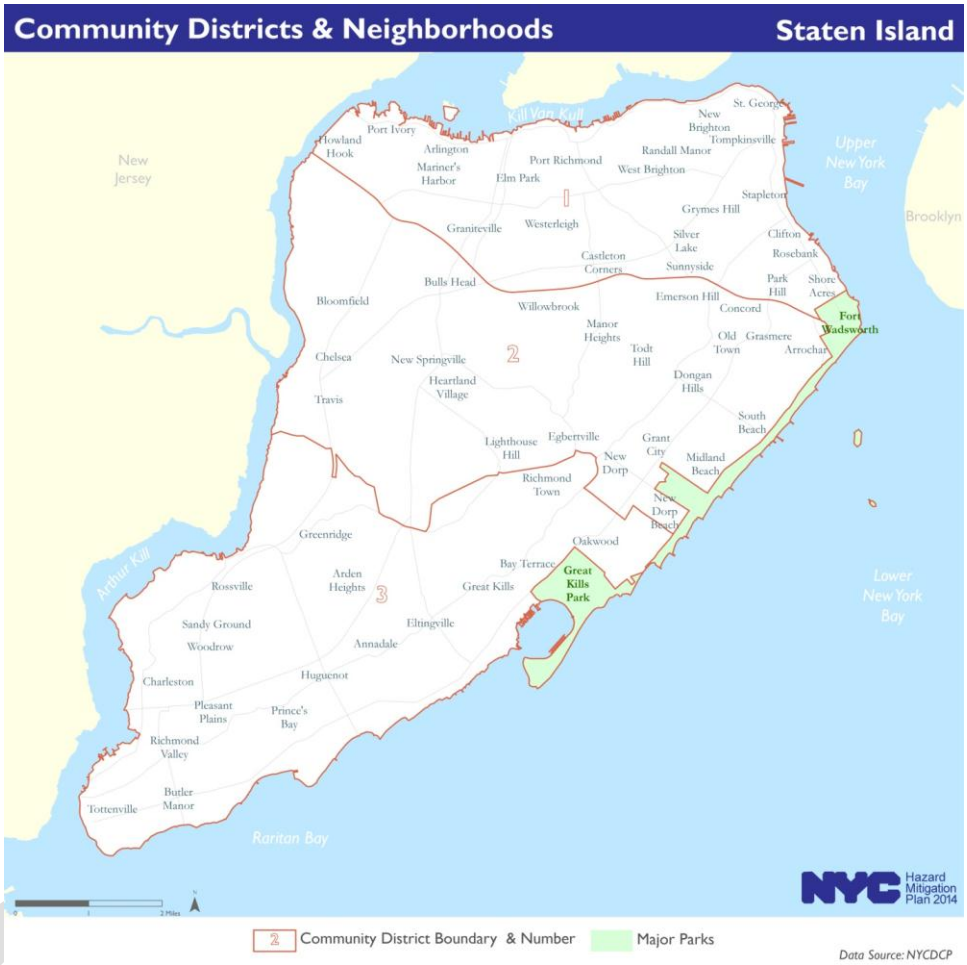

Figure 16: Staten Island Community Districts and Neighborhoods

C. Economy

New York City is the world's financial capital and the backbone of the nation's economy. It is home to a broad spectrum of industries–from finance and high-tech to tourism and manufacturing–and millions of regional jobs (see Table 1).

Industry	Number of Employees
FIRE	436,585
Finance and insurance	318,395
Securities	163,421
Banking	91,516
Other	63,458
Real estate	118,190
SERVICES	2,196,258
Information	174,920
Professional and business	639,055
Professional, scientific, and technical Services	361,275
Management of companies and enterprises	63,157
Administrative services	214,623
Educational	201,153
Health and social assistance	621,254
Arts and entertainment	81,469
Accommodation and food	300,844
Other	177,563
TRADE	482,209
Retail	337,930
Wholesale	144,279
MANUFACTURING	75,133
TRANSPORTATION AND UTILITIES	126,121
CONSTRUCTION	119,403
TOTAL PRIVATE	3,435,709
GOVERNMENT	543,751
TOTAL (Private + Government)	3,979,460

Table 7: New York City Employment by Industry August 2013 (Source: New York City Economic Development Corporation)

New York City leads the country in the number of *Fortune* 500 and 1,000 companies headquartered in a metropolis, including the country's top securities and law firms as well as banks representing every major country. These firms create jobs that attract highly skilled professionals from across the world and the country. According to the New York City Economic Development Corporation (EDC), private sector employment has risen by 84,700 jobs, or 2.5%, since August 2012.

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New York City is also a global center for the arts, fashion, tech/information, and both old and new media. Most major publishing houses and many TV and radio stations are located in the city. TV and film production are long-standing, and growing, industries, with established studios in Manhattan and new ones sprouting in Brooklyn other parts of the city.

Drawn by world-class museums, architecture, arts, and fashion, tourists flock to New York City, making tourism a major industry and contributing greatly to the local economy. In 2012, tourism generated a record $55.3 billion in economic impact, welcoming an all-time high of 52 million visitors and employing more than 363,000 New Yorkers across all five boroughs. In fact, tourism jobs have been growing at a faster rate than any other major industry in the city with an increase of 27% since 2006. Direct visitor spending was $36.9 billion, with $4.2 billion spent on arts, recreation, and entertainment. Over the past six years, the city has added 167 new hotels, increasing room inventory by 26% to a record 90,387.

In recent years, tech/information and new media (which includes tech start-ups and established tech companies, along with major information companies such as Bloomberg L.P. and the New York Times Company) have become billion-dollar industries in New York. The City supported growth in this arena—particularly in what is referred to as "Silicon Alley" in Manhattan, now expanding into other boroughs—by investing in fiber-optic cable and other infrastructure systems that enable and enhance high-speed business communication. There are established world-class academic and research facilities such as NYU-Poly Tech and Columbia University, and plans for the Cornell-Tech campus on Roosevelt Island. Alongside cutting-edge research, professional services firms related to financial consultation or legal issues of intellectual property have also rapidly developed.

Given the leading role New York City plays in the national and international economy, natural and non-natural hazards in New York City can have impacts that ripple out into areas well beyond the city's borders. For example, a severe storm or flood, like Hurricane Sandy in 2012, can cause devastating damage to inventory, equipment, and interior spaces, not to mention structural damage to buildings. According to estimates released by the Mayor's Office, the direct private losses in New York City from Sandy totaled approximately $8.6 billion, of which up to $4.8 billion were uninsured.

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3. The Built Environment

No other American city can match New York in the diversity of its built environment. From beachfront bungalows to Manhattan skyscrapers, street networks to ferry terminals, power plants to fuel pipelines, airports to marinas–New York is one of the most varied and complex cities in the world. It has more than 6,000 miles of streets and highways, over 800 miles of subway track, more than 2,000 bridges, and four major tunnels–all working together to move millions of people in and through the city. Additionally, the city has nearly a million structures of almost every imaginable type and use, including more than 2,647, schools, over 60 hospitals, scores of museums, four major stadiums, and two major airports. Beneath the surface, below the streets and buildings, lies a vast network of critical underground infrastructure—including pipes and fiber-optic cables—that enable millions of people to live in and visit the city daily.

While millions of physical assets exist throughout the city, certain assets are vital to the city's security, public health and safety, economy, and way of life. In the event of a major natural disaster, the city will need these critical assets to continue operating and sustain daily activities for its residents.

A. Land Use

Land Use	Lots		Total Lot Area		Total Building Area	
	#	%	Sq. Feet	%	Sq. Feet	%
Residential	705,635	82.2%	2,649,548,962	39.4%	2,922,803,217	54.3%
Mixed use	48,692	5.7%	205609256	3.1%	718,420,953	13.3%
Commercial	24,367	2.8%	268421354	4.0%	763,858,049	14.2%
Industrial	12,044	1.4%	239745799	3.6%	257,319,628	4.8%
Transportation/utility	6,615	0.8%	509482165	7.6%	77,891,060	1.4%
Public facilities	12,145	1.4%	457299192	6.8%	562,221,009	10.4%
Open space	4,915	0.6%	1813244034	27.0%	37,252,673	0.7%
Parking	11,346	1.3%	86694408	1.3%	36,107,008	0.7%
Vacant land	28,548	3.3%	443466595	6.6%	1,889,225	0.0%
All others or no data	3,657	0.4%	51344029	0.8%	5,333,136	0.1%
Total	857,964	100%	6,724,855,794	100.0%	5,383,095,958	100%

Table 8: Summary of New York City Land Use (Source: MapPluto 13V1)

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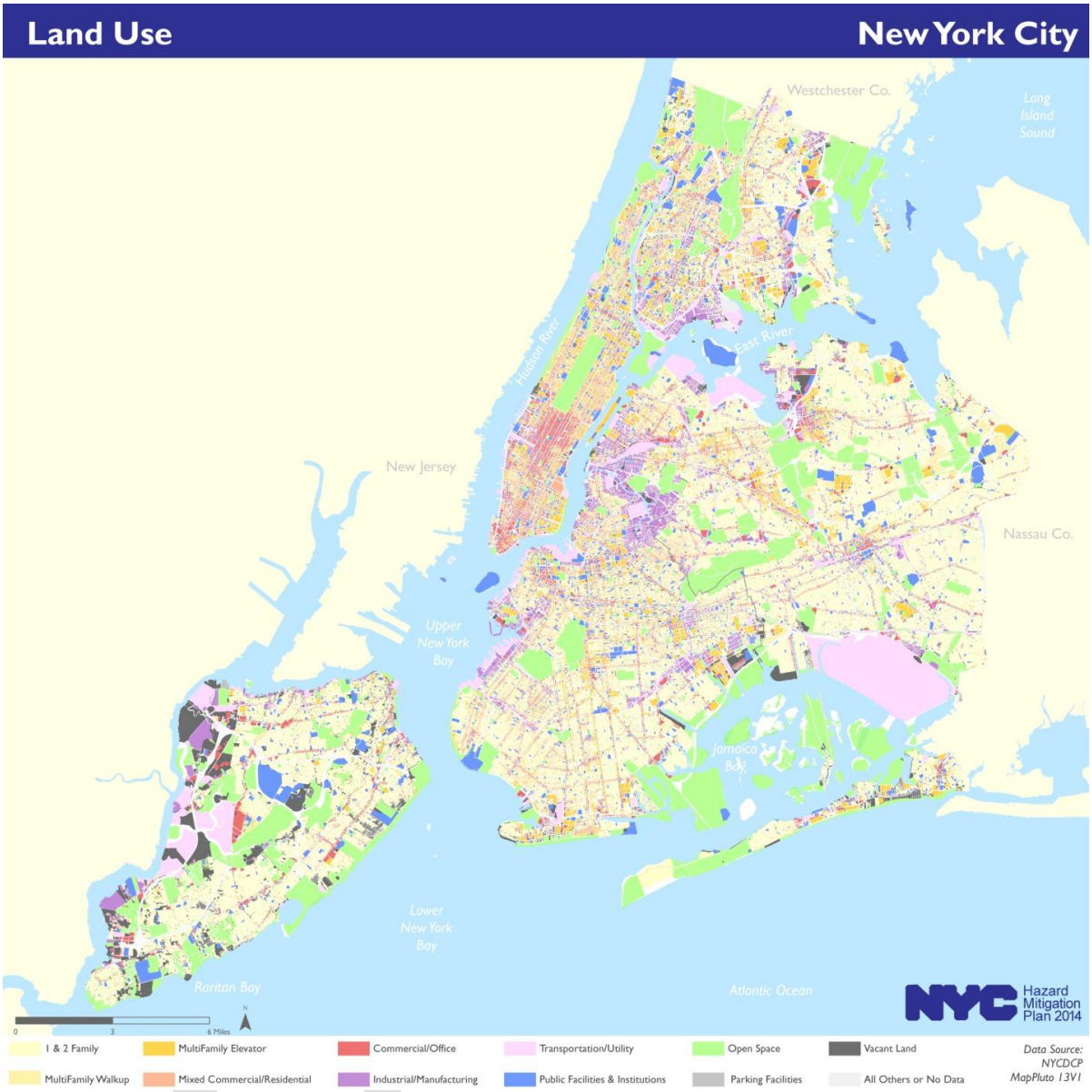

Figure 17: Land Use in New York City

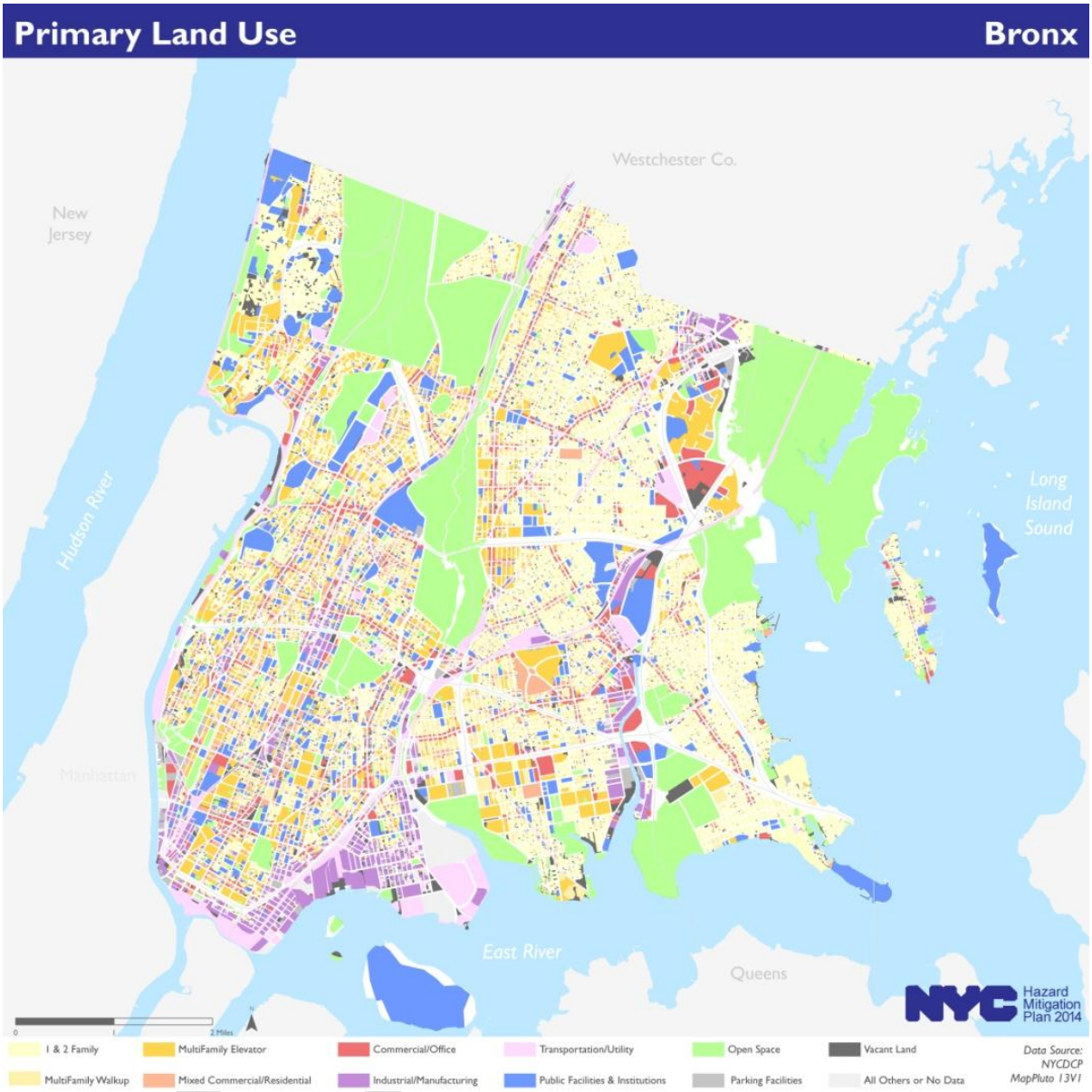

Figure 18: Primary Land Use in the Bronx

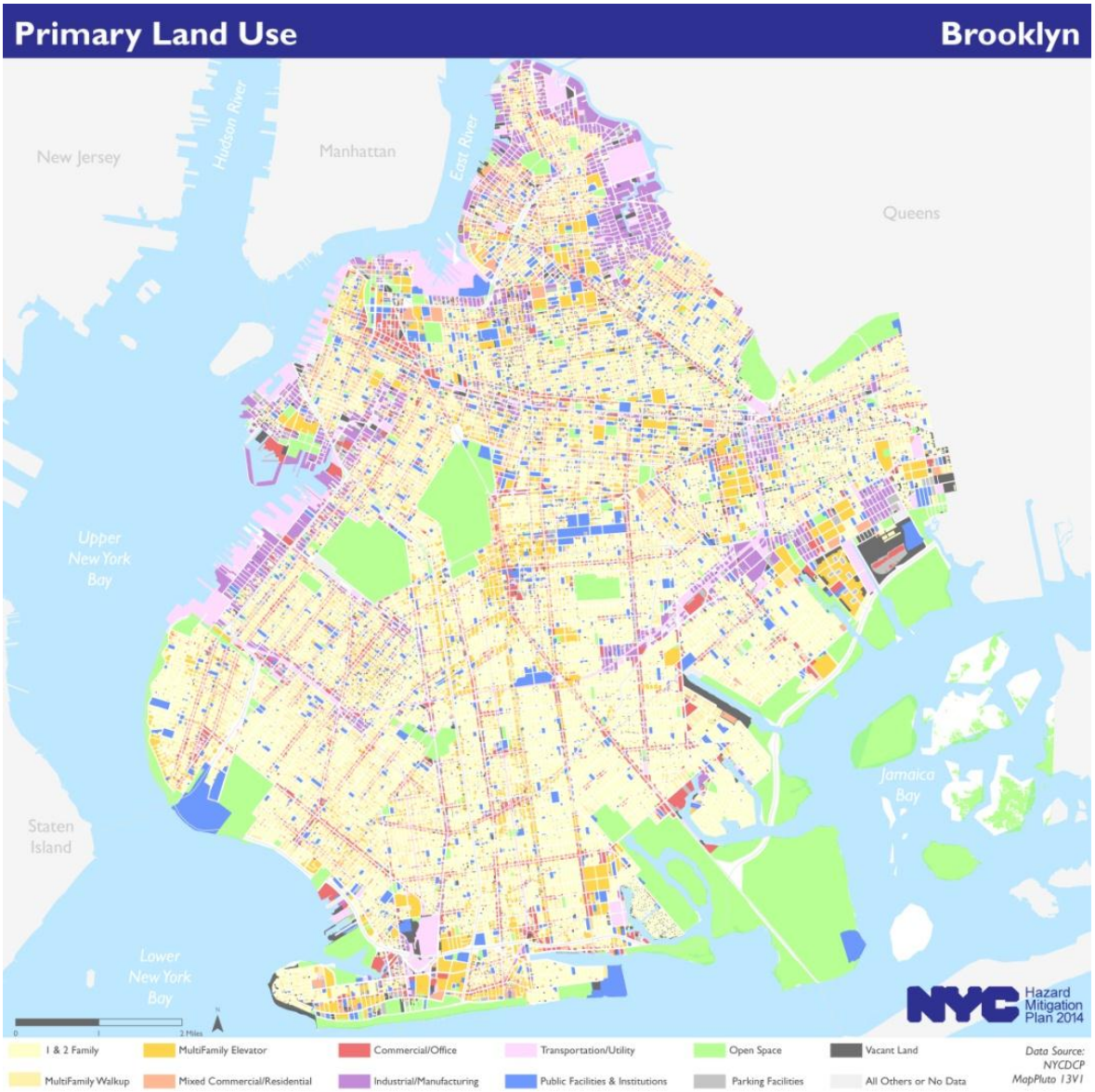

Figure 19: Primary Land Use in Brooklyn

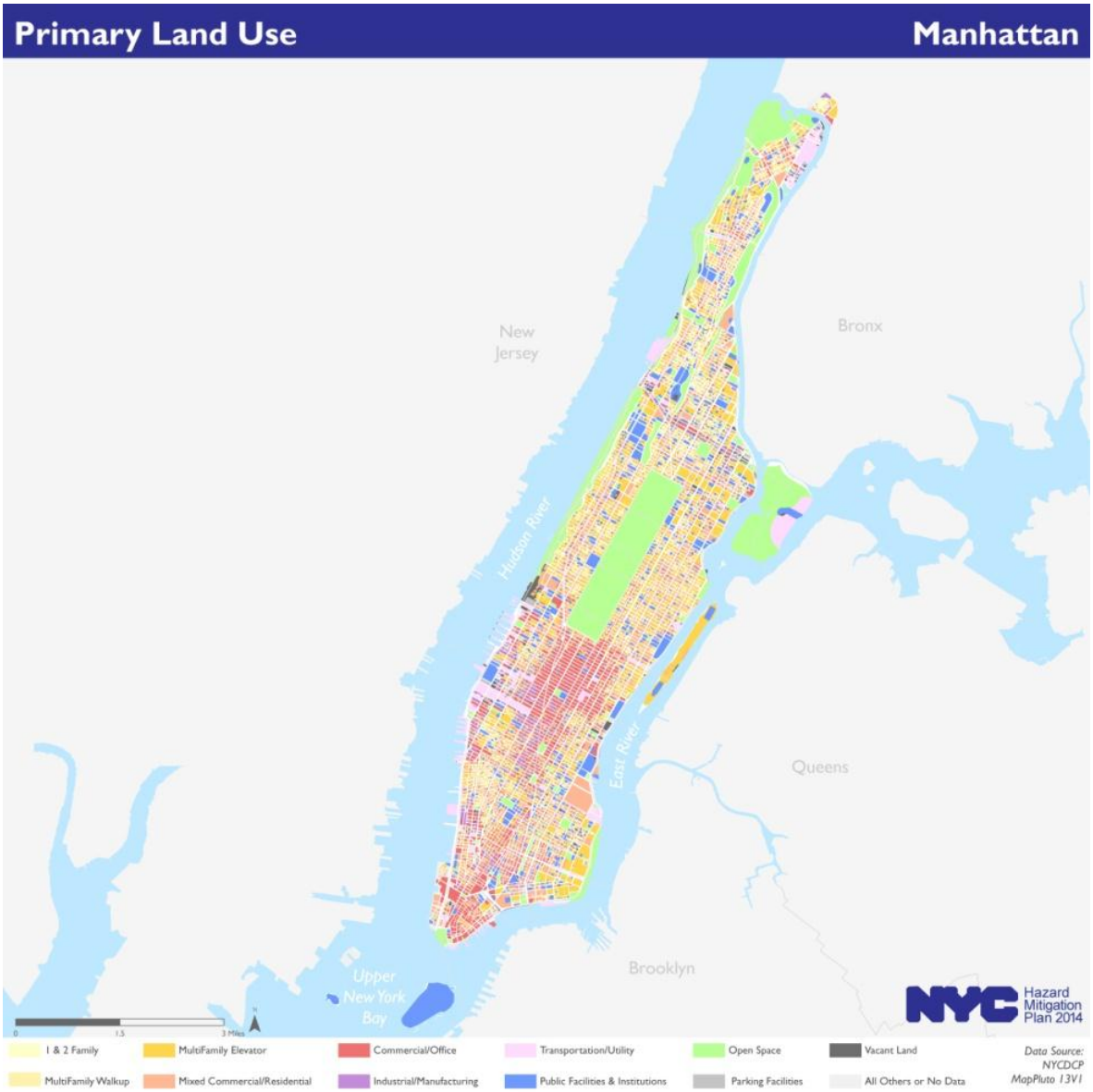

Figure 20: Primary Land Use in Manhattan

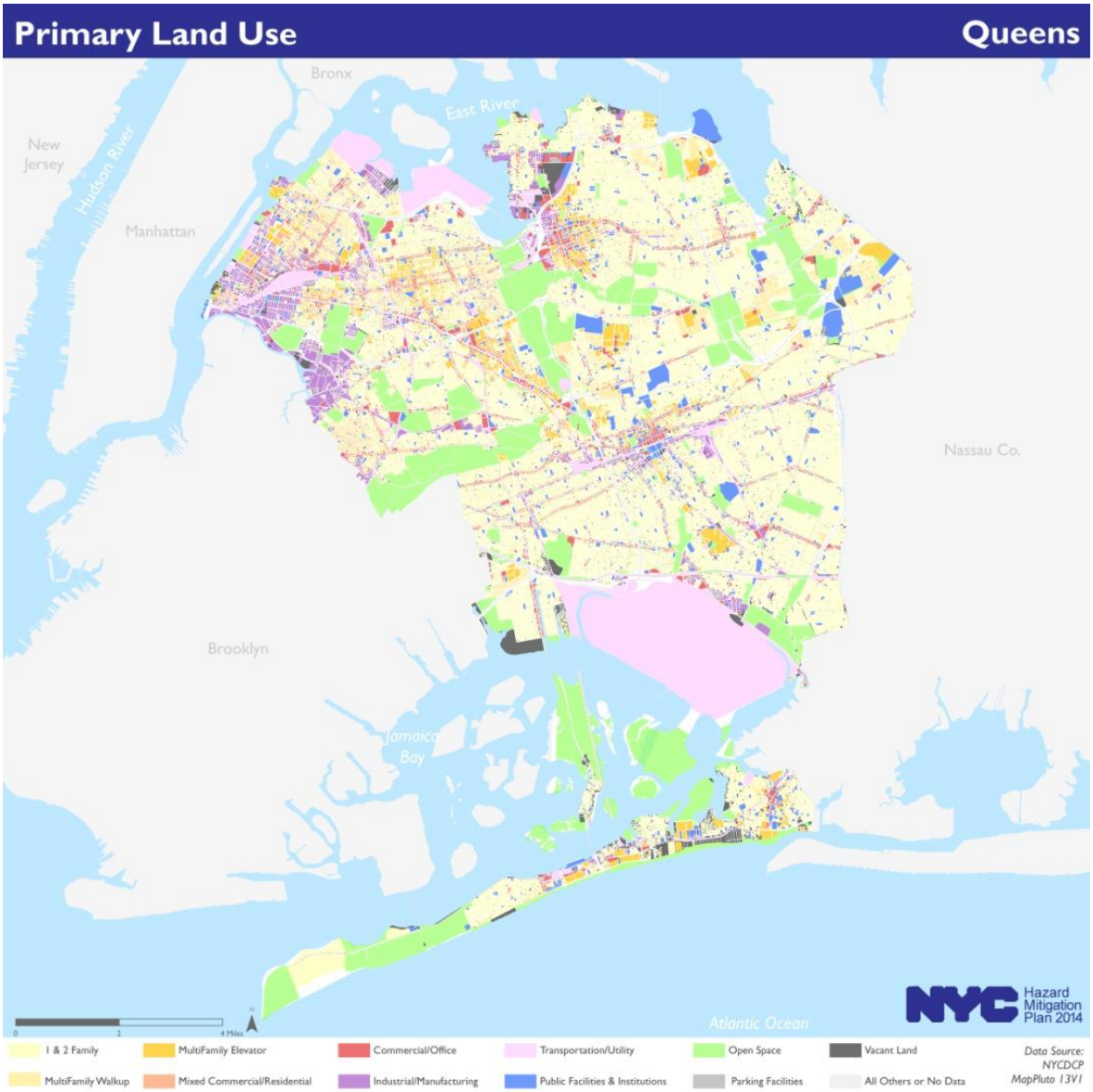

Figure 21: Primary Land Use in Queens

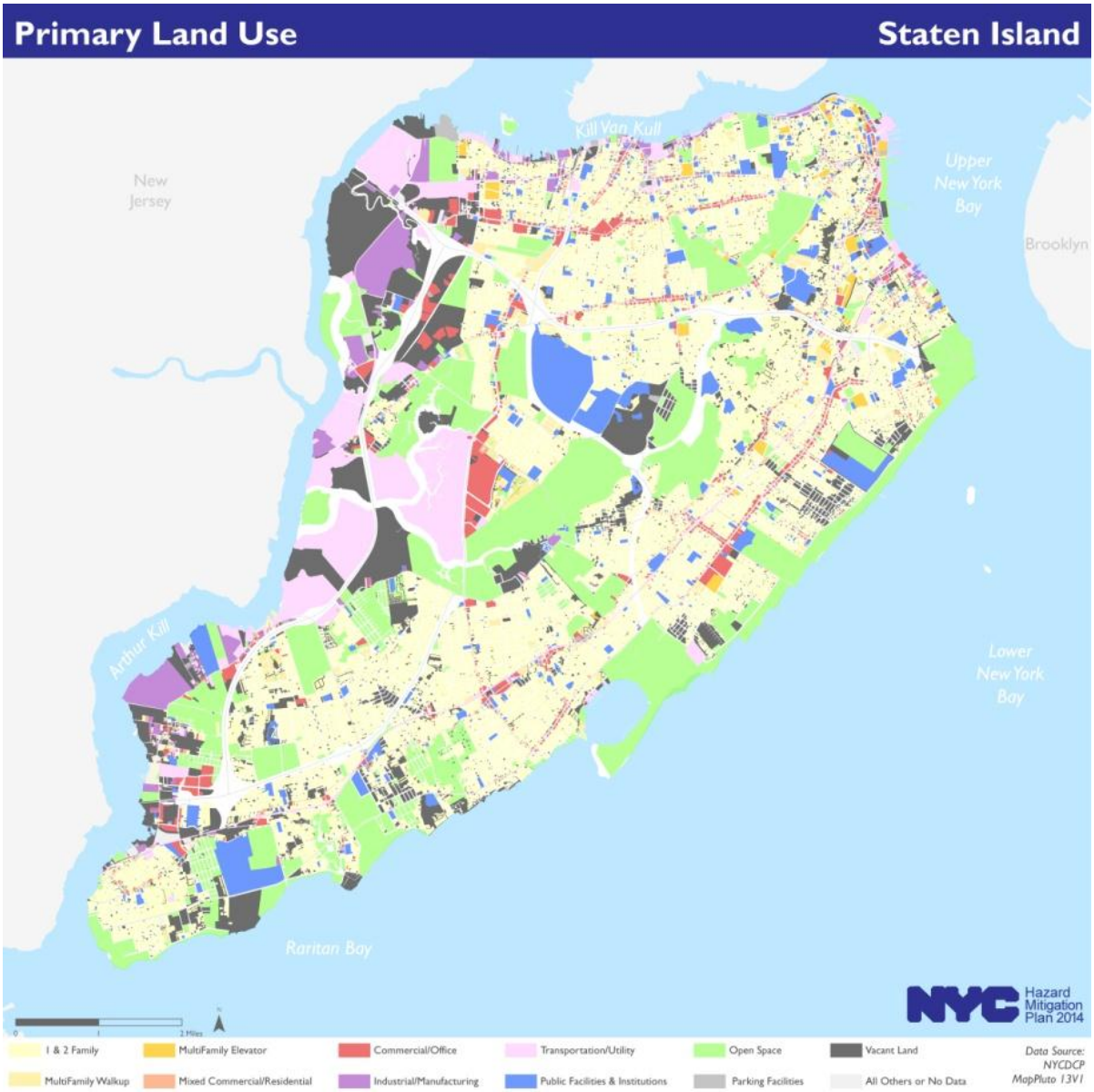

Figure 22: Primary Land Use in Staten Island

B. Buildings

a. Building Stock and Construction Type

New York City has a diverse building stock encompassing nearly a million structures of almost every imaginable type and combination of uses (See Table 9). These buildings are New York City's homes, workplaces, museums, historic landmarks, community centers, and places of worship—and they are also critical contributors to the rich and varied character of communities in each borough and across the city.

Borough	Number of Buildings	% of city
Brooklyn	315,875	31.7
Bronx	102,180	10.3
Manhattan	46,249	4.6
Queens	396,520	39.8
Staten Island	135,057	13.6
Total	995,881	100.0

Table 9: New York City Number of Buildings Summary Data (Source: MapPluto 13V1 2013)

In New York City, materials used in building construction are often referred to as combustible and non-combustible. So-called "combustible" buildings are built using lighter stud-frame construction or wood joists on masonry bearing walls; and heavier "non-combustible" buildings, use steel or masonry and concrete frames.

Table 10 uses 2013 New York City parcels data to show a summary of New York City's building stock based on Hazard Multi-Hazard (HAZUS-MH) categories for construction and occupation type. According to this analysis, of the 801,298 buildings with a known construction type, 49% are masonry and 50% are wood. Manhattan is the only borough that commonly sees a third construction type—steel—which comprises 9% of the total buildings in the borough. As Map 23 indicates, Manhattan has very few wood structures (only 5% of the total 38,249 buildings), whereas 85% of the structures are masonry. Staten Island is the inverse, with 92% of structures made from wood, a common construction type for the single-family residential buildings that are prevalent in that borough.

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Borough	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Total
HAZUS-MH Construction Type (known)						
Masonry	178,601	56,452	32,481	117,462	8,253	393,249
Wood Frame	79,011	25,148	1,933	188,744	103,876	398,712
Steel	1,400	335	3,284	1,504	331	6,854
Concrete	652	390	542	397	291	2,272
Manufactured Housing	58	31	9	75	38	211
Total	***259,722***	***82,356***	***38,249***	***308,182***	***112,789***	***801,298***
HAZUS-MH Occupation Type (known)						
Residential	74,507	242,024	31,273	291,680	108,217	747,701
Commercial	8,284	20,649	7,829	18,264	6,358	61,384
Industrial	866	2,542	751	2,633	486	7,278
Religion	729	1,906	805	1,324	218	4,982
Educational	478	1,106	659	644	199	3,086
Government	118	211	222	171	71	793
Total	***84,982***	***268,438***	***41,539***	***314,716***	***115,549***	***825,224***
Value ($)						
Total Building Market Value	$71,967,721,908	$231,659,712,807	$402,716,508,225	$249,063,864,554	$65,034,758,932	$1,020,442,566,426
Total Building Content Value	$50,612,689,861	$144,298,565,503	$309,714,342,696	$163,048,002,129	$40,753,569,150	$708,427,169,339
Total	**$122,580,411,769**	**$375,958,278,310**	**$712,430,850,921**	**$412,111,866,683**	**$105,788,328,082**	**$1,728,869,735,765**

Table 10: New York City Building Stock Summary Data (Source: MapPluto 13V1 2013)

Note: While the summary table uses best available parcels data, the number of buildings is undercounted since there can be multiple buildings in once parcel and that the data only provides information for the primary building on the parcel.

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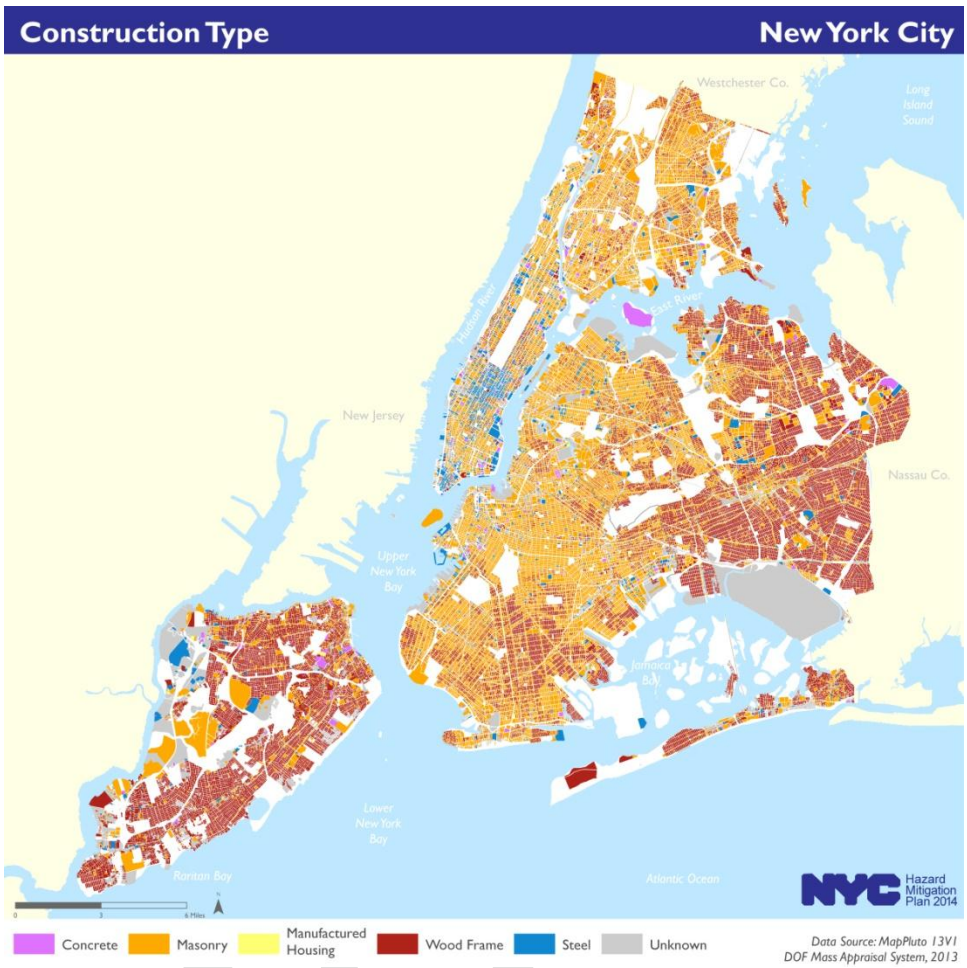

Figure 23: New York City Buildings by Construction Type

b. Building Age

Buildings in New York City can also be categorized by their age. The majority of the city's building stock, approximately 80% (excluding lots with parks, open space or with no data), was built before the 1961 Zoning Resolution that helped to modernize building regulations and improve safety standards.

Building age is an important indicator of structural vulnerability to the effects of some hazards. This is in part because different rules relating to building construction and materials were in effect at different times. For example, In New York City, light-frame buildings built decades ago according to less stringent codes tend to sustain more structural damages during a hazard than newer, heavier buildings made with non-combustible materials like steel, concrete, and masonry, and constructed to modern standards (particularly those enacted since the 1961 Zoning Resolution and Building Code of 1968). As larger buildings continued to be constructed to accommodate the city's growing population, the City amended its Building Code to increase fire protection requirements in areas with high concentrations of residents. Additionally, the city has been actively incorporating resiliency into its building regulations since 1983, when FEMA first released its Flood Insurance Rate Maps (FIRMs) for New York City, setting the boundaries of the 100-year floodplain.

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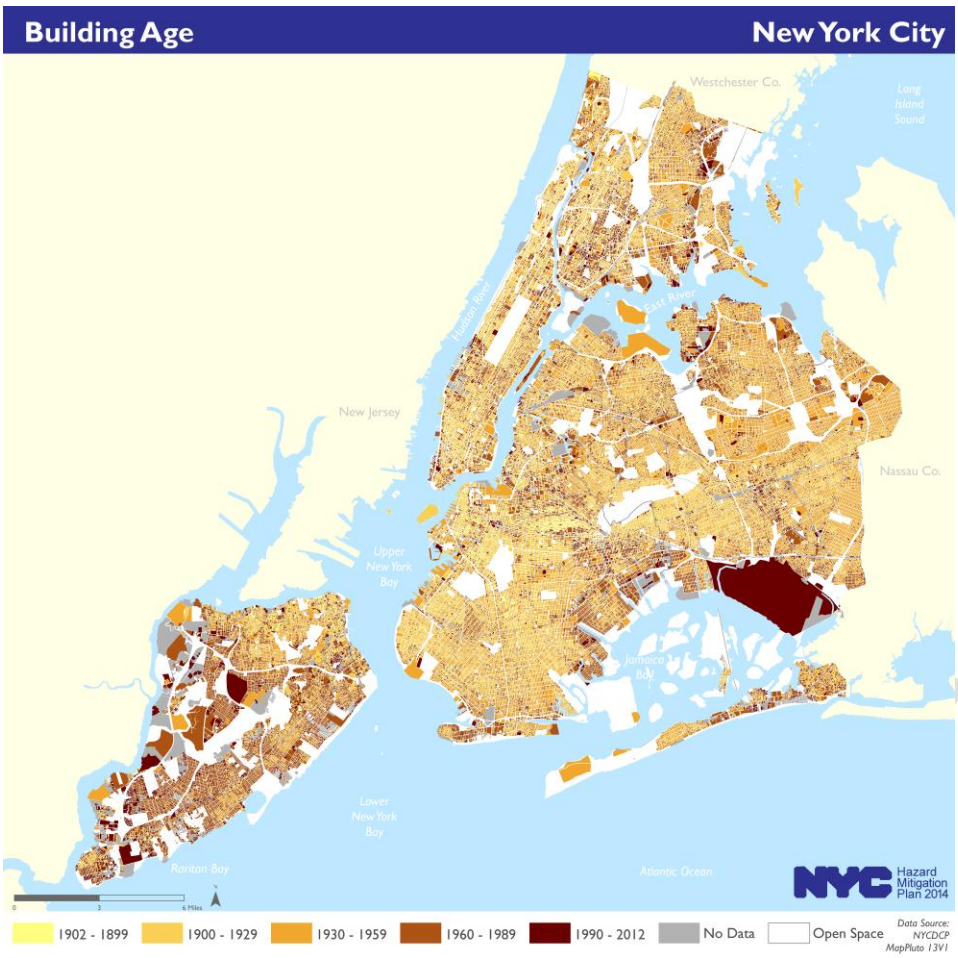

Figure 24: New York City Buildings by Age

c. Building Value

According to the New York City Department of Finance's latest available data, New York City's total building and market value is slightly over one trillion dollars. By applying Hazard Multi-Hazard (HAZUS-MH) assumptions for determining the content value within these buildings, it can be estimated that New York City's total content value is $708 billion. Manhattan accounts for the largest proportion with approximately 40% of the city's building value and 44% of its contents value.

However, the physical value of a building and its contents are not reflective of overall value. The businesses and industries housed in many of these buildings, especially in Manhattan's financial district and midtown, are sometimes worth billions more.

Building Content Value

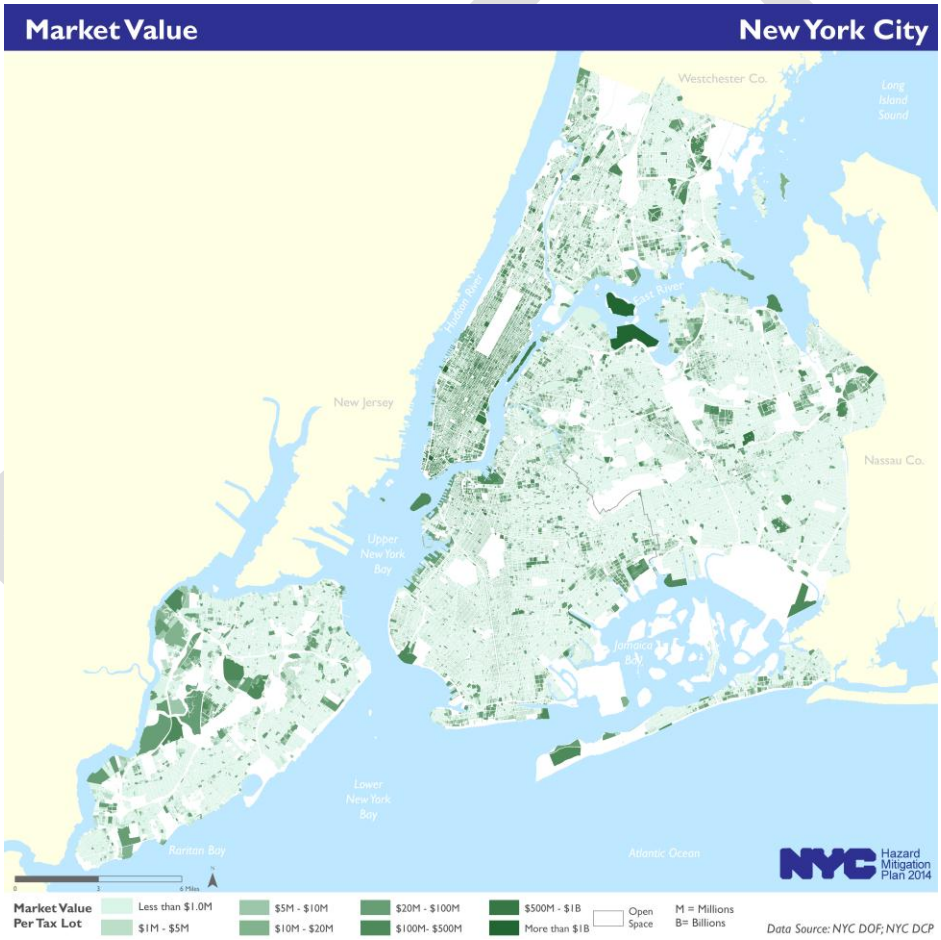

Figure 25: Market Value of Buildings in New York City

d. New York City Construction Code

Enacted in 1968, the New York City Building Code was one of the country's most stringent building codes. However, decades of piecemeal modifications produced a long, cumbersome code that was difficult to interpret. In 2002, Mayor Bloomberg assembled an advisory committee to study the possibility of adopting a Model Code. The committee, led by the Department of Buildings (DOB), concluded that adopting the International Building Code (IBC) format would ensure an up-to-date and comprehensive building code to meet the present and future challenges of New York City's dense urban environment.

Using the ICB, the Committee developed a new code for the city, and this revised New York City Construction Code (Construction Code) became effective on July 1, 2008 and applies to all new construction within the city. Many of the new code provisions address natural hazard mitigation, including new standards to protect buildings from drought, earthquakes, extreme temperatures, flooding, wind, and winter weather.

- **Drought**

The Construction Code addresses water conservation by providing rebates to encourage the use of products and engineering that reduce consumption, such as waterless urinals and rain/wastewater recycling for non-potable uses, in the construction of new and sustainable buildings.

- **Earthquakes**

The Construction Code updates the seismic engineering requirements to current national standards. In addition, and for the first time, the Construction Code takes soil and foundation underpinning into account during construction, requiring seismic detailing and inspections to ensure compliance with new construction standards.

- **Extreme Temperatures**

The Construction Code adopts sustainable elements in the design of new and old buildings. It allows the construction of "green roofs," a thin layer of vegetation installed on a roof to help absorb rainwater, provide insulation and combat the heat island effect, whereas the previous code required special permission before a green roof could be constructed. The Construction Code also requires heat-reflective coverings on roofs with a slope less than 25%. These two provisions will help New York City reduce the urban heat island effect and mitigate extreme heat. Changes to zoning provisions in 2012 (the Zone Green Text Amendment) allow for green roofs to be excluded from zoning height limitations.

- **Flooding**

To protect against extreme rainfall events, the Construction Code requires the installation of overflow drains to safeguard roofs should primary drains fail. The new requirement for secondary drainage systems also requires that the structural members of roofs are able to support the load of accumulated rainwater.

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For construction in flood zones, Appendix G of the Construction Code establishes regulations that require flood-resistant construction in all new, substantially damaged, or substantially improved buildings pursuant to the latest national standards, meeting or exceeding state and federal flood regulations. In addition, the Construction Code requires critical facilities located in flood zones, such as fire stations and hospitals, be elevated to protect the structures. Local law 990-2012 modified Appendix G of the Construction Code to adopt the Preliminary Flood Insurance Rate Maps as the standard for determining flood risk in advance of the issuance of final maps by FEMA, thus exceeding federal requirements in the interim period. In addition, a new set of zoning regulations was established in 2013 to facilitate reconstruction and retrofitting of existing buildings in flood zones, and to remove obstacles for safer, more resilient new buildings in the flood zone.

- **Wind**

The Construction Code updates wind load requirements and brings them in line with current wind-design practices used throughout the United States. It also establishes wind exposure categories that take into account the influence of surrounding ground surface irregularities and building heights in wind design.

- **Winter Storms**

The Construction Code updates snow-load requirements to incorporate thermal factors for heated and unheated buildings, as well as provisions for snowdrifts caused by parapets and adjacent buildings.

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C. Transportation

New York City's transportation system is sprawling and complex, comprised of large, interconnected rail, roadway, and water networks. All these transportation elements are both essential for daily travel and during hazard event.

a. Rail Transportation

New York City has one of the most complex rail systems in the country. It is made up of an interconnected system of subway and railroad networks that carry two-thirds of all rail riders in the nation. Approximately, 5.3 million daily subway riders and approximately 850,000 daily commuter rail riders commute into and within New York City each day. The Metropolitan Transportation Authority (MTA), the largest transit authority in the nation, operates the three main rail systems: New York City Transit (NYCT), which operates the subway; Long Island Rail Road (LIRR); and Metro-North Railroad (MNR). In addition, the Port Authority of New York and New Jersey (PANYNJ) provides commuter rail service between New Jersey and New York City on the Port Authority Trans-Hudson (PATH) train.

The city's rail transportation relies on electricity for power, consuming 1.8 billion kilowatt hours of power each year. Rail infrastructure is located both underground and above-ground and due to historical development patterns and operational needs, many parts of the city's rail and subway infrastructure are located near the waterfront or in low-lying areas, making them particularly vulnerable to storm and flood risk hazards.

Operator	Average Daily Ridership	Annual Ridership
MTA New York City Subway	5,380,184	1,654,582,265
MTA Long island Railroad	285,082	81,753,411
MTA Metro North	281,333	82,953,628
NJ Transit Penn Station*	79,616	N/A
PATH - New York	105,297	31,634,954
** Reflects ridership information for fiscal year 2012 (7/1/11 - 6/3012) and only average weekday boarding at Penn Station New York*		

Table 11: New York City Rail Ridership (Source: MTA, NJ Transit, and Port Authority 2013)

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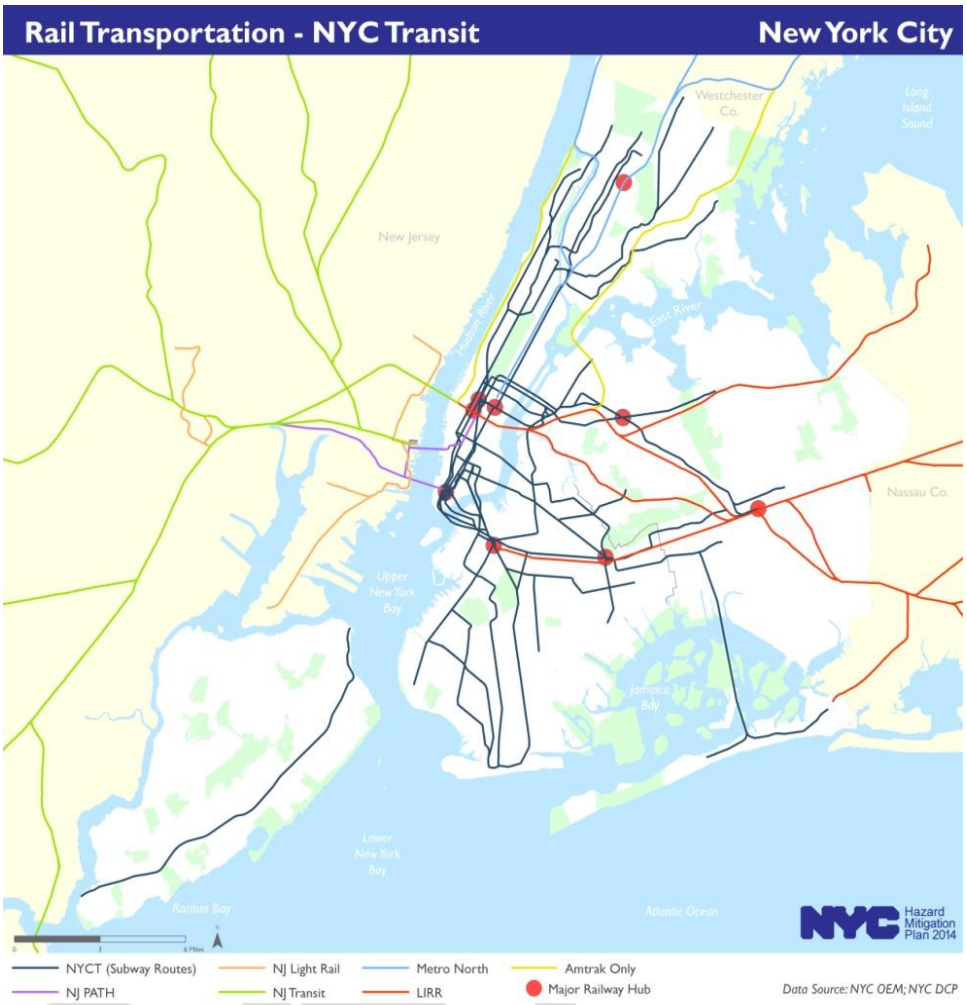

Figure 26: New York City Rail Network

b. Roadway Transportation

The New York City Department of Transportation (DOT), New York State Department of Transportation (NYS DOT), MTA, and PANYNJ manage roadway travel in New York City. The roadway network contains 6,000 miles of streets and 12,000 traffic signals. Bridges and tunnels are vital components of roadway transportation, providing inter-borough connections for vehicles and public transit as well as access to and from New York City. In total, the city has 2,027 bridges, many of which are over a century old. DOT manages 787 bridge structures including six tunnels. DOT also maintains approximately 5,800 miles of streets, sidewalks, and highways. The MTA operates 304 bus routes throughout the city and oversees seven bridges and two tunnels that service more than 300 million vehicles each year. PANYNJ manages most of the transportation between New York and New Jersey including four bridges, two tunnels, and two bus terminals. Figure 27 represents the major roads, bridges, tunnels, and bus stations in New York City.

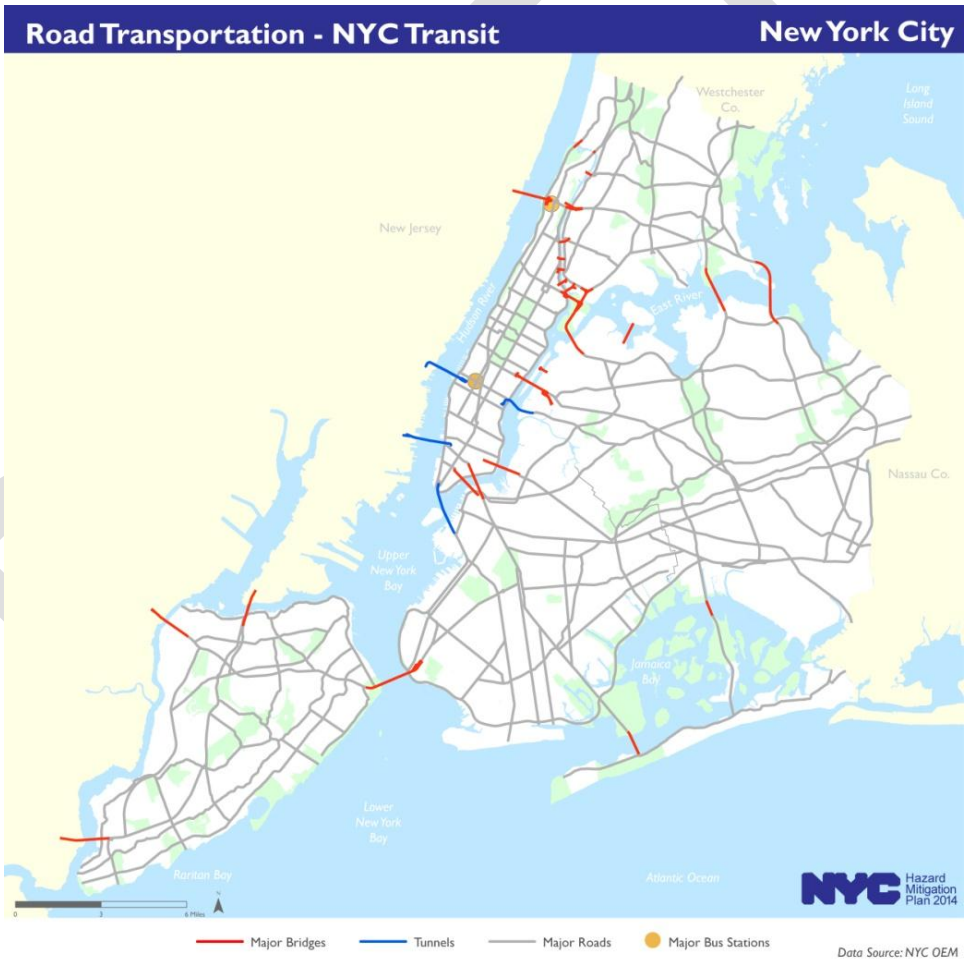

Figure 27: Major Elements of the New York City Road Network

c. Air and Water Transportation

Airports, port facilities, and ferry landings are located throughout the New York City region. New York City has two major airports, LaGuardia Airport (LGA) and John F. Kennedy International Airport (JFK), both in Queens. In 2012, 75 million passengers traveled through these two airports. Newark Liberty Airport, located in New Jersey, also serves the New York City area. PANYNJ operates all three airports in the area.

The Port of New York and New Jersey, managed by PANYNJ and used by private operators, is the largest port complex on the East Coast. In 2012, more than 34 million tons of ocean-borne general cargo with an estimated value of $171 billion moved through the port. There are three passenger cruise terminals in the port—two in New York and one in New Jersey. In addition, there are more than 50 piers, docks, and ferry terminals that are owned by New York City agencies such as DP&R, DOT, and the New York City Economic Development Corporation (EDC).

Ferries are an increasingly popular mode of transit with the expansion of both private and publicly operated vessels between New Jersey and New York City and within the five boroughs. Ferries run by public and private operators are a regular mode of transit for many commuters. The largest commuter ferry is the Staten Island Ferry, which is operated by DOT and carries more than 22 million passengers each year on a 5.2-mile route between Staten Island and Lower Manhattan. This ferry is the only non-vehicular mode of transportation between Staten Island and Manhattan. In total, there are 35 active ferry landings providing services for the city and region.

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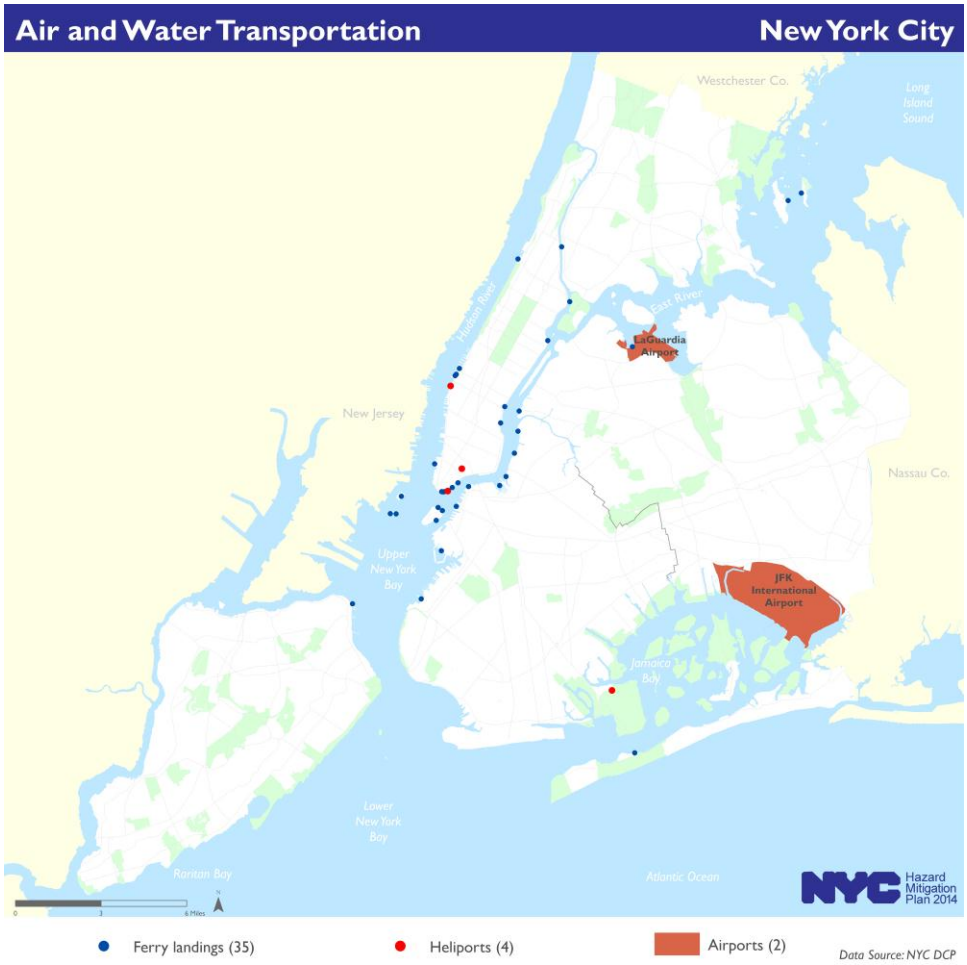

Figure 28: Air and Water Transportation Assets in New York City

D. Water Supply and Wastewater Treatment

Water Supply

New York City's drinking water is world-renowned for its quality. Each day, more than 1 billion gallons of drinking water is delivered to the taps of the city's 8.2 million residents, approximately one million people living in Westchester, Putnam, Ulster, and Orange counties, as well as the millions of tourists and commuters who visit the city throughout the year. In all, the system supplies nearly half the population of New York State with water.

The Department of Environmental Protection (DEP) manages the City's water supply system and ensures the steady flow of clean drinking water from large upstate reservoirs—some more than 125 miles from the City— through a complex network of aqueducts and tunnels to in-city reservoirs.

The Croton watershed was the city's first upstate water supply and is located entirely east of the Hudson River in Westchester, Putnam, and Dutchess Counties, with a small portion in Connecticut. The watershed contains 13 reservoirs and three controlled lakes. Historically, 10% of the city's average daily water demand has been provided by the Croton system. As of the writing of this report, the system is offline temporarily while the City constructs a water treatment plant to filter the Croton water. Once completed, Croton water will be filtered and disinfected before flowing into Jerome Park Reservoir in the Bronx.

The Catskill system consists of two reservoirs—Schoharie and Ashokan—located west of the Hudson River in Ulster, Schoharie, Delaware, and Greene Counties. Water leaves Schoharie. Reservoir via the 18-mile Shandaken Tunnel, which empties into the Esopus Creek and then travels 22 miles through the Esopus to Ashokan Reservoir. Water leaves Ashokan Reservoir via the 75-mile-long Catskill Aqueduct, which travels to Kensico Reservoir in Westchester County. The Catskill system provides, on average, 40 percent of the city's daily water supply.

The Delaware system consists of four reservoirs west of the Hudson River: Cannonsville, Pepacton, and Neversink in the Delaware River basin, and Rondout in the Hudson River basin. The outflow from the first three reservoirs arrives in Rondout via three separate tunnels. Water then leaves Rondout and travels to West Branch Reservoir in Putnam County via the 90-mile Rondout/ West Branch Tunnel. Water from West Branch subsequently flows through the Delaware Aqueduct to Kensico Reservoir. The Delaware system provides, on average, 50 percent of the city's daily demand.

Because waters from the Catskill and Delaware watersheds mix at Kensico Reservoir, they are frequently referred to as one system: the Catskill/ Delaware system. In 2012, all of the city's drinking water came from the Catskill/Delaware system.

The City designed and built the three water collection systems with various interconnections, permitting exchange of water from one to another, to increase flexibility and resiliency during heavy rain events. Once the water reaches the City, the 7,000 miles of water mains and pipes that distribute water throughout the five boroughs are buried and pressurized, which protects them from flooding. Furthermore, there is necessary redundancy built into the system so that water supply can be diverted to different pipes within the system to ensure the constant flow of water.

New York City's water distribution system is almost entirely dependent on gravity, minimizing the need for pumping. Water travels from reservoirs with sufficient pressure to reach up to the sixth floor of most buildings. High-rise buildings rely on rooftop water towers or pump systems to provide water to upper floors.

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Figure 29: New York City's Water Supply System

Wastewater Treatment

Every day, 1.3 billion gallons of wastewater goes down toilets and drains in homes, schools, businesses, and factories and then flows into New York City's sewer system. In some New York City neighborhoods, separate storm sewers carry runoff from the streets directly to local streams, rivers, and bays. However, like most old urban centers, the city relies on a combined sewer system—which makes up 60% of the city sewer infrastructure–to collect sanitary and industrial wastewater, rainwater, and street runoff together and convey all of it to wastewater treatment plants. Stormwater enters the system from catch basins that direct flow to the city's sewer system. Sanitary waste enters the sewer system through direct connections from buildings.

All of the city's 14 wastewater treatment plants are located along the waterfront at relatively low elevations (see Figure 30). Waterfront locations significantly reduce the cost and environmental impact of treating wastewater in New York City, making it easier for flow to arrive by gravity and treated effluent to be discharged into waterways (though in low-lying areas the city has 96 pumping stations that lift wastewater and stormwater to a higher elevation and help it continue on its journey). Secondarily, but also importantly, the waterfront locations allow sludge to be transported efficiently by boat to DEP facilities for additional treatment.

New York City's wastewater treatment plants remove most pollutants from wastewater before releasing it to local waterways. At the plants, physical and biological processes closely duplicate how wetlands, rivers, streams, and lakes naturally purify water. Treatment at these plants is quick, taking only about seven hours to complete (whereas in the natural environment, this process could take many weeks, and at any rate nature alone cannot handle the volume of wastewater New York City produces).

Under normal conditions, the system is adequate to perform full treatment on the combined volume of sewage and stormwater. During periods of heavy rain or snow, however, when flow exceeds two times dry-weather capacity, the volume of sewage and stormwater quickly can exceed the capacity of the wastewater treatment plants. When this occurs, the mix of excess stormwater and untreated sewage flows directly into the city's waterways in what is called "combined sewer overflow" (CSO) events.

In response to these CSO events, the City has invested billions of dollars in infrastructure. Recently the City restructured its approach to implement innovative strategies to absorb rain before it can enter sewers in the first place, and, in the process, create systems of greenery that shade and beautify the city. In 2010, Mayor Bloomberg launched the *NYC Green Infrastructure Plan*, a comprehensive 20-year effort to meet water quality standards, and in 2012, the plan was incorporated into a consent order with New York State that will eliminate or defer $3.4 billion in traditional investments and result in approximately 1.5 billion gallons of CSO reductions annually by 2030.

The City's Bluebelt program complements its Green Infrastructure program. Bluebelts are natural areas that often enhance existing drainage corridors (such as streams, ponds, and other wetland areas) and convey, treat, and retain stormwater in place of traditional "grey" infrastructure. Bluebelts engineer these natural features to slow the flow of water and use vegetation and other elements to absorb and filter impurities. DEP's Bluebelt program started in Staten Island (where there are now almost 10,000 acres in place) and is expanding in Staten Island and into other parts of the city, including southeastern Queens.

Figure 30: Wastewater Treatment Plants in New York City

E. Energy

New York City's energy infrastructure–comprised of electricity, natural gas, and steam networks–is one of the oldest and most concentrated in the nation. Yet it is still among the most reliable. Every day, pipelines bring in natural gas from across the country, power lines link the city to the larger regional grid, generators burn gas to produce electricity, steam travels from large boilers and cogeneration facilities to buildings through miles of underground service pipes. On average, New Yorkers spend roughly $19 billion per year on the energy to power, heat, and cool their city.

a. Electricity

The electric system consists of three major elements: generation, which produces electricity; the transmission system, which transports electricity at high voltages to large substations; and the distribution system, which carries electricity from large substations to smaller ones and ultimately to homes, businesses, and other customers. The city's electrical distribution system is a combination of underground networks and overhead utility lines. This system is owned, operated, and regulated by a wide array of private and public entities.

New York City is a "load pocket," which means transmission lines cannot carry enough energy into the city to meet its peak load. Regulations require in-city generation to supply 80% of the forecasted demand. Transmission lines connecting the city to upstate New York, Long Island, and New Jersey import the balance. New York City's transmission and distribution system is unique in that approximately 70% of the 130,000 miles of lines are underground.

The following parties own and operate nearly all of the in-city generation:

- US Power Generating Company
- NRG Energy
- TransCanada
- New York Power Authority
- Astoria Energy

The following parties own and operate New York City's electric transmission and distribution system:

- Con Edison (majority of New York City electric customers)
- Long Island Power Authority/National Grid (customers in Rockaway Peninsula, Queens)

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b. Natural Gas

Natural gas is responsible for approximately 65% of heating and a significant percentage of cooking needs in buildings throughout New York City. It also fuels more than 98% of in-city electricity production by power plants.

The route that natural gas takes to reach New York City is complex. A system of four privately owned interstate pipelines transports natural gas from the Gulf Coast, Western Canada, and other production areas into the city at interconnection points called "city gates." From the various city gates, high-pressure gas flows through an intra-city transmission system known as the New York Facilities. Gas that is destined for New York City's power plants generally is drawn at high pressure directly from the New York Facilities. To reach most other customers, gas is delivered through a set of regulator stations that reduce the pressure of the gas and send it into a vast network of underground distribution mains. The low-pressure system is composed of cast iron and bare steel mains—outdated infrastructure that gradually is being replaced by the system's operators. This system is located mostly in the oldest parts of the city. Newer, high-pressure mains tend to be made of coated steel and plastic.

In New York City, Con Edison owns and operates the gas distribution system in Manhattan, the Bronx, and parts of Northern Queens. National Grid owns and operates the system in the rest of the city.

c. Steam

Con Edison is the only steam operator in New York City and its system in the city is the largest district steam system in the United States. Con Edison provides over 1,700 customers in Manhattan south of 96th Street—including 10 hospitals and many of the city's largest institutions—with energy for heat, hot water, and, in some cases, air conditioning. The most concentrated steam distribution centers are located in the Financial District and Midtown Manhattan. For customers, the advantage of the steam system is that it allows them to avoid owning and maintaining their own boiler systems. Instead, these customers are only responsible for maintaining on-site steam traps and condensate pumps.

Con Edison's six natural gas- and fuel oil-fired steam generating facilities in Manhattan, Brooklyn, and Queens can collectively produce over 10 million pounds of steam per hour, either cogenerating this steam along with electricity, or producing steam alone in massive boilers. A network of 105 miles of underground pipes transports steam to customers.

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F. Telecommunications

New York City's telecommunications – made up services such as internet, information services, phone services, and cable television – is an essential component of the city's basic infrastructure and not only serves New York's population of 8.2 million, but also the city's 3.9 million workers, 250,000 businesses, and more than 50 million annual visitors. The city's telecommunications infrastructure also plays a critical global role: It is estimated that New York City accounts for approximately 3% of the world's web traffic—even though the city is home to only 0.1 percent of its population.

Generally, telecom services are provided through physical properties such as wire-line, wireless, satellite, cable, and broadcasting equipment. New York City's telecommunications system is comprised of four main components: critical facilities, cabling, cell sites, and equipment in individual buildings:

- **Critical facilities** are large distribution and switching centers. They provide connectivity across all major services, and each supports tens of thousands of customers.
- **Cabling** provides the connections essential to telecommunications and can be strung overhead via utility poles or run underground. New York's oldest cabling is lead-encased copper, with sections ranging from 10 to 90 years old. Conduit, an underground pipe through which cable is threaded, is the way most cable snakes beneath New York City. While it is more expensive to construct than overhead wires, it is also more protected and less intrusive. Conduit is used in the densest areas of the city—Manhattan, the Bronx, and parts of Brooklyn, Queens, and Staten Island. Manhattan and the Bronx have a shared conduit network run by Empire City Subway, a private company that is responsible for providing conduit infrastructure for providers in all areas of those boroughs. In the other boroughs, Verizon, Time Warner Cable, and Cablevision have the most extensive conduit infrastructure, some of which is rented to other providers.
- **Cell sites** are typically placed on the roofs of buildings and have three components: an antenna, electronics, and backhaul circuits (cables that connect the cell site to the larger telecommunications network).
- **Equipment in homes, offices, and other buildings** distributes signals transmitted via cabling from critical facilities to individual customers.

New York City's telecommunication networks and services are provided, used, protected, and regulated by both private and public sector entities.

All three tiers of government – federal, state, and city - are involved in the regulation of the telecommunications industry. At the Federal level, the Federal Communications Commission (FCC) has significant authority over wireless, long-distance phone, and Internet services. At the state level, New York State Public Service Commission (PSC) has authority regarding local traditional landline telephone service. At the local level, the Department of Information Technology and Telecommunications (DoITT) is responsible for providing IT services, infrastructure, and telecommunications for City agencies and overseeing franchises that permit

communication companies to use public rights of way (above and below city streets) to place infrastructure necessary for providing communication services. The Department of Transportation (NYCDOT) also plays a role as manager of street access through its control of permitting for street construction. Finally, the Department of Buildings (DOB) is the custodian of the Building Code, which determines, among other things, the placement of electrical equipment, backup power, and fuel storage at critical telecommunications facilities.

Though federal, state, and city agencies have shared authority in the city's telecom sector, none currently has comprehensive responsibility for the entire system, and none is charged with ensuring that required service is available in emergencies. Also, while the Federal Communications Commission (FCC) has a Communications Security, Reliability, and Interoperability Council promotes best practices for resiliency, it does not require compliance with these standards. Currently, there is no single entity that is prioritizing or enforcing resiliency across the entire system.

Multiple companies provide voice, data, and video services using a variety of technologies (see Table 12). The primary fixed-line telephone provider in New York City is Verizon, although there are a number of other companies that provide this service to residential and business customers.

Although New York City's telecommunications systems are generally very reliable, a large volume of traffic is routed through a small number of collocation facilities in Lower Manhattan. This centralization may increase the network's vulnerability.

Major Wireless Carriers	Cable and Internet Providers
AT&T	Cablevision
Sprint/Nextel	RCN Telecom Services of New York
T-Mobile	Time Warner Cable
Verizon Wireless	Verizon -FiOS
Metro-PCS	Comcast

Table 12: Telecommunications Companies in New York City

Telecommunications are increasingly important to New Yorkers' health and public safety. Particularly for vulnerable populations during emergencies, being able to send a text to a family member or make a 911 call can be the difference between getting help and being stranded or worse. As hospitals and other healthcare providers transition to electronic medical records, connectivity is becoming even more essential to the city's healthcare system.

G. Structural Vulnerability to Natural Hazards

Though New York City's physical assets have become safer and more structurally sound as building codes and land use laws have been modernized, they remain vulnerable to a variety of natural and non-natural hazards. For example, buildings located within the floodplain or storm

surge zone are susceptible to flooding and/or coastal storms. Buildings along the coastline are also vulnerable to the impacts of long-term coastal erosion. Unreinforced masonry buildings are at a higher risk to earthquake damage than buildings made from sturdier materials, or buildings that are reinforced. Extreme temperatures can cause pavement to buckle and damage overhead electric and telephone lines. Windstorms can cause trees and power lines to fall and debris to fly in the air. High-wind events, such as coastal storms or tornadoes, can cause less robustly built structures to suffer roof failures and building collapses. Winter weather can cause surface degradation to buildings and roadways, and disrupt movement on the roadway.

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H. Emergency Services

New York City's emergency services include the Police Department (NYPD), Fire Department (FDNY), Fire Department Emergency Medical Services (FDNY-EMS), and the Office of Emergency Management (OEM). A number of other City agencies—including DOHMH, DEP, and DOB—also have emergency-response functions. Emergency services are generally well dispersed across the city and correlate with population density. Figure 31 shows the locations of police and fire stations as well as OEM's headquarters.

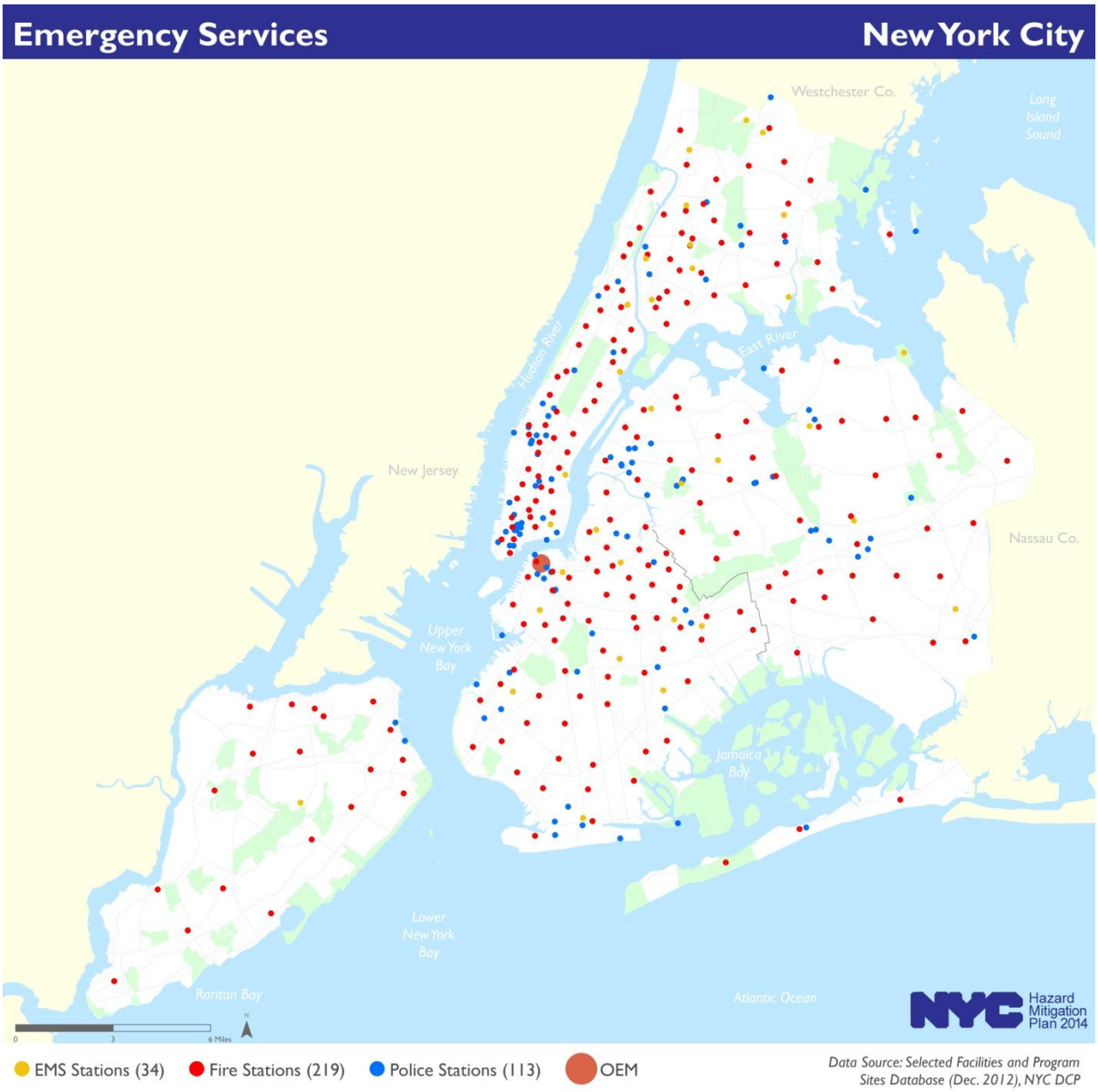

Figure 31: Emergency Service Providers in New York City

I. Hospitals and Healthcare

New York City has the greatest concentration of healthcare facilities in the world. There are 65 hospitals, 177 nursing homes, 35 adult day care centers, and nine hospices citywide. Additionally, 1,400 residential-based providers care for more than 80,000 patients at any given time. Included in this category are nursing homes and other residential providers offering treatment, care, and supportive housing for individuals with substance abuse problems, developmental disabilities, or other behavioral or mental health challenges. The healthcare services that keep most New Yorkers well on a day-to-day basis are delivered primarily through community-based providers. In the majority of cases, these providers are the ones with which patients interact most frequently. These providers offer services from over 10,000 buildings across the five boroughs.

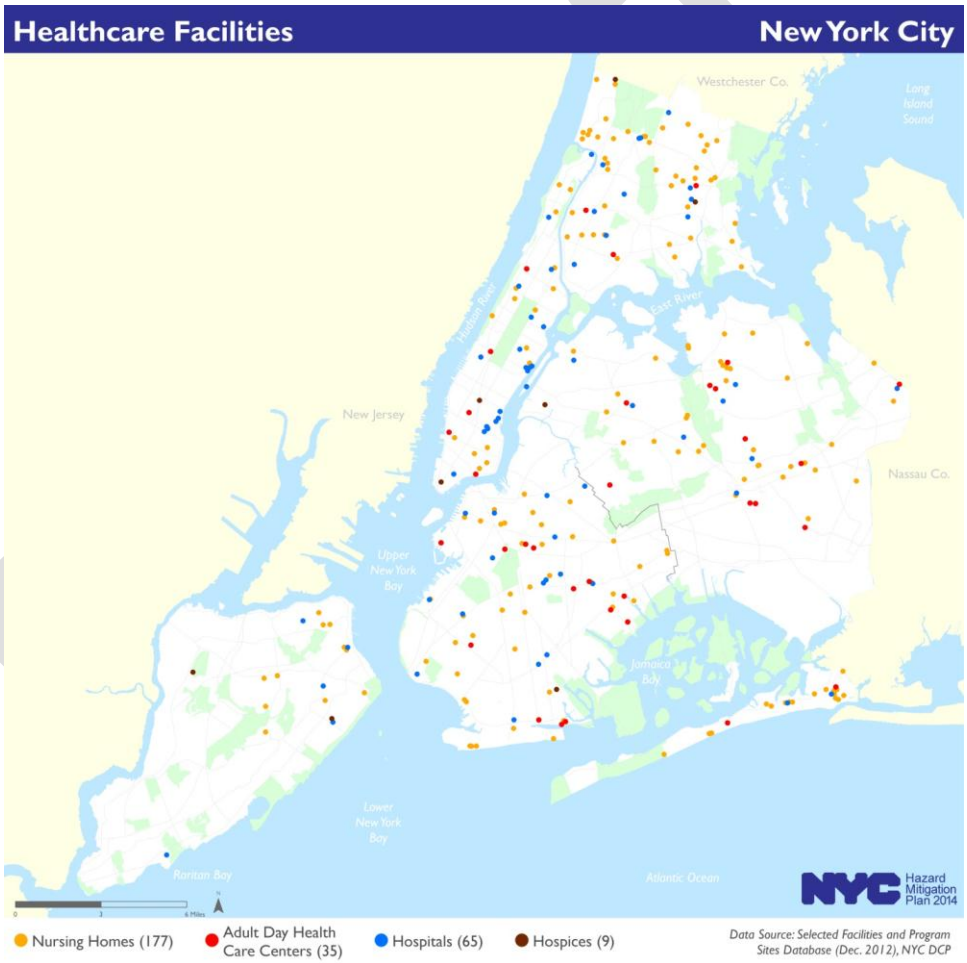

Figure 32: Healthcare Facilities in New York City

J. Educational Facilities

New York City has 2,647 educational facilities. As Figure 33 through Figure 35 show, there are 102 colleges, 845 private schools, and 1,700 public schools. According to the 2011 ACS, approximately, 40% of all New York City households have children enrolled in elementary school (grades 1 to 8) and 20% in high school (grades 9 to 12). In New York City, public school facilities not only educate, they also have a public safety function, serving as emergency shelters during hazard events.

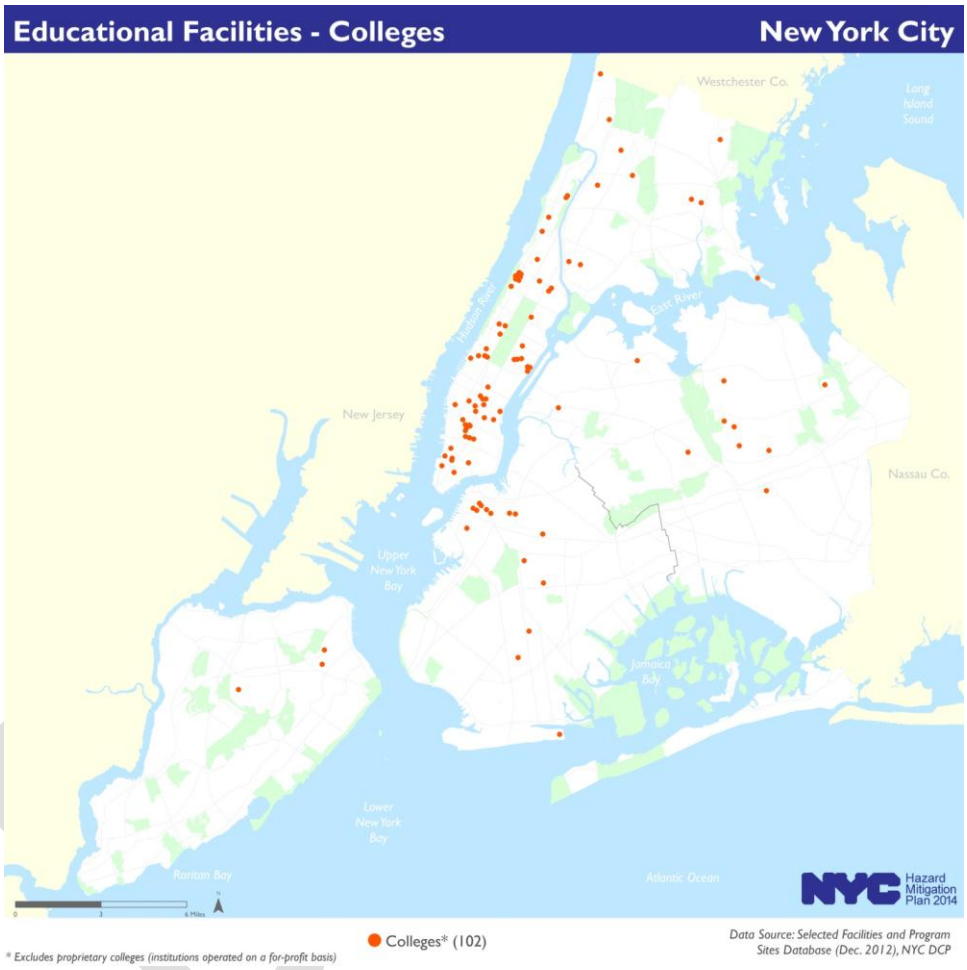

Figure 33: Colleges in New York City

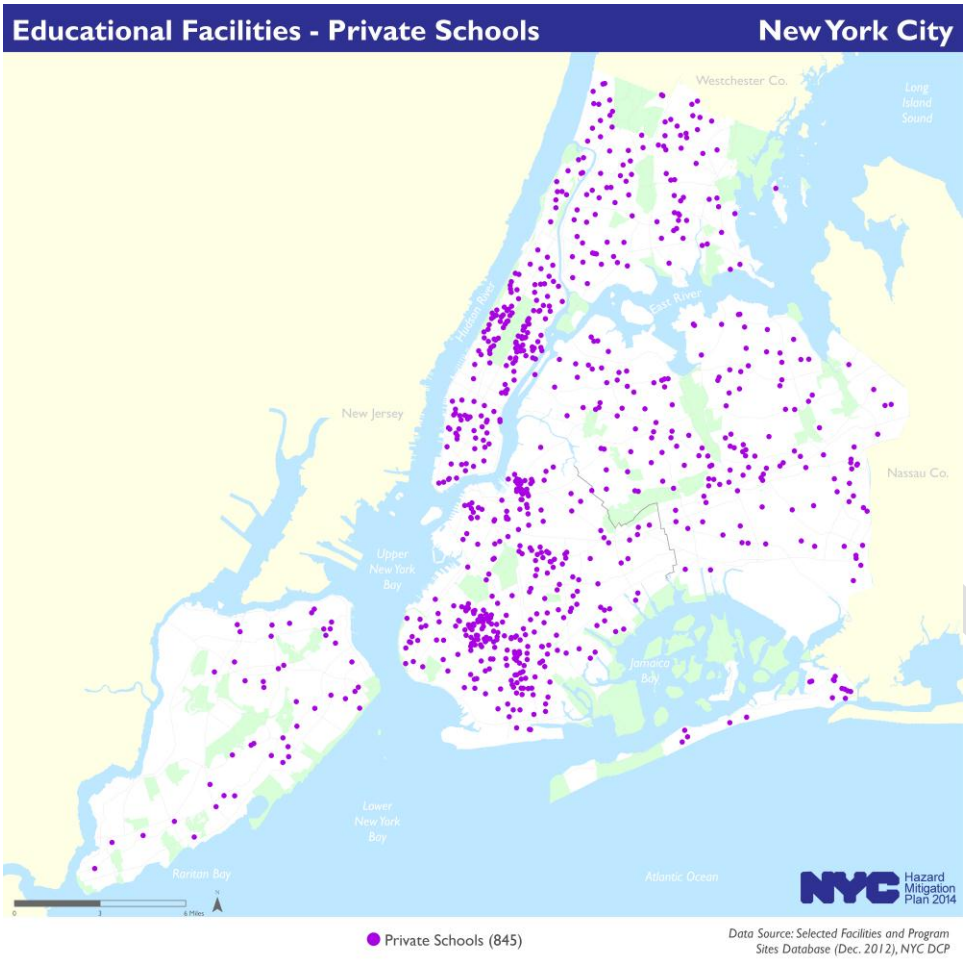

Figure 34: Private Schools in New York City

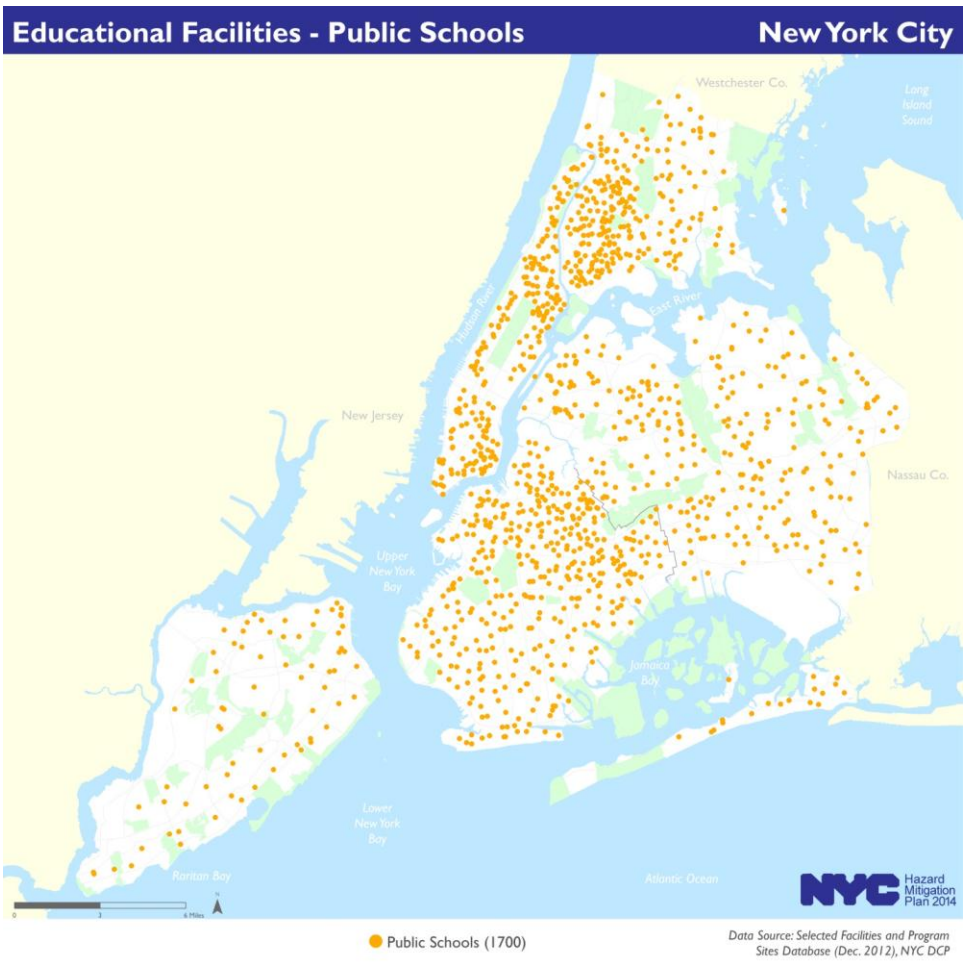

Figure 35: Public Schools in New York City

K. Cultural Facilities

New York City has one of the greatest concentrations of cultural institutions in the world. The map below displays some of New York City's most visited museums, zoos, stadiums, iconic buildings, theaters, and concert halls.

Figure 36: Major Cultural Facilities in New York City

3. The Future Environment

New York City's future environment will be affected by climate change, population growth, and land-use a development trends.

A. Impact of Climate Change

Today and in the future, climate change poses significant risks to New York City. People, homes, businesses, streets, power plants, and other assets are vulnerable to a range of climate hazards, including heat waves, torrential downpours, high winds, and more frequent and severe snow storms and storm surges. Hurricane Sandy was a reminder of the tragic impact weather extremes can have. While it is not possible to attribute any single extreme event such as Sandy to climate change, it is undeniable that sea level rise already occurring in the New York City area, which is in part related to climate change, increased the extent and magnitude of flooding during the storm.

To help respond to climate change in New York City and accomplish the goals outlined in PlaNYC, the City's long-term sustainability plan, Mayor Bloomberg convened the New York City Panel on Climate Change (NPCC) in 2008. This body of leading climate and social scientists and risk management experts was charged with advising the Mayor and the New York City Climate Change Adaptation Task Force on issues related to climate change and adaptation. In 2009 the NPCC produced a ground-breaking set of climate projections specific to New York City.

In January 2013, the City reconvened the NPCC on an emergency basis to update its projections to inform planning for rebuilding and resiliency after Sandy. Drawing on the latest climate models, recent observations about climate trends, and new information about greenhouse gas emissions, the NPCC produced *Climate Risk Information 2013*, which can be accessed here: http://www.nyc.gov/html/planyc2030/downloads/pdf/npcc_climate_risk_information_2013_report.pdf. The report includes projections for sea level rise, heat waves, and precipitation.

Sea Level Rise

New York City's sea levels are rising and according to the NPCC this trend is expected to continue in the coming decades. By the 2020s, middle range projections indicate a 4 to 8 inch rise in sea levels, while high-end sea level rise projections show sea levels rising as much as 11 inches. By mid-century, sea levels could rise as much as 2.5 feet (31 inches), especially if the polar ice sheets melt at a more rapid rate than previously anticipated. That magnitude of sea level rise would threaten low-lying communities in New York with regular and highly disruptive tidal flooding, and make flooding as severe as from today's 100-year storm at the Battery up to five times more likely. For example, by the 2020s, 6,600 acres (27 percent) of the city's parkland could lie in the 100-year floodplain, increasing to over 7,400 acres (or 31 percent) by the 2050s.

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Sea Level Rise		2020s		2050s	
	Baseline	Middle Range (25th-75th percentile)	High End (90th percentile)	Middle Range (25th-75th percentile)	High End (90th percentile)
	0	+4 to 8 inches	+11 inches	+11 to 24 inches	+31 inches

Table 13: NPCC Sea Level Rise Projections 2013

FEMA's FIRMs show flood-prone land areas called floodplains. Coastal flooding (areas near the coast at risk to flood) and riverine flooding (areas near streams and rivers at risk to flood) are the most common types of flooding in New York. The 100-year floodplain is the area where a 100-year flood event has a 1% chance of occurring in any given year. This is also referred to as the Special Flood Hazard Area (SFHA). Structures located within this area are required to carry flood insurance if they have a Federally-backed mortgage. A 500-year floodplain is the area where a 500-year flood event has a 0.2% chance of occurring in any given year. These zones are geographic areas classified according to levels of flood risk and/or type of flooding.

Future Flood Maps

The City worked with the NPCC to develop a series of "future flood maps" for New York that will help guide the city's resiliency and mitigation efforts. These forward-looking maps are created by using a simplified bathtub model approach of combining the NPCC's "high end" sea level rise projections with FEMA's Preliminary Work Maps (PWMs). The future flood maps illustrate how the 100-year floodplain could increase over the next several decades with high-end projections for sea level rise. Because these maps were not developed using advanced coastal modeling, the accuracy of the flood projections is limited. The maps are not suitable for evaluating risks to individual properties but they are extremely useful for understanding the general extent of future flood risks.

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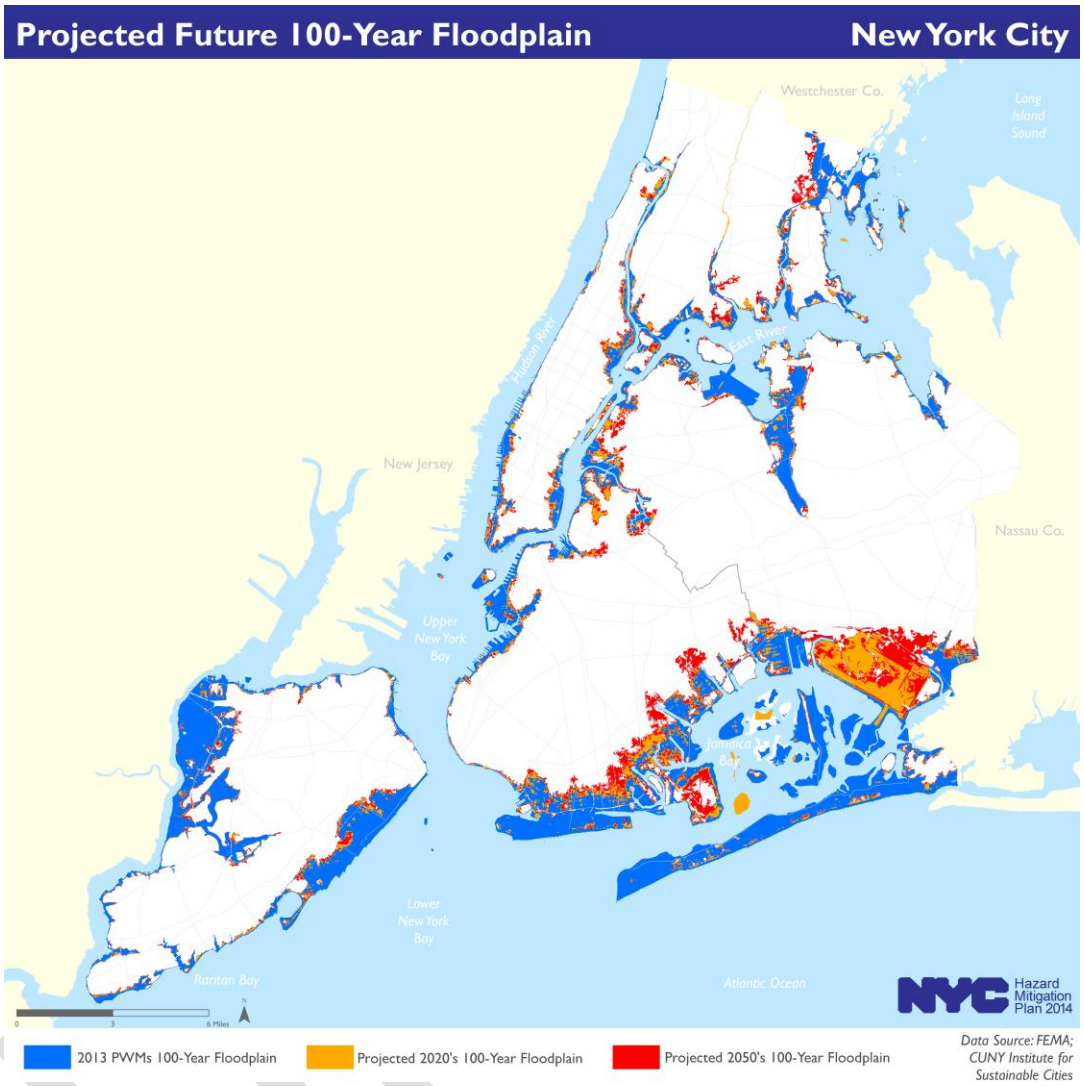

Figure 37: Future Flood Maps for the 2020s and 2050s

The future flood maps show that by the 2020s, the area that could be flooded in a 100-year storm could expand to 59 square miles (up 23% from the PWMs) and encompass approximately 88,000 buildings (up 31%). By the 2050s, with more than 2.5 feet of sea level rise, New York City's 100-year floodplain could be 72 square miles—a staggering 24% or nearly a quarter of the city—an area that today contains approximately 114,000 buildings (almost twice as many as on the PWMs). This area currently accounts for 97% of the city's power generation capacity, 20% of its hospital beds, and a large share of its public housing. Over 800,000 New Yorkers, or 10% of the city's current population, now live in the 100-year floodplain projected for the 2050s—a number of flood-vulnerable residents that is greater than the total number of people living in the entire city of Boston.

Heat Waves

Meanwhile, the NPCC predicts that by the 2050s the city could have as many days at or above 90 degrees annually as Birmingham, Alabama, has today—a threefold increase over what New York currently experiences. Heat waves–three or more consecutive days of daily high temperatures at or above 90 degrees—could more than triple in frequency, lasting on average one and a half times longer than they do today.

Heat Waves and Cold Events	Baseline (1971-2000)	2020s		2050s	
		Middle Range (25th-75th percentage)	High End (90th percentile)	Middle Range (25th-75th percentage)	High End (90th percentage)
Number of days per year at or above 90°F	18	26 to 31	33	39 to 52	57
Number of heat waves per year	2	3 to 4	4	5 to 7	7
Average duration (days)	4	5	5	5 to 6	6
Number of days below 32°F	72	52 to 58	60	42 to 48	52

Table 14: NPCC Projections for Heat Waves and Cold Events 2013

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Precipitation

The NPCC projects that total annual precipitation will increase slightly in the coming decades (up to 10% by the 2020s and up to 15% by mid-century). It is very likely (more than 90% probable) that the New York City area will see an increase in heavy downpours by midcentury, according to the NPCC (see Table 15).

		Baseline (1971 – 2000)	2020s		2050s	
			Middle Range (25th-75th percentage)	High End (90th percentile)	Middle Range (25th-75th percentage)	High End (90th percentage)
Precipitation		50.1 inches	+0 to 10%	+10%	+5 to 10%	+15%
Intense Precipitation	Days per year with rainfall exceeding 2 inches	3	3 to 4	5	4	5

Table 15: NPCC Projections for Precipitation and Intense Precipitation 2013

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B. Population Projections

New York City has a dynamic population, with several hundred thousand people coming and going each year. This "churn," also known as net migration, has long characterized the city, which has always been a magnet for those seeking opportunities. According to 2012 population estimates by the U.S. Census Bureau, New York City has gained just under 200,000 new residents since 2010, constituting a population growth rate of approximately 2%. New York City's population increase since April 2010 represented 84% of the total increase in New York State. Most of this growth has occurred in the outer boroughs, with Brooklyn experiencing the largest percentage change with a growth rate of 2.4% or just over 60,000 persons.

The growth rate since the 2010 Census in New York City is substantial when compared to that of the previous decade. According to U.S. Census, the annual average rate of growth for the city for July 2010 to July 2012 was about 74,000, compared to an annual average of just 17,000 in the 2000s. This is a trend that is likely to continue in the future, though at a more tempered rate, given housing constraints and high cost of living.

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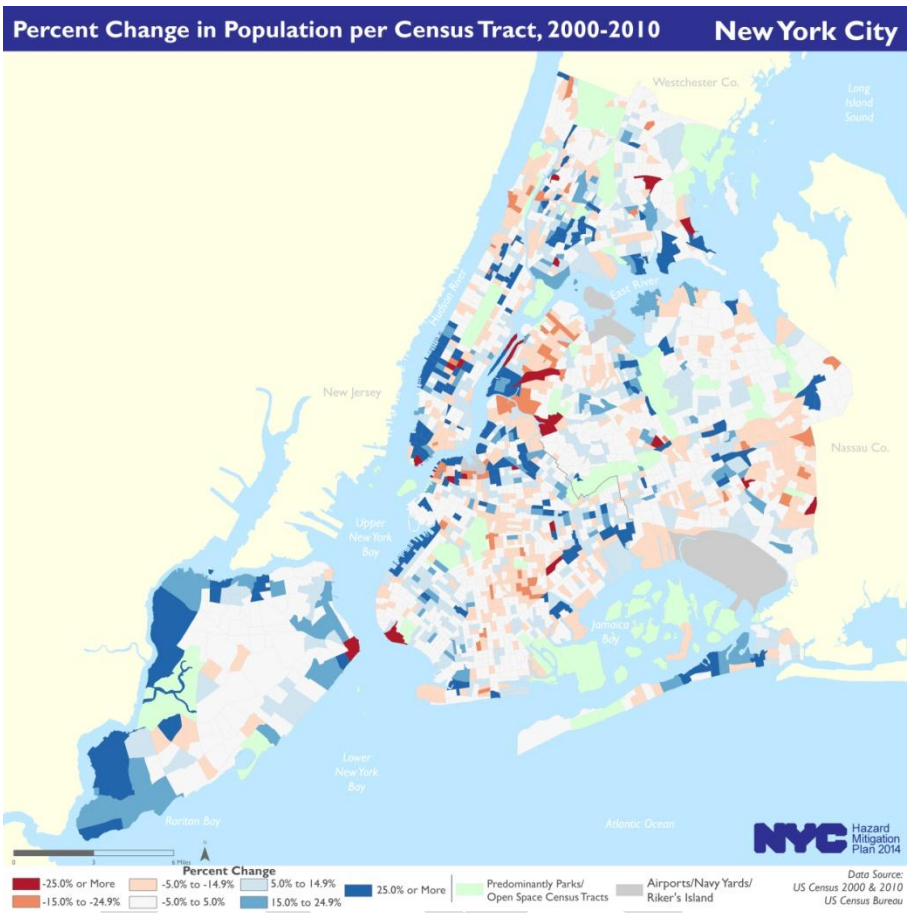

Figure 38: **Percent change in Population per Census Tract 2000 to 2010**

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C. Development Trends

Land use and economic development trends in New York City are influenced by population changes and economic trends, and are guided by strategic planning initiatives designed to accommodate future growth. It is expected that New York will be home to approximately nine million residents in the upcoming decades, and the share of residents 65 years and older will significantly increase. In order to accommodate anticipated growth while addressing both the causes and implications of climate change, "PlaNYC: A Greener, Greater New York" (PlaNYC), launched in 2007, established a long-term strategy for how the City will address the physical challenges of population growth, aging infrastructure, and climate change.

PlaNYC contains over a hundred initiatives designed to achieve sustainability goals for areas including land, water, transportation, energy, air quality, climate change. The Mayor's Office of Long-Term Planning and Sustainability (OLTPS) oversees implementation of initiatives involving coordination with appropriate city agencies. With regard to land use, PlanNYC aims at guiding housing and commercial development to transit-accessible areas; redeveloping vacant, underutilized and brownfield sites; and preserving and creating affordable housing.

To encourage future growth in transit-oriented neighborhoods as outlined in PlaNYC, the Department of City Planning has undertaken a substantial work program of neighborhood rezonings. More than 120 area-wide and targeted rezonings (see figure 39) spanned almost 40% of the city's landmass excluding parks and open space in the last decade and have increased the capacity for housing and economic development opportunities by increasing allowable densities along transit corridors, while protecting neighborhood character and lowering allowable densities in more auto-dependent areas. Since the issuance of PlaNYC, over 87% of all new units constructed were located within ½ mile of transit and, as of 2013, rezoning initiatives have produced 27,000 new housing units as well as significant opportunities for commercial development and new public open spaces.

The focus of City-initiated rezoning initiatives has been multifaceted. Broad-reaching land use plans to foster creation and enhancement of central and regional business districts direct significant residential and commercial development to transit rich areas across the five boroughs, including areas such as Hudson Yards, 125th Street in Harlem, Downtown Brooklyn, Greenpoint-Williamsburg, Jamaica and Long Island City in Queens, and Lower Concourse in the South Bronx. Early results of these plans have transformed vacant and underutilized land and waterfront areas to vibrant, mixed-use centers leveraging existing transit infrastructure to foster economic development opportunities and neighborhood enhancements.

In transit-served neighborhoods throughout the city, balanced rezonings tailored zoning regulations to protect and preserve existing character of neighborhoods while allowing for growth opportunities along major corridors, where appropriate. These contextual rezonings included neighborhoods such as the East Village, Lower East Side and East Harlem, Manhattan; Bedford Stuyvesant, Flatbush and Park Slope, Brooklyn; Morris Park, Williamsbridge and Baychester in the Bronx; Astoria and Sunnyside/Woodside and Maspeth, Queens; and St.

George and Stapleton in Staten Island. In more auto-dependent neighborhoods distant from transit, rezoning initiatives limited the potential for growth while promoting contextually appropriate buildings in neighborhoods including eastern Queens, Southern Brooklyn, northern Bronx and much of Staten Island.

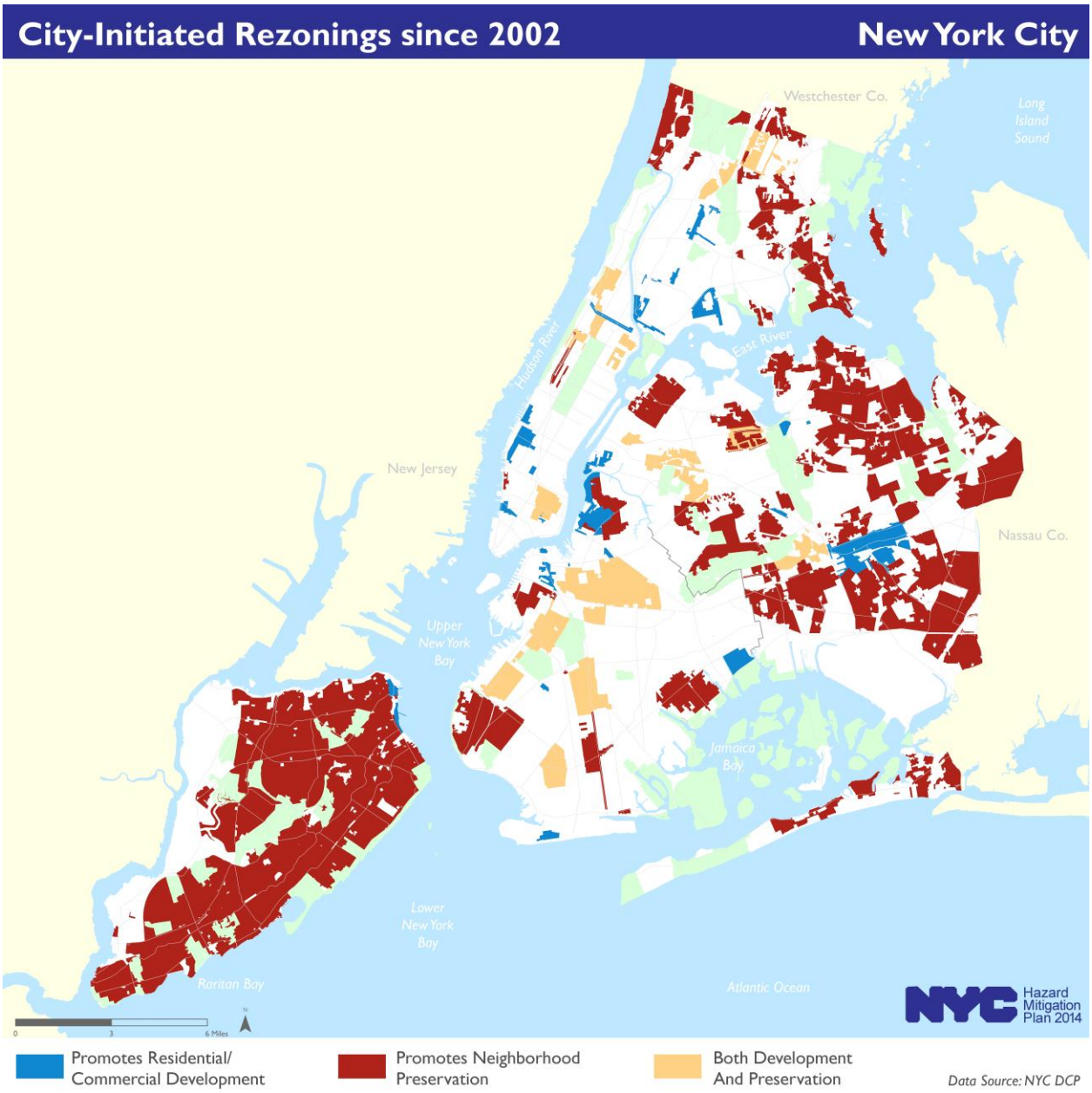

Figure 39: City-Initiated Rezonings Since 2002

5. COASTAL EROSION

A. Hazard Profile

i. Hazard Description

Coastal erosion is a loss or displacement of land along the coastline resulting from beach-ocean interaction coupled with human activity.

In its natural state, the coastal system is in dynamic equilibrium. Sand and sediment are moved from one location to another, driven primarily by wind, waves, long shore currents, tides, runoff of surface waters, or groundwater seepage. However, the sand and sediment do not leave the system altogether (unless human activities, such as dredging, permanently remove them from a particular location). Coastal storms may remove significant amounts of sand, creating steep, narrow beaches. Then, during quiet periods, waves return the sand, widening beaches and creating gentle slopes.

The removal and deposition of sand permanently changes beach shape and structure. Sand may be transported to landside dunes, deep ocean trenches, other beaches, and deep ocean bottoms.

Human activity may worsen coastal erosion through poor land use methods. Building without considering the impact on erosion or without an understanding of the changed hydrodynamics may increase erosion or shift it to adjacent areas. In many cases, ill-conceived coastal erosion control structures, built with the intention of *preventing* erosion in one location, may actually *increase* erosion in adjacent locations.

Coastal erosion poses many challenges to coastal communities when valuable property is lost to this dynamic process. Beach erosion control and restoration are thus leading concerns in coastal communities.

ii. Severity

Coastal erosion can be gradual or occur rapidly—as it does during storms, for instance. During storms, erosion can be severe, and during the most intense storms entire beaches may be lost while other portions of the shoreline may become unstable and collapse into the waterways.

Long-term erosion is difficult to measure since it can vary significantly from year to year. In addition, along much of the coast changes may be too small to accurately measure with the techniques presently available. Human activities, such as dredging and beach nourishment projects, also make it difficult to determine how much beach is being lost through natural processes.

Geologists measure erosion as a rate of either linear retreat (feet of shoreline recession per year) or volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year). According to the Evaluation of Erosion Hazards study conducted by the Heinz Center

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(2000), the average annual erosion rate on the Atlantic coast is roughly two to three feet per year.

iii. Probability

Long-term shoreline change is a continuous process and therefore 100% certain for the locations below. The probability of rapid erosion events will vary based on a number of factors including the recurrence intervals for coastal storms (see "Probability" in Risk Assessment Section 6: Coastal Storms).

iv. Location

Erosion rates vary significantly depending on location. The city's south shore is exposed to the effects of coastal erosion and wave action from the Atlantic Ocean as well as from the waters of Lower New York, Gravesend, Raritan, and Jamaica Bays. Some of the highest erosion rates have been observed near stabilized inlets and hardened structures, which disrupt the natural movement of sand. Because so many factors are involved in coastal erosion—including seasonal fluctuations and human activity—sand movement will not be consistent year after year in the same location, or between nearby locations.

To protect against the effects of coastal erosion, the New York State Department of Environmental Conservation (NYS DEC) has developed the Coastal Erosion Hazard Area (CEHA) permit program. This program identifies coastal locations that are particularly vulnerable to erosion and provides written approval of regulated activities or land disturbance to properties within these areas.

NYS DEC has identified three distinct CEHAs for New York City:

- Coney Island, Brooklyn
- Rockaway Peninsula, Queens
- South Shore, Staten Island

Within the CEHAs, NYS DEC manages and regulates the following:

- Natural Protective Feature Areas (NPFAs), such as the near shore, beaches, bluffs, primary dunes, and secondary dunes. NFPAs protect natural habitats, infrastructure, and built structures from wind and water erosion and storm-induced high water.
- Structural Hazard Areas (SHAs), which are areas landward of the NPFAs that have demonstrated a long-term average recession rate of one foot per year or greater.

The United States Army Corps of Engineers (USACE) monitors coastal erosion rates for each of the CEHAs in New York City. The most recent values that New York City has for coastal erosion were obtained from USACE and measured between 1966 and 1988. During this period, erosion rates along the western Rockaway Peninsula were around two feet per year, while erosion rates along the eastern Rockaway Peninsula were closer to five feet per year. Along the ocean shore of Coney Island, the erosion rate was measured at 1.3 feet per year, although historically

these rates were higher (2.5 feet per year between 1836 and 1966). The shoreline is generally stable along the South Shore of Staten Island, with several exceptions, including Oakwood Beach and Annandale, which are eroding faster than the citywide average. Figure 1, below, shows the shoreline change from 1924 to 2012 for Annandale, Staten Island.

Figure 1: Shoreline Change for Annandale, Staten Island, 1924 to 2012 (Source: DoITT, OEM)

CEHA maps depict regulated areas, including the landward limit of the NPFAs and SHAs, and indicate the recession rate in feet per year, where applicable. The maps now available were last updated in 1988, although they are currently being evaluated and revised to reflect changes in NPFA and SHA boundaries and in natural protective features. The map updates also require a

comparison of historical imagery to more recent imagery to determine long-term shoreline recession rates.

CEHA maps for New York City were obtained from NYS DEC's Coastal Erosion Management Unit on January 14, 2008. The maps are dated 1988, with legend updates in 1991. CEHA maps were available only in hard-copy format. For the purposes of this plan, CEHAs were translated from the hard-copy format into GIS format for more efficient viewing, sharing, and estimation of assets within the CEHA (see Figure 2, Figure 3, and Figure 4). This was not a formal translation of the hard-copy data into GIS format, and the resulting images are for analysis purposes only and do not serve as official digital representations of the CEHA boundaries in New York City. On the CEHA maps, the CEHA boundaries were drawn at the location of NPFAs. The maps do not designate SHAs.

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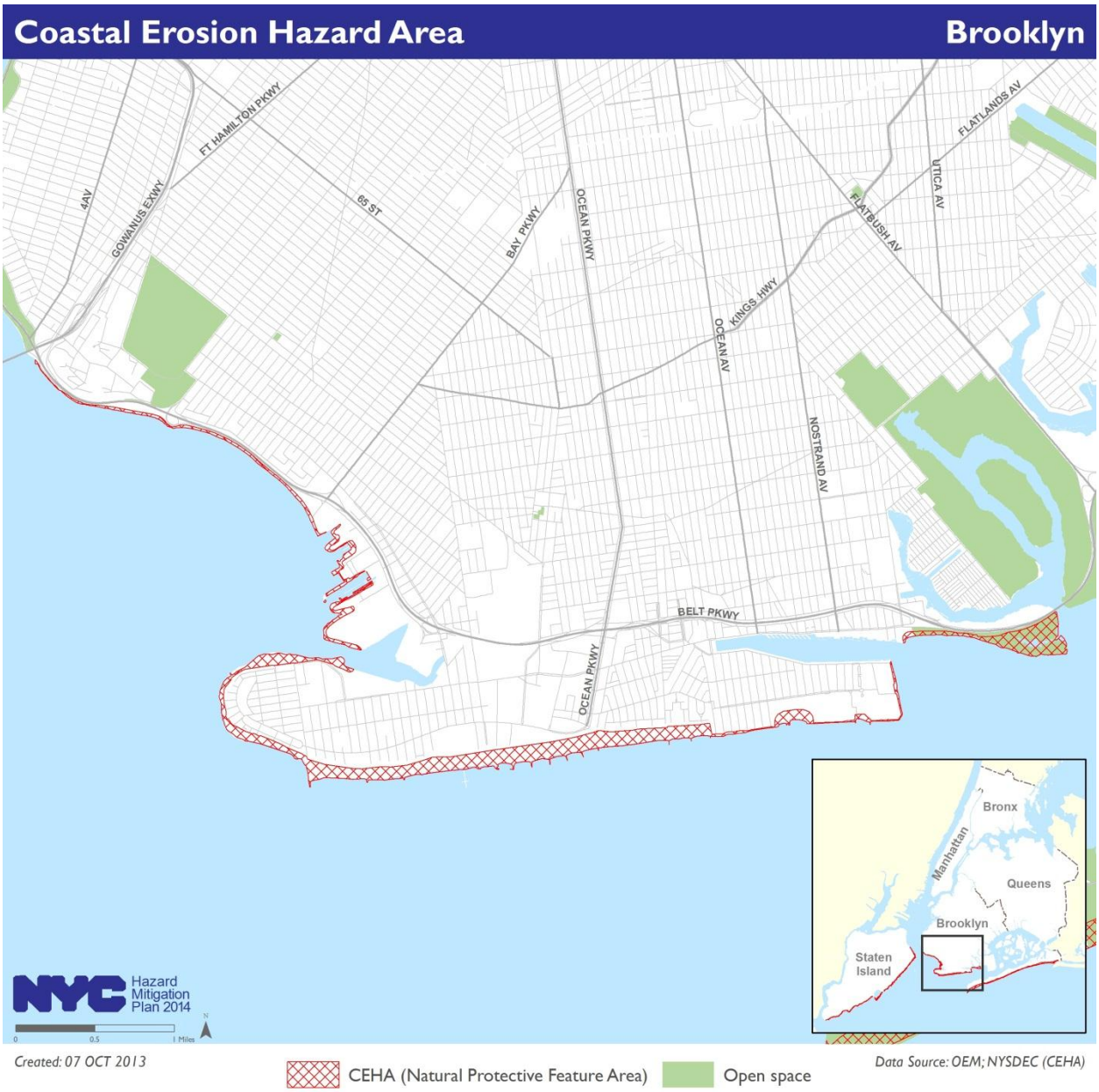

Figure 2: Brooklyn Coastal Erosion Hazard Areas (Source: NYS DEC)

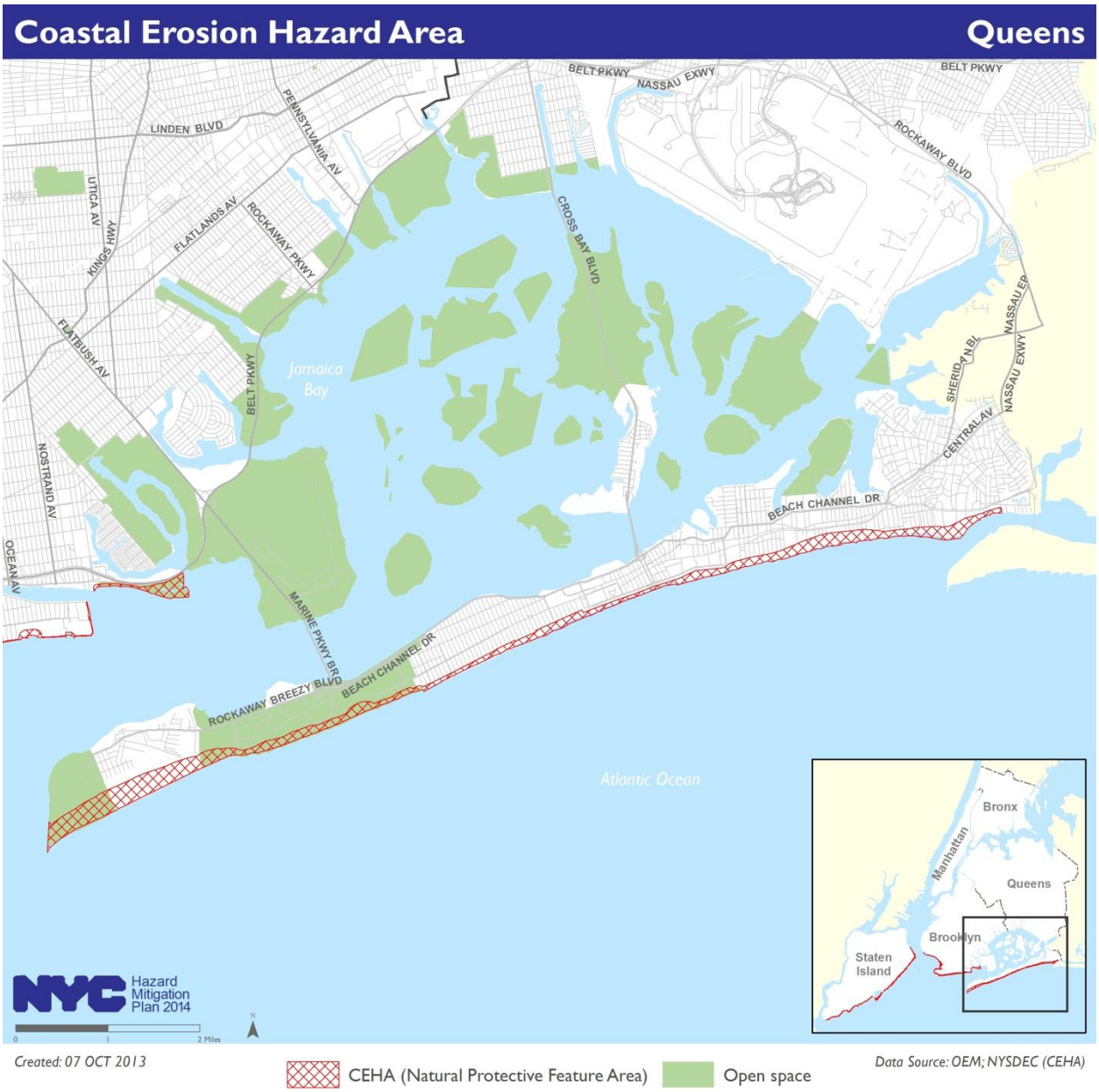

Figure 3: Queens Coastal Erosion Hazard Areas (Source: NYS DEC)

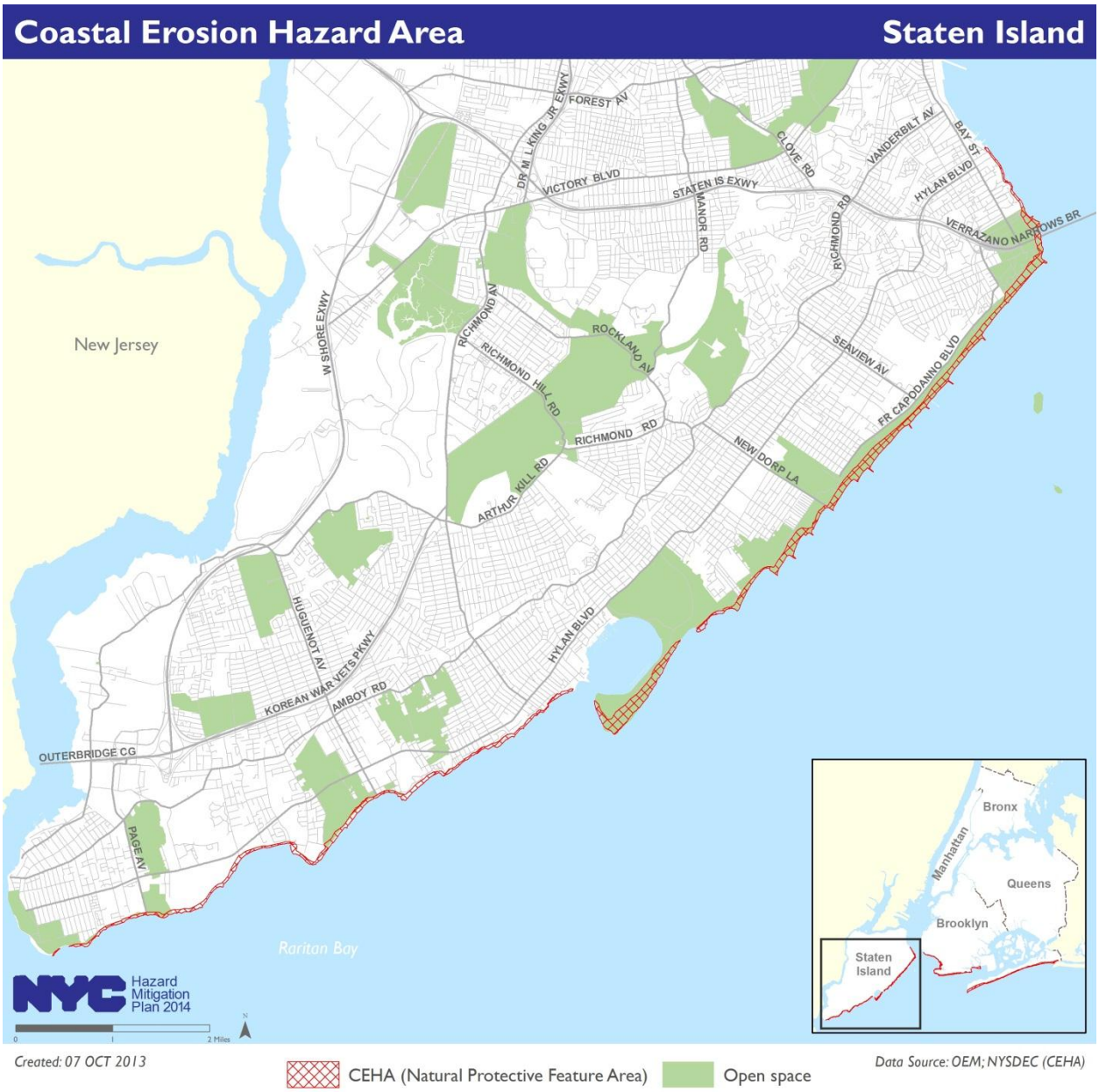

Figure 4: Staten Island Coastal Erosion Hazard Areas (Source: NYS DEC)

v. Historic Occurrences

Coastal erosion is an ongoing natural process frequently exacerbated by human activity. Large-scale coastal erosion events are generally associated with significant coastal storms, such as nor'easters or hurricanes (see "Historic Occurrences" in Risk Assessment Section 6: Coastal Storms).

B. Vulnerability Assessment

i. Social Environment

Since coastal erosion is a gradual process, it typically does not pose an immediate risk to human life, safety, or well-being. Special needs populations are not necessarily at an increased risk from coastal erosion.

ii. Built Environment

Coastal erosion can cause extensive damage to public and private property because eroding coastlines bring structures closer to the water's edge. If erosion is not mitigated, the structures will become inundated with water, causing damage or destruction. As the force of water begins to affect the structure, it also places the building's contents, foundation, and utilities at risk.

Shoreline protection and proper structure placement are crucial to withstanding the forces of coastal erosion. Engineering structures—such as seawalls, riprap, armoring, and bulkheads—are used to control erosion in New York City.

Approximately 1,428 acres are located within a CEHA, representing 0.7% of New York City's land area. There are 207 buildings whose footprints are at least partially within a CEHA, although many of these buildings have only a small portion of their footprints in a CEHA (see Table 1). Since the CEHA maps were digitized from hard copies, the maps may inaccurately present data and overstate building risks. For instance, buildings with only one edge touching the CEHA might not actually be at risk. On the other hand, buildings whose centroids are located within the CEHA (of which there are 135) may more accurately be considered exposed building stock. In New York City the only significant structures that may be considered exposed (excluding public bathrooms, beach concession stands, etc.) are located within one hotel complex on the Rockaway Peninsula; these structures are built on pilings on the beach.

Coastal Erosion Hazard Area (CEHA)	Acreage Exposed	Exposed Building Footprints	Exposed Building Centroids
Coney Island, Brooklyn	305	53	22
Rockaway Peninsula, Queens	708	26	17
South Shore, Staten Island	415	146	96
Total	**1,428**	**207**	**135**

Table 1: Acreage and Buildings within NYS DEC-mapped Coastal Erosion Hazard Areas

iii. Natural Environment

Coastal erosion can cause extensive damage to coastal natural resources.

Under natural conditions, beaches (particularly barrier islands or spits like the Rockaway Peninsula) are dynamic features of the landscape. The shape and location of the coastline changes over time, and erosion is one of the processes by which this occurs. In a natural state, some areas erode and some areas accrete, but overall the two processes are in balance.

Although coastal erosion is a natural phenomenon, human activity contributes to enhanced erosion rates. The construction of hardened structures—such as seawalls, jetties, and groins—can contribute to erosion. Shoreline stabilization structures prevent the natural migration of the beach, and thereby can contribute to a significant imbalance between erosion and accretion, with some areas eroding much faster than they would under natural conditions. These structures may block sand movement, deflect or increase wave energies, and remove vegetation.

Human activities can contribute to coastal erosion by damaging or destroying natural protective features such as wetlands, dunes, beaches, and barrier bars. Increased erosion rates due to human development can also contribute to the loss of habitat or disrupt migration routes for marine and terrestrial animal species.

iv. Future Environment

According to the New York City Panel on Climate Change, local sea level in New York City has risen 1.1 feet since 1900 and is expected to rise an additional one to two feet by the middle of the 21st century. Sea level rise is expected to exacerbate coastal erosion in the future, especially during significant storms.

However, exactly how much erosion is directly attributable to sea level rise is unclear. Over planning time frames of 30 to 50 years, the effect of sea level rise is less significant than that of other contributors to shoreline change, and a higher rate of sea level rise is not expected to substantially change the observed rates of shoreline change in the areas experiencing the most severe erosion. Thus, future erosion rates remain difficult to predict, underscoring the need to establish more baseline data and monitoring stations along the coast to determine annual shoreline changes.

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A. HAZARD PROFILE

i. Hazard Description

Coastal storms, both tropical cyclones and nor'easters, can and do affect New York City. In fact, the city's densely populated and highly developed coastline makes it one of the most vulnerable cities in the United States to damage from coastal storms.

Tropical Cyclones

Tropical cyclones are organized areas of precipitation and thunderstorms that form over warm, tropical ocean waters. These storms rotate counterclockwise around a low-pressure center. Tropical cyclones are classified as follows:

- A **tropical depression** is an organized system of clouds and thunderstorms with a defined surface circulation and maximum sustained winds of 38 miles per hour (mph) or less.
- A **tropical storm** is an organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds of 39 to 73 mph.
- A **hurricane** is an intense tropical weather system of strong thunderstorms, a well-defined surface circulation, and maximum sustained winds of 74 mph or greater.

A number of variables must come together for tropical cyclones to form and maintain their intensity. Most importantly, water temperatures must be greater than 80°F. In the North Atlantic Basin, these conditions are most likely to occur off the coast of Africa, in the Caribbean Sea, and in the Gulf of Mexico.

Once tropical cyclones form, they often track northward or westward until they reach the mid-latitudes (usually the northern Gulf of Mexico, southeastern United States, or the northwest Atlantic), where they turn northward or eastward due to the prevailing winds. However, when certain meteorological conditions are in place, they may track up the East Coast of the United States and reach New York City.

The Atlantic hurricane season lasts from June through November, with an average of 11 tropical storms and six hurricanes per year. New York City is at highest risk between August and October because this is when water temperatures in the Northern Atlantic are most likely to reach a temperature warm enough to sustain a hurricane. According to the National Hurricane Center (NHC), the Atlantic hurricane season is currently in a period of heightened activity that started around 1995 and could last at least another decade.

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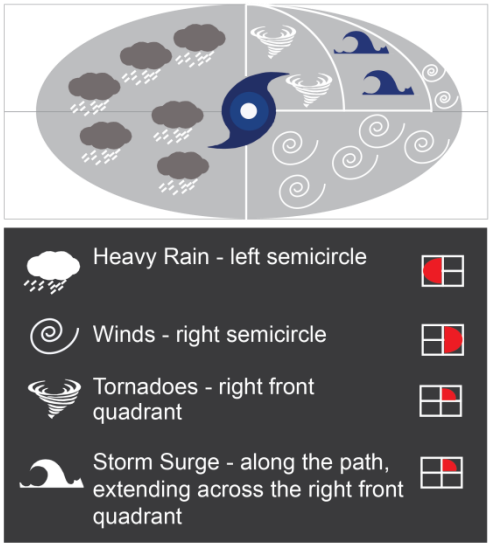

Figure 1: Primary Hazards of Coastal Storms

When tropical systems make landfall, the primary hazards are heavy rain, wind, tornadoes, and storm surge (see Figure 1). The most dangerous conditions typically occur near the center of circulation, or eye wall (region surrounding the eye), and in the right-front quadrant of the storm, where the speed of forward motion adds to the effect of the wind and storm surge.

Heavy rain from tropical systems can cause freshwater flooding, which occurs as rivers and streams overflow their banks, or it can cause flash flooding in low-lying areas when the rainfall rate exceeds the capacity of the ground or drainage systems to absorb the water. Although heavy rain can occur throughout the storm, the highest values are typically expected on the left side of the eye (left semicircle). The amount of rainfall associated with a particular storm is less dependent on the storm's classification than it is on its speed and size as well as the geography of the area it moves over.

Strong winds associated with tropical systems can knock down trees and power lines and cause structural damage to buildings and property. Flying debris carried by winds is also a threat to human life and property. The strongest winds typically occur on the right side of the storm (right semicircle).

During the passage of a tropical system, tornadoes may form in the eye wall or in thunderstorms embedded in rain bands far away from the center, most commonly in the right-front quadrant of the storm. In general, tornadoes produced by tropical cyclones are relatively weak and short in duration, but they can still pose significant risk.

Storm surge is the storm-related hazard that causes the most significant damage and greatest number of deaths. Storm surge is a rise in water level as it is pushed towards the shore by the force of the winds in a storm. It is thus measured as the difference between tide levels and observed storm water levels.

The intensity of the storm surge is dependent on several storm characteristics, including the maximum winds, forward speed, size of the wind field, bearing of the storm's track at landfall, and the geography of the coastline. The most significant storm surge typically occurs near the eye and in the right-front quadrant of the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can raise the mean water level even higher during periods of high tide and cause severe inundation of coastal areas. Beaches along the open ocean are not only exposed to stillwater flooding from the surge and tides, they are

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also exposed to powerful wave action, which is superimposed on the storm tide. Wave action exerts a tremendous force on the beach, local buildings, property, and infrastructure (see Figure 2).

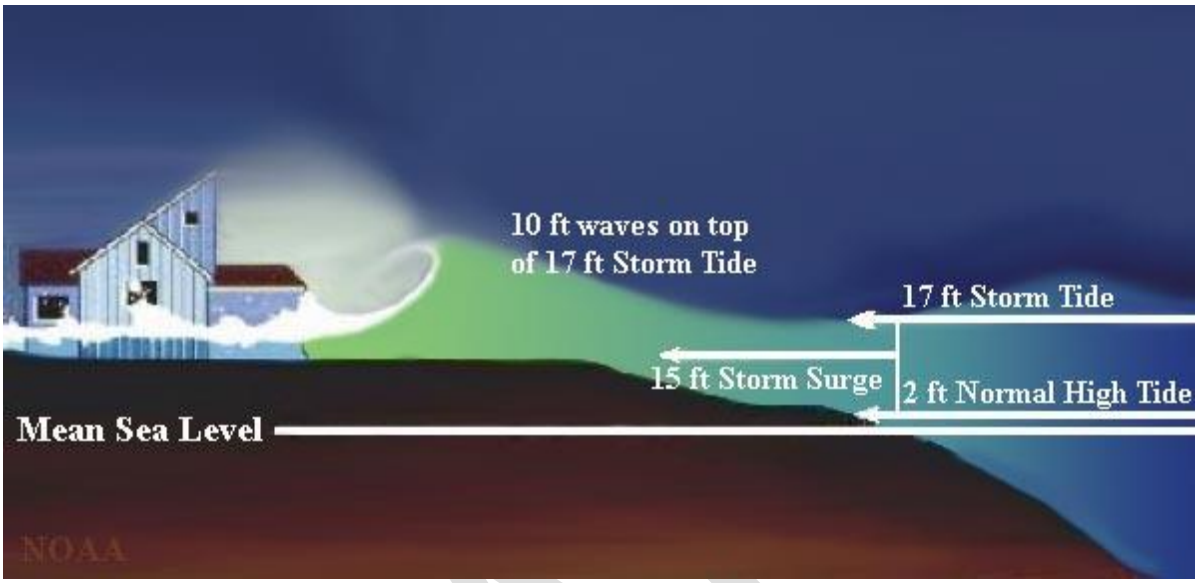

Figure 2: Combined Effect of Storm Surge, Tide, and Wave Action (Source: NOAA)

Storm surge inundation is the storm surge height above ground level. This is calculated by subtracting the local land elevation (referenced to a vertical datum) from the total storm surge height. For example, a storm surge height of 20 feet at an elevation of five feet above local sea level would result in a storm surge inundation of 15 feet.

Nor'easters

A nor'easter is a type of cyclone that primarily affects the Mid-Atlantic and New England states, most commonly between October and April. Like tropical cyclones, these storms are associated with heavy precipitation and a counterclockwise rotation around a center of low pressure. However, unlike tropical cyclones, nor'easters form outside of the tropics, typically over the central or western United States, northern Gulf of Mexico, or northwestern Atlantic. In addition, they can originate and sustain themselves over land and form during the cooler months of the year.

When these storms reach the Northeast or Mid-Atlantic coast, the counterclockwise circulation brings winds from a northeasterly direction—hence the name nor'easters. Although nor'easters are typically weaker than hurricanes, they can be larger and have more widespread impacts. Furthermore, nor'easters strike the New York City area more frequently than hurricanes do. Thus, the cumulative destructive potential of nor'easters can be greater than that of hurricanes.

Nor'easters can bring heavy precipitation, inland flooding, and winds that are often strong enough to knock down trees and power lines and cause structural damage to buildings. They may also bring coastal flooding from storm surge and large waves. While nor'easters do not commonly have tornadoes associated with them, they do bring the threat of heavy snowfall (see Risk Assessment Section 15: Winter Storms). If a wintertime nor'easter moves up the coast and follows a track west of New York City, wintry precipitation will often change to rain. However, if the storm maintains a track just off the eastern coast of the City, snow or mixed precipitation is likely to occur.

Coastal Geography and Storm Surge Risk

New York City is particularly vulnerable to storm surge because of a geographic characteristic called the New York Bight. A bight is a curve in the shoreline of an open coast that funnels and increases the speed and intensity of storm surge. The New York Bight is located at the point where New York and New Jersey meet, creating nearly a right angle in the coastline. For New York City, the worst-case scenario hurricane track is landfall just to the south along the coast of New Jersey, putting the city in the right front quadrant of the storm and funneling the storm surge directly into Raritan Bay and New York Harbor (see Figure 3). This, in fact, is precisely what happened during Hurricane Sandy and a primary reason the storm had such a disastrous impact on New York City (see Risk Assessment Section 12: Hurricane Sandy Retrospective Analysis).

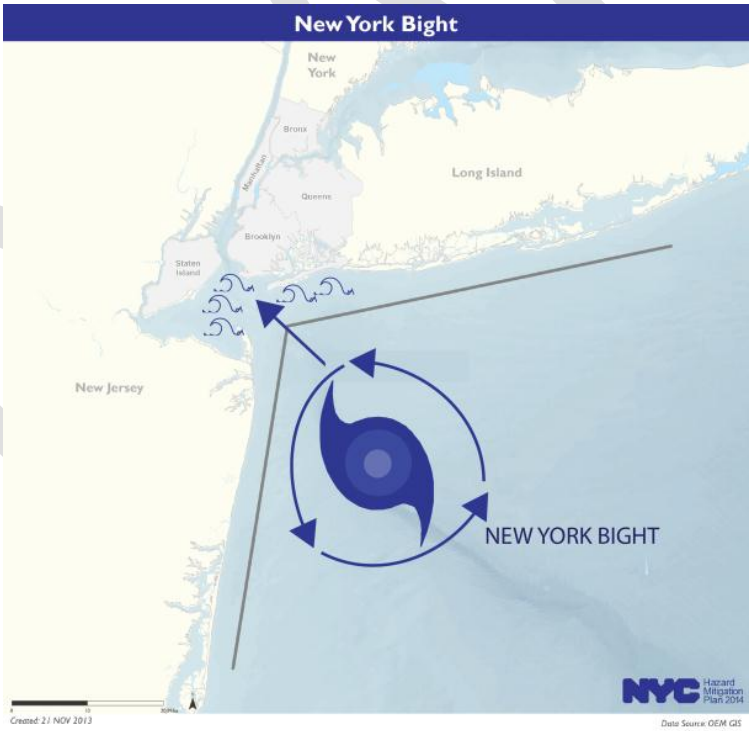

Figure 3: New York Bight with a Hypothetical Storm Approaching New Jersey, Just South of New York City

ii) Severity

Tropical Cyclones

Once a tropical cyclone reaches hurricane status (winds ≥74mph), the National Weather Service (NWS) uses the Saffir-Simpson Hurricane Wind Scale (see Table 1) to classify its severity. This system categorizes a hurricane's present intensity on a scale ranging from one to five and provides an estimate of potential property damage. A hurricane's rating on the Saffir-Simpson scale is determined by the storm's maximum sustained wind speed.

Category	Winds (mph)	Damage	Damage Description
Tropical Storm	39-73	Minor	• Minor damage to trees, power lines, and poorly-constructed homes
1	74–95	Moderate	• Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters • Large branches of trees will snap and shallowly rooted trees may be toppled • Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96–110	Moderate-Severe	• Well-constructed frame homes could sustain major roof and siding damage • Many shallowly rooted trees will be snapped or uprooted and block numerous roads • Near-total power loss is expected with outages that could last from several days to weeks
3	111–130	Extensive	• Well-built framed homes may incur major damage or removal of roof decking and gable ends • Many trees will be snapped or uprooted, blocking numerous roads • Electricity and water will be unavailable for several days to weeks after the storm passes
4	131–155	Extreme	• Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls • Most trees will be snapped or uprooted and power poles downed • Fallen trees and power poles will isolate residential areas • Power outages will last weeks to possibly months • Most of the area will be uninhabitable for weeks or months
*5	>155	Catastrophic	• A high percentage of framed homes will be destroyed, with total roof failure and wall collapse • Fallen trees and power poles will isolate residential areas • Power outages will last for weeks to possibly months • Most of the area will be uninhabitable for weeks or months

*Not predicted to occur in the New York City area

Table 1: Saffir-Simpson Hurricane Wind Scale, including Tropical Storms (Source: National Hurricane Center)

Although the Saffir-Simpson scale is a practical way of measuring hurricane strength, there are other important factors that contribute to a hurricane's impact on a given location. These factors include the storm's size, speed of forward motion, central pressure, and the angle at which the storm moves onshore or passes nearby. For example, a larger, slower-moving storm may cause more widespread damage than a smaller, faster-moving storm with higher sustained winds. Storm size and speed are also important in determining wave heights and storm surge, which are dependent on wind speed, duration, and the distance over which the wind blows across the water surface (fetch).

Nor'easters
Nor'easters do not have a universally recognized classification system. However, their strength and severity are influenced by factors similar to those that influence the strength and severity of hurricanes.

iii. Probability

Hurricanes
The National Hurricane Center (NHC) has calculated return periods for both hurricanes and major hurricanes (Category 3 or higher) for various locations along the east coast of the United States. These return periods are equal to the average amount of time between the passages of two hurricane eyes within a 50-nautical-mile (57.54-mile) radius of a given location. According to these NHC probability models, New York City currently is expected to experience a hurricane on average once every 19 years. The same models predict a recurrence interval of 74 years for major hurricanes. Scientists do not predict that a Category 5 hurricane would reach New York City because it is at relatively high latitude and offshore water temperatures never reach values high enough to sustain a storm of this magnitude. A Category 4 hurricane is also unlikely, although still possible.

Nor'easters
New York City typically experiences several nor'easters every year, and these storms can range significantly in intensity. Most of these storms are relatively weak but still have the potential to produce significant rainfall or snowfall and minor-to-moderate damage. More severe nor'easters are much less frequent but do strike New York City on occasion.

iv. Location

Within New York City, vulnerability to coastal storms is highly variable, depending to a large extent on location. To predict storm surge and help guide the City's planning for coastal storms, the Office of Emergency Management (OEM) utilizes a computer model from the NHC called SLOSH (Sea, Lake, and Overland Surges from Hurricanes). The SLOSH model calculates surge heights for storms moving in different directions and varying in strength from Category 1 to

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Category 4. SLOSH is not used for nor'easters, although similar criteria will apply when determining storm surge extent or heights from nor'easters of varying magnitudes.

The SLOSH calculations are based on the storm surge above high tide and the strongest potential winds for each category storm. Storm size and forward speed are also factored into the SLOSH zones. The SLOSH model calculates surge levels as if that location were hit by the most intense part of the storm. The culmination of these factors results in a worst-case scenario for storm surge in the SLOSH model.

The storm surge inundation map utilizes the SLOSH calculations for life safety and represents locations that may experience flooding from hurricane storm surge. In contrast, the floodplain map represents locations that may experience either freshwater or coastal flooding (may be unrelated to hurricanes), and are within the FEMA-defined 100-year floodplain (see Risk Assessment Section 11: Flooding). Hurricane storm surge inundation areas overlap the designated 100-year floodplain, but these areas are considerably larger and represent a different hazard than the 100-year flood. Figure 4 shows the areas of the City that would experience inundation from different storm categories, based on calculations from the SLOSH model.

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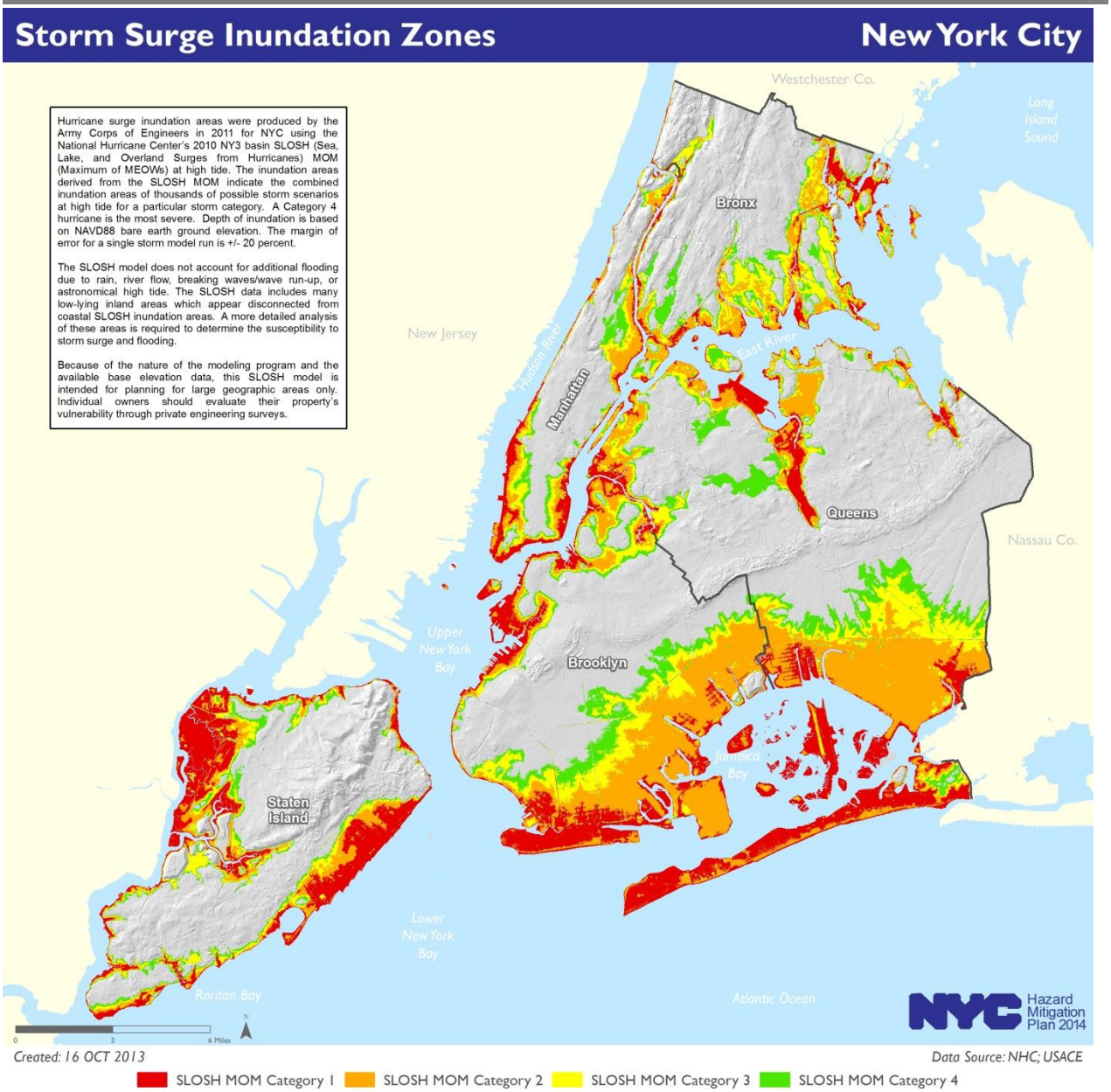

Figure 4: New York City Storm Surge Inundation Zones

Figure 5 shows the inundation depths from storm surge for the worst-case scenario for each hurricane category (inundation depth = storm surge height – land elevation), using output from the SLOSH analysis.

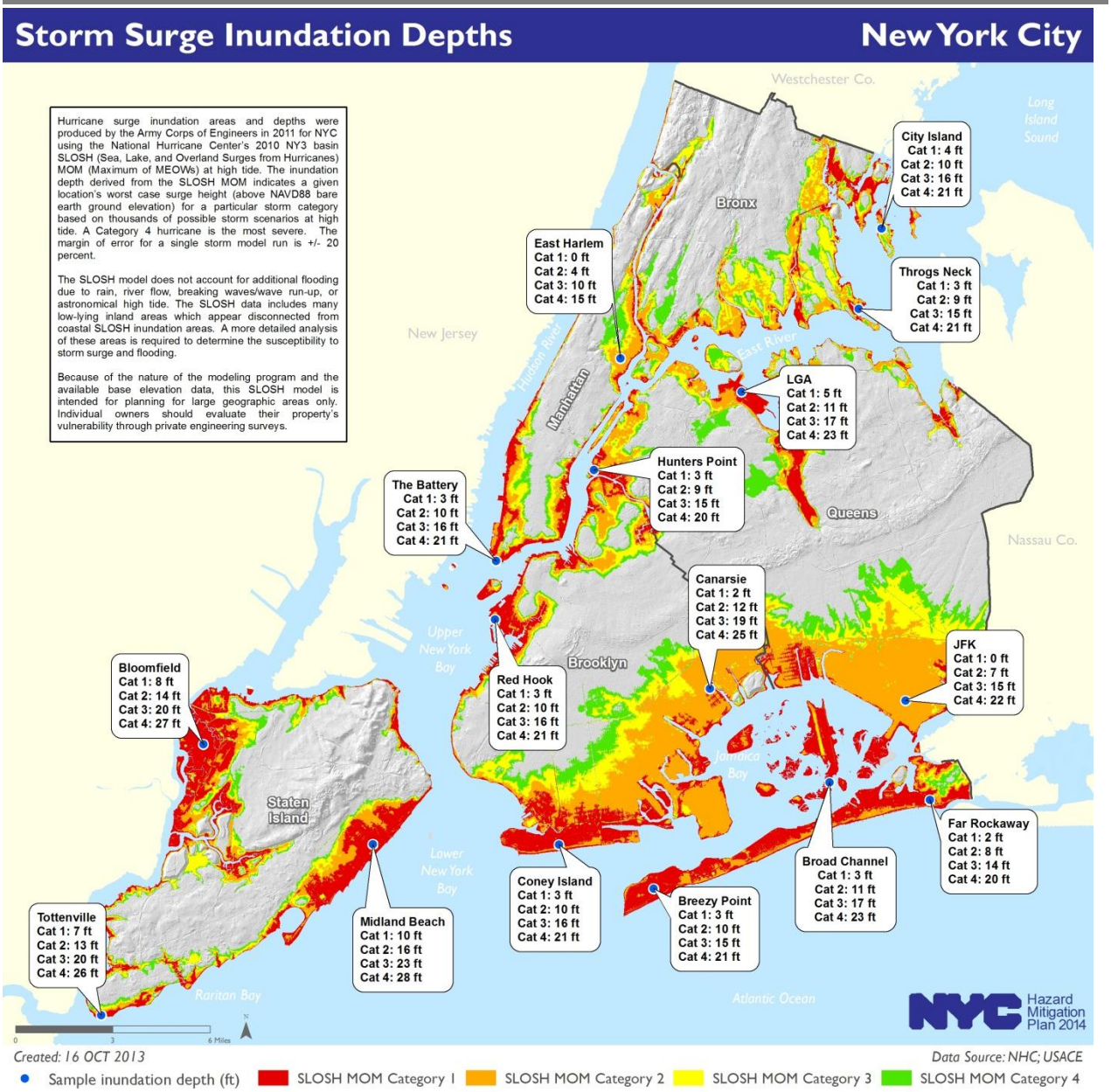

Figure 5: Storm Surge Inundation Zones with Selected Inundation Depths for Storm Categories

To prepare for coastal storms, the City has used SLOSH data to develop a *New York City Coastal Storm Plan* (CSP), which defines the areas that may be required to evacuate in the event of a storm. Unlike the evacuation zones that were in place when Hurricane Sandy struck in 2012, new zones, released in June 2013, also consider the storm's bearing (the direction the storm is moving when it reaches New York City). The new zones are based on a SLOSH output called Maximum Envelope of Water (MEOW). MEOWs show the maximum surge inundation from a set of hypothetical storms with fixed intensity and bearing but varied size, forward speed, and landfall locations. The evacuation zones employ a range of possible scenarios from the MEOWs,

whereas the SLOSH maps only display one scenario for each category. The SLOSH maps above represent the worst-case scenario storm surge, or MOM (Maximum of MEOWs).

v. Historic Occurrences

Table 2, below, reviews coastal storms that have affected New York City since 1785 (details vary based on available data).

Date	Event	Location	Description
September 23, 1785	The Equinoctial Storm	Manhattan	• Large ships driven onto Governors Island
August 19, 1788	Unnamed coastal storm	Citywide	• West side of Battery "almost laid in ruins"
September23, 1815	The Great September Gale	Citywide	• Montauk Lighthouse heavily damaged
September3, 1821	Norfolk and Long Island Hurricane	Citywide	• Storm tide rises 13 feet in one hour and causes the East River and the Hudson River to converge across lower Manhattan • Widespread flooding as far north as Canal Street
June 4, 1825	Unnamed coastal storm	Citywide	• Ships wreck off New York coast • Some trees down
November 13, 1846	Great Havana Hurricane	Citywide	• 100 yards of the Battery wash away
October 6, 1849	Unnamed coastal storm	Citywide	• Considerable structural damage
July 18, 1850	Unnamed coastal storm	Citywide	• Coney Island bathhouses demolished
August 23, 1893	Unnamed hurricane	Citywide	• Destroys Hog Island (near the Rockaway Peninsula)
September21, 1938	The Great Hurricane of '38, a.k.a the Long Island Express	Citywide	• Most powerful hurricane to make landfall near New York City • Eye crosses over Long Island, giving the storm its nickname • Kills 200 to 300 people, with 10 in New York City • Electricity knocked out north of 59th Street in Manhattan • 100 large trees in Central Park destroyed • Shinnecock Inlet created
August 31, 1954	Hurricane Carol	Citywide	• Makes landfall in eastern Long Island and southeastern Connecticut • Sustained winds of more than 100 mph and gusts 115 to 120 mph • At time was most destructive hurricane to hit the

Date	Event	Location	Description
			northeast to date
September10, 1954	Hurricane Edna	Citywide	• Passes east of Long Island, producing 9 inches of rain
September12, 1960	Hurricane Donna	Citywide	• Creates an 11-foot storm tide in New York Harbor and causes extensive pier damage
March 7, 1962	Ash Wednesday Nor'easter	Citywide	• One of most intense winter storms to ever hit the East Coast • Wave heights reach 40 feet offshore of New York City • Significant damage reported from North Carolina to southern New England
June 22, 1972	Tropical Storm Agnes	Citywide	• Agnes fuses with another storm system in the northeastern U.S., flooding areas from North Carolina to New York State • Causes 122 deaths and more than $6 billion in damage (adjusted for inflation)
September27, 1985	Hurricane Gloria	Citywide	• Makes landfall on Long Island at 80 mph • Produces a modest storm surge of 4 to 7 feet above normal across the Atlantic • Could have produced a much stronger and intense surge if it had hit at high tide • Causes largest single power loss in U.S. history to date • Total damage estimated at $900 million • Some moderate beach erosion
December 21, 1992	Nor'easter	Citywide	• Flooding, coastal erosion, and debris • Damage to residential and commercial structures, utility lines, roads, and other infrastructure
August 21, 1995	Hurricane Felix	Citywide	• Lingers off the East Coast for nearly a week, menacing the northeastern United States before drifting out to sea
June 18, 1996	Hurricane Bertha	Citywide	• Weakening storm brings heavy rain to the city
January 3, 1999	Nor'easter	Citywide	• 2.42 inches of rain • 50 vehicle accidents in Queens
September16, 1999	Tropical Storm Floyd	Citywide	• Floods subway tunnels across the city, causing service disruptions • Drops 10 to 15 inches of rain in 24 hours • Public schools close for the day
September18, 2003	Tropical Storm Isabel	Brooklyn, Bronx, Queens, Staten Island	• A fallen tree branch in the Bronx seriously injures a man • Total damage exceeds $1 billion along East Coast

6. COASTAL STORMS

Section III: Natural Hazard Risk Assessment

Date	Event	Location	Description
April 15, 2007	Nor'easter	Citywide	• Produces 7 inches of rain at LaGuardia Airport and 8.41 inches of rain in Central Park, with high winds and storm surge
October 28, 2009	Remnants of Hurricane Danny	Citywide	• 2.75 inches of rain in Sheepshead Bay, Brooklyn
August 24, 2011	Tropical Storm Irene	Citywide	• 6.87 inches of rain in Central Park, with wind gusts exceeding 50 mph • $1.3 billion in damage statewide
October 29, 2012	Hurricane Sandy	Citywide	• Costliest natural disaster in New York City history • Wind gusts exceed 60 mph at Central Park and LaGuardia and Kennedy Airports and reach more than 80 mph in some parts of the city • 11- to 14-foot storm tide in New York City—in some spots the highest in recorded history • Widespread flooding, building damage, and power outages

Table 2: Coastal Storms in New York City 1785 to 2012

Figure 6 shows the tracks of coastal storms to come within 100 miles of New York City between 1851 and 2013.

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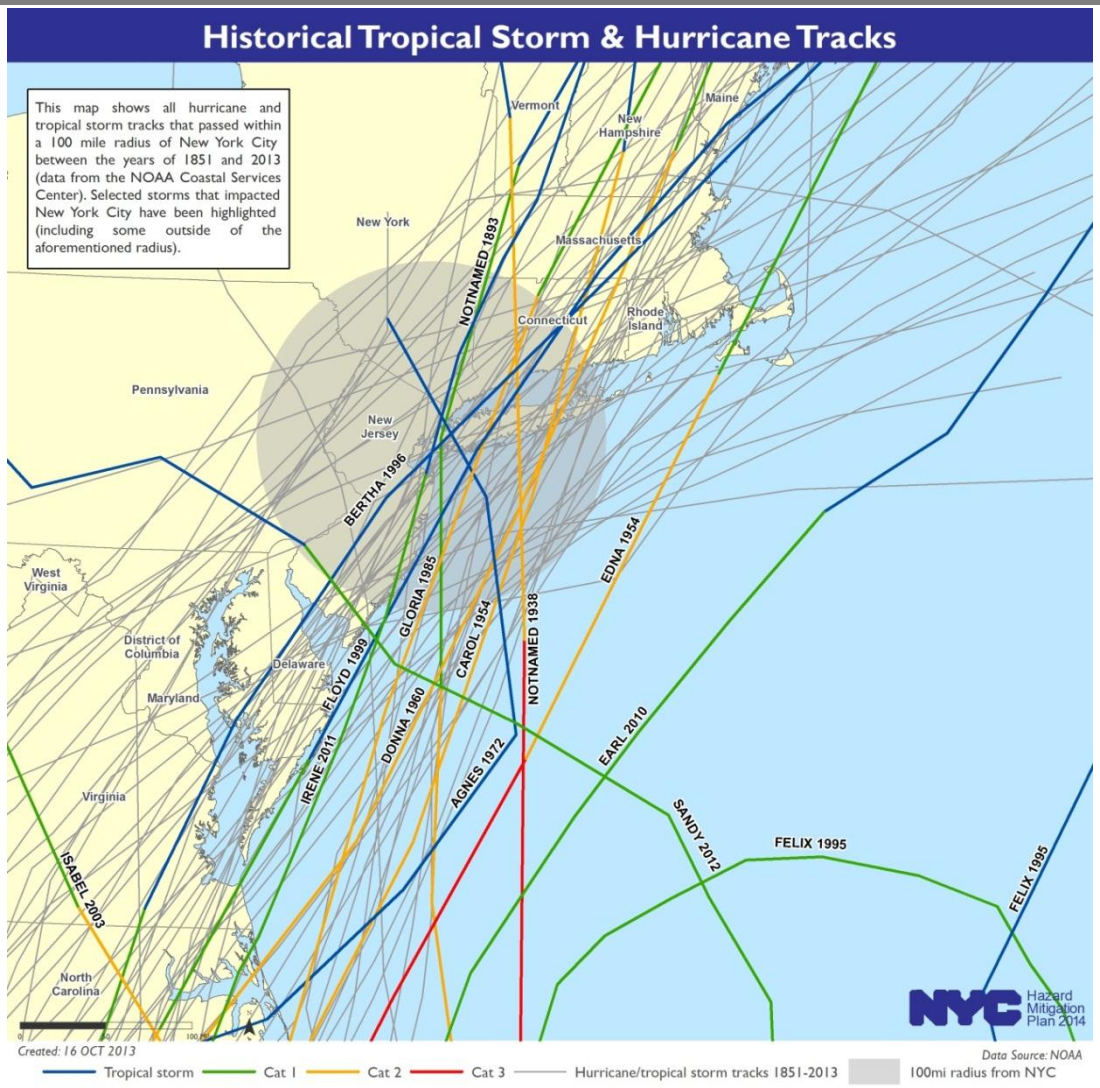

Figure 6: Tropical Storm and Hurricane Tracks within a 100-mile Radius of New York City (1851 to 2013)

B. VULNERABILITY ASSESSMENT

i. Social Environment

The social impacts of coastal storms on New York City can be significant. Based on population figures from the 2010 Census, nearly 2.5 million New York City residents live within a SLOSH zone, putting them at significant risk (see Table 3).

SLOSH Zone	Population (2010 Census)
Category 1	318,000
Category 2	796,000

SLOSH Zone	Population (2010 Census)
Category 3	674,000
Category 4	702,000
Total	2,490,000

Table 3: New Yorkers Living in SLOSH Zones

New York City residents, particularly special needs populations, can be exposed to significant health risks during and after the passage of a storm. Health risks can result from direct exposure to storm impacts: people may drown in rising waters, or they may be struck by flying debris and falling trees. People may also be forced to shelter in inadequate housing with no heat or hot water. They may be exposed to contaminated floodwaters, spoiled food, or mold, or they may experience the disruption of basic services (Lane et al. 2013). Rain, wind, and runoff may also contribute to high levels of turbidity (suspended pollutants) in local reservoirs, which interferes with the disinfection of drinking water.

Risk factors that increase vulnerability to coastal storms include lack of mobility, lack of access to medical resources, lack of information, or language barriers. The elderly are among the most vulnerable groups because they often lack mobility or the means to evacuate. In addition, the elderly are most likely to be physically disabled or have pre-existing medical conditions that can make evacuation more difficult, particularly those living in elevator buildings experiencing utility outages.

New York City has a large immigrant and non-native English speaking population. This can result in language barriers, resulting in difficulty to receive warnings, and may further inhibit the translation of warnings to action (for more information on vulnerable populations, see Risk Assessment Section 4: New York City Hazard Environment).

Vulnerable populations are also at an increased risk due to their reliance on healthcare facilities (hospitals, nursing homes, adult care facilities, and pharmacies), which can shut down or operate at reduced capacity during coastal storms. Patients and residents of such facilities are at risk due to power loss, especially those requiring life support equipment that runs on electricity, such as ventilators. Since many of these facilities are located in SLOSH zones (see Table 4), they are at an increased risk if backup generators and essential equipment are located on lower floors that are more likely to flood. Thus, a coastal storm event has the potential to put a tremendous strain on the healthcare system. As the number of patients goes up, the amount of available space goes down, and people may be unable to receive essential medical treatment. Furthermore, evacuation of patients, especially those with critical ailments or injuries, can be particularly challenging.

People who are unable to evacuate during a storm and instead shelter in place are at risk in the event of a medical emergency. This is because medical personnel may be delayed in responding due to lack of transportation or access to certain areas, non-functioning medical facilities, or a

high volume of calls. In the event of power outages, systems that use electric pumps to distribute water to upper floors of high-rises may not work, leaving people without potable water or water for washing and flushing. Homebound residents may be stranded in their home in they live in a high rise and lose power in the elevator. During the summer months, loss of air conditioning puts people at risk for heat-related illness (most likely after a hurricane). Similarly, during the colder months, if the heat is off because boilers located in basements are damaged by floodwaters, people may at risk for hypothermia if temperatures drop rapidly after a storm (most likely after a nor'easter). If residents remain stranded in flooded or damaged homes with no power after the storm passes, they may be exposed to secondary health hazards from contaminated drinking water, spoiled food, or growth of toxic mold.

Following a major storm or other disaster, those who are significantly affected may also experience mental health problems such as post-traumatic stress disorder (PTSD) and other anxiety and mood disorders. These effects are most common during the months immediately following the storm, but can potentially last much longer depending on the severity of the storm, the nature of exposure, chronic stressors related to the storm (such as prolonged displacement or power disruption), pre-existing mental health issues, and access to adequate care and assistance.

ii. Built Environment

The built environment is subject to significant damage during coastal storms. As the analysis in *PlaNYC: A Stronger, More Resilient New York* following Hurricane Sandy revealed, the vulnerability of the built environment to surge and flood damage depends on various building characteristics, including height, construction type, age, and location (SIRR, 2013). In general, low-rise buildings are more vulnerable to damage and destruction than mid-rise and high-rise buildings. Low-rise buildings have proportionally more floor area on or closer to the ground, and by their very nature, tend to house primary uses on the ground floor and therefore face higher risks of experiencing substantial damage from storm surge. In addition, low-rise buildings are often built from combustible materials, and buildings of this type are more prone to structural damage than buildings with the steel, masonry or concrete frames characteristic of high-rise buildings (see "The Built Environment" section of Risk Assessment Section 4: New York City's Hazard Environment).

Building age is also an important indicator of structural vulnerability. Older buildings are more likely to sustain significant damage than newer buildings, primarily due to the fact that building and zoning standards have become more stringent over time. During Sandy, for example, structures built before New York City's 1961 Zoning Resolution and the 1983 federal standards associated with Flood Insurance Rate Maps (FIRMs) from the Federal Emergency Management Agency (FEMA) suffered more severe damage than newer buildings. This proved to be the case with many New York City Housing Authority facilities.

Buildings subject to the force of wave action are much more likely to sustain serious damage than buildings subject to stillwater flooding only.

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Much of New York City's aging transportation and utility infrastructure is also highly vulnerable to significant damage from coastal storms. Within the transportation sector, at particular risk are subway tunnels, subway stations, and bus depots in low-lying, flood-prone areas, as well as bridges and passenger car tunnels. Vulnerable utilities include above-ground telecommunications and power distribution infrastructure (power lines and electric substations), which are directly exposed to wind, flooding, or falling trees and debris.

Table 4 shows the total numbers of critical facilities and key assets located within SLOSH zones for Categories 1 through 4. These facilities and assets are at risk to storm surge and severe damage during coastal storms.

ASSET TYPE	SLOSH CAT 1	SLOSH CAT 2	SLOSH CAT 3	SLOSH CAT 4	IN SLOSH ZONE	NOT IN SLOSH ZONE	*TOTAL*	*% IN SLOSH ZONE*
Airports (perimeter)*	1	1	0	0	2	0	2	100%
Nursing homes (FP)	13	23	14	16	66	107	173	38%
Hospitals (FP)	4	7	10	4	25	36	61	41%
Police stations (FP)	2	6	13	4	25	52	77	32%
Fire stations (FP)	17	20	16	18	71	157	228	31%
EMS stations (FP)	7	6	10	6	29	50	79	37%
WWTPs (FP)	12	2	0	0	14	0	14	100%
Power plants (est. FP)	8	16	2	0	26	0	26	100%
DOE school sites	43	140	122	107	412	878	1,290	32%
Private schools	23	63	80	74	240	608	848	28%
Colleges	4	9	10	11	34	89	123	28%
Ferry landings**	47	0	0	0	47	0	47	100%
Subway station (point)	31	32	37	52	152	338	490	31%
Rail station	9	2	2	2	15	27	42	36%
Cultural facilities (DCP)***	2	2	3	4	11	26	37	30%
Bus depots	6	13	2	2	23	7	30	77%
Bridges****	N/A	N/A	N/A	N/A	61	9	70	87%
Tunnels****	N/A	N/A	N/A	N/A	4	0	4	100%
Major roads (mi)****	N/A	N/A	N/A	N/A	479	408	887	54%
City total	229	342	321	300	**1,736**	**2,792**	**4,528**	**38%**

DISCLAIMERS:

Unless otherwise noted, a facility point was used to do a spatial calculation. This may result in some inaccuracies in category designation. Assets types with "FP" indicate that the actual facility footprint was used in the calculation (FPs were estimated for power plants).
*Based on airport perimeter - significant SLOSH impact only
**Active New York City commuter/commercial/recreational ferry landings only (including Ellis and Liberty Islands). All landings assumed Cat 1.
***Determination of what assets to include made by the Office of Emergency Management (OEM) and Department of City Planning
****Based on visual review of bridge/tunnel segments with ortho photo (aerial photo geometrically modified to uniform scale) or UNOFFICIAL designation of "major road" (by OEM). Considered not in a zone if all New York City bridge approaches are fully clear of SLOSH. Major roads do not include bridge/tunnel spans.

Table 4: Critical Assets within SLOSH Zones

Potential Losses to the Built Environment from Coastal Storms

Losses to the built environment in various potential storm scenarios were calculated using HAZUS-MH (see Risk Assessment Section 3: Hazard Risk Assessment Organization). HAZUS-MH hurricane module is a wind model and does not include damages from storm surge. Damage calculations are based on the effects of wind, wind-driven rain, and other wind-related hazards such as projectile impacts. Even though the module is for hurricanes, it can apply to any coastal storms that produce wind-related damages.

The general damage classes provided by HAZUS-MH for the hurricane module are: None, Minor, Moderate, Severe, and Destruction. These classes are an attempt to simplify a range of wind-related structural damages into several basic groups. Table 5 outlines damage states for residential structures.

Damage State	Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
0	**No Damage or Very Minor Damage** Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof over, with no or very limited water penetration.	≤2%	No	No	No	No	No
1	**Minor Damage** Maximum of one broken window, door or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No
2	**Moderate Damage** Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water	>15% and ≤50%	> one and ≤ the larger of 20% & 3	1 to 3 panels	Typically 5 to 10 impacts	No	No
3	**Severe Damage** Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% & 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
4	**Destruction** Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

Table 5: Damage States for Residential Structures (Source: HAZUS-MH 2.1 Hurricane Technical Manual, Table 6.9)

All of the coastal storm results are based on a probabilistic analysis because the historic record of deterministic events for our immediate area is limited. As with the other hazards modeled, the focus is on damage to buildings. The probabilistic hurricane model in HAZUS-MH is based on "the range of probability losses estimated from a 100,000-year simulation of expected hurricane activity" (HAZUS-MH 2.1 Hurricane User Manual, section 10.2). Probabilistic analysis in HAZUS-MH allows for a summary of results from seven discrete return periods: 10, 20, 50, 100, 200, 500, and 1,000 years. Output such as building damage counts (see Table 6) or dollar losses (see Table 7) may be analyzed for any of these return periods.

Return Period (years)	Minor	Moderate	Severe	Destruction	Total Damaged	% of Building Stock Damaged
10	0	0	0	0	0	**0.0%**
20	1,766	87	0	0	1,853	**0.2%**
50	8,254	833	51	0	9,138	**0.9%**
100	33,806	5,559	204	5	39,574	**3.7%**
200	95,113	20,825	852	100	116,890	**10.9%**
500	214,050	74,327	5,937	1,827	296,141	**27.6%**
1,000	278,151	138,990	22,631	8,664	448,436	**41.8%**

Table 6: HAZUS-MH Calculation of Number of Buildings Damaged due to Wind from a Coastal Storm, by Return Period

Return Period (years)	Building Damage ($)	Contents Damage ($)	Inventory Loss ($)	Income Loss ($)	Total ($)
10	0	0	0	0	**0**
20	27,764,000	1,745,000	0	332,000	**29,841,000**
50	803,789,000	50,340,000	2,000	50,998,000	**905,128,000**
100	3,061,473,000	244,777,000	420,000	256,471,000	**3,563,142,000**
200	8,088,942,000	825,247,000	3,127,000	873,512,000	**9,790,829,000**
500	22,028,575,000	3,649,592,000	25,684,000	2,859,507,000	**28,563,358,000**
1,000	38,448,295,000	9,978,726,000	56,005,000	5,077,610,000	**53,560,636,000**

Table 7: HAZUS-MH Calculation of Economic Losses due to Wind from a Coastal Storm, by Return Period

In addition, HAZUS-MH provides an estimate of annualized economic building losses (see Table 8 and Figure 7). Since the New York City area does not frequently experience hurricane-level wind events, annualized losses can be helpful in estimating the impact over time of such events.

Borough	Building Damage ($)	Contents Damage ($)	Inventory Loss ($)	Income Loss ($)	Total ($)
Bronx	28,098,000	6,143,000	32,000	3,478,000	37,752,000
Kings	62,762,000	14,400,000	116,000	7,741,000	85,019,000
New York	37,748,000	6,150,000	32,000	4,733,000	48,663,000
Queens	63,918,000	15,577,000	86,000	7,327,000	86,907,000
Richmond	12,447,000	3,062,000	11,000	1,275,000	16,795,000
City Total	**204,972,000**	**45,333,000**	**277,000**	**24,555,000**	**275,136,000**

Table 8: HAZUS-MH Calculation of Annualized Economic Losses due to Wind from a Coastal Storm, by Borough

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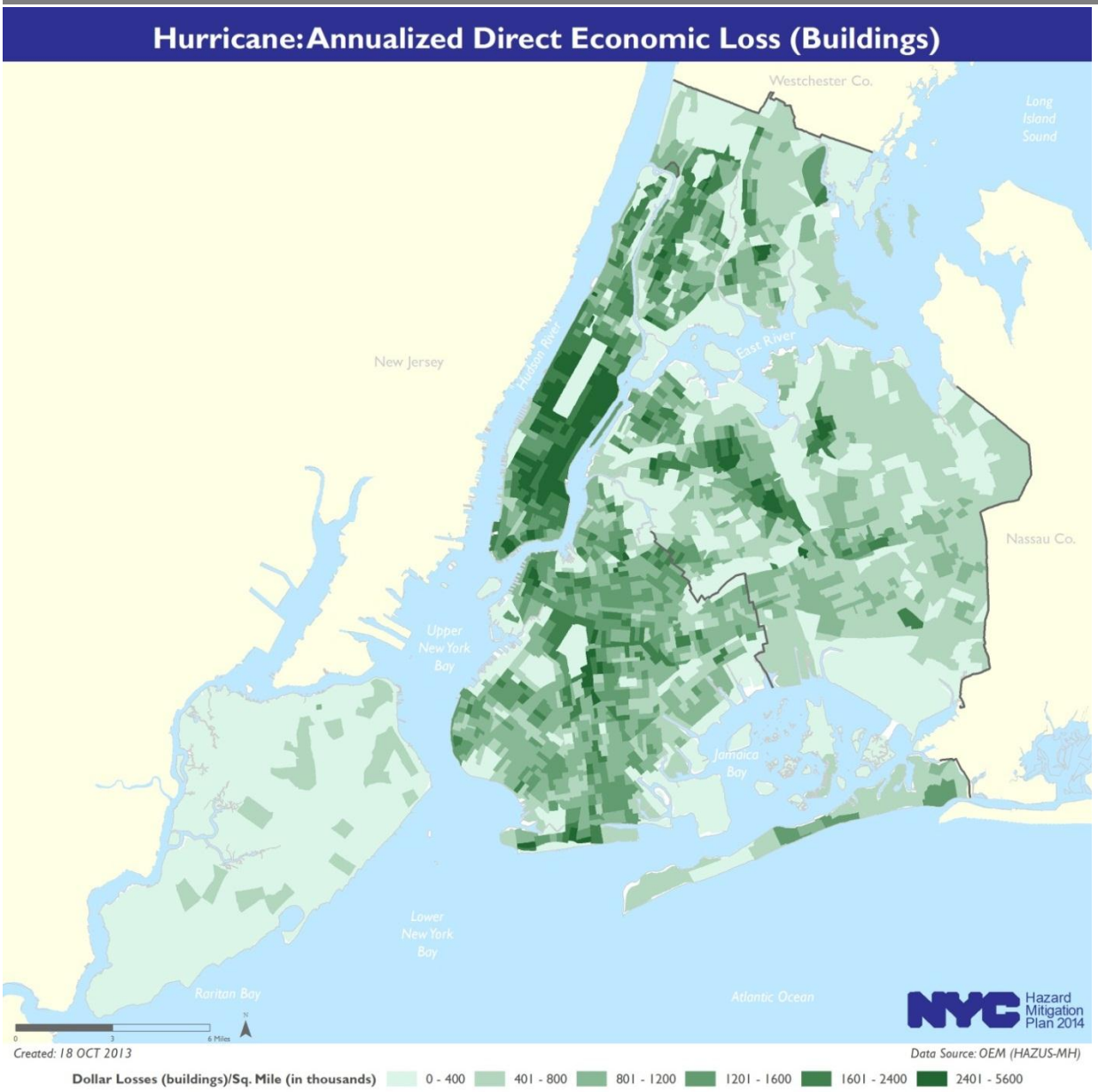

Figure 7: HAZUS-MH Results for Annualized Losses to Buildings due to Wind from a Coastal Storm, by Census Tract

iii. Natural Environment

Coastal storms can have significant impacts on natural areas and coastal ecosystems. Although storms are natural events, the highly developed state of New York City's coastline prevents the natural migration of barrier islands and wetlands. Significant storms have the potential to permanently submerge wetlands and cause barrier islands to narrow or split. Erosion of beaches and dunes, wetland loss, and barrier island breaching are all direct impacts of coastal storms that can damage or destroy coastal habitats and disrupt migration patterns of terrestrial animals. The loss of these natural storm barriers also leaves wooded areas and parks farther inland more exposed to the impacts of wind and storm surge.

Marine and aquatic species are also vulnerable to the impacts of coastal storms. Following the passage of a storm, contaminated runoff may lead to elevated levels of dissolved nutrients in coastal waters. This reduces the amount of dissolved oxygen in the water and may result in localized fish kills. Sources of contaminated runoff include chemical spills or leaks from commercial or industrial areas and overflow from sewers and wastewater treatment plants. Large volumes of debris in local waterways can also be hazardous to local species. Large-scale changes in the population, distribution, and migrations of marine and aquatic species are possible over the long term.

iv. Future Environment

When considering the prospect of coastal storms in the future, planners and emergency managers must understand how climate change will affect the probability of these storms for our area, and the impacts the storms will have if they do make landfall in or near New York City.

As the climate continues to warm, ocean surface temperatures are projected to increase. As a result, storms may become more intense. Although it is still unclear how all of the climatic variables affecting hurricanes will change, there is a general consensus among climate scientists that the frequency of the most intense hurricanes (not the frequency of hurricanes in general) may increase on a global scale and in the North Atlantic Basin.

Scientists are less certain as to how the probability of these storms will change at the local level, including potential changes in storm tracks. Several recent studies have found a possible link between melting Arctic Sea ice and storm tracks. This evidence suggests that melting sea ice may change the pattern of the Jet Stream, which, in turn, can shift the tracks of storms in the Atlantic. However, this research is in its early stages and is still only suggestive at this point.

Although there is still uncertainty about how probability will change, scientists are fairly certain that the impacts of coastal storms will worsen in the future when combined with sea level rise due to climate change (NPCC, 2013). It is known that climate change contributes to sea level rise in several ways. As ocean water warms, it expands and takes up more volume, which in turn causes sea level to rise. Global warming is also causing land glaciers and polar ice caps to melt at a rising rate, which increases the amount of water in the oceans. Since 1900, relative sea level has risen approximately 1.1 feet in New York City owing in part to climate change and in part to local factors such as land subsidence. By the middle of the 21st century, sea level in New York City could rise more than 2.5 additional feet, according to the high end NPCC projections. As sea levels continue to rise, coastal flooding from future storms will cause more extensive damage than from an equivalent storm today because sea level will already be higher to begin with.

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A. Hazard Profile

i. Hazard Description

Disease outbreaks occur when disease cases exceed what would normally be expected in a defined community, geographic area, or season. The spread, duration, and severity of outbreaks vary tremendously depending on the disease and can disproportionately impact some populations that are more susceptible to an outbreak. Disease outbreaks can cause sudden, pervasive illness in all age groups on a local or global scale. There are several modes of transmission, which include airborne, direct contact, and indirect contact.

Traditionally, significant disease outbreaks have been caused by bacterial or viral organisms. With improvements in sanitation, the likelihood of a bacterial outbreak, such as cholera or typhoid, has been significantly reduced in New York City, although there are still periodic outbreaks of food-borne illnesses. In contrast, viral outbreaks are still a regular threat. Each year New York City is impacted by seasonal influenza outbreaks. In addition, several global viral threats are being monitored by the New York City Department of Health and Mental Hygiene (DOHMH) for pandemic potential.

Disease outbreaks are caused by several types of viruses or bacteria, as described below.

Pandemic or Severe Seasonal Influenza
Influenza pandemics occur when there is a significant genetic change in a circulating strain of influenza. Because people have not previously been exposed to this new strain, they do not possess immunity to it and are therefore susceptible to contracting the illness. The new strain of influenza can spread rapidly from person to person, with a large portion of the population vulnerable to infection.

Symptoms of influenza include fever, achiness, respiratory difficulties, and extreme fatigue the effects of which can last up to two weeks for some people. Transmission of the disease occurs when persons come into contact with infected droplets, expelled by coughing, or contact with contaminated materials and surfaces.

A pandemic may be mild/moderate or severe. The pandemic of 1918 is the most recent example of a severe outbreak. Mild/moderate outbreaks occurred in 1957-1958, 1967-1968, and 2009.

Current influenza strains being monitored globally for pandemic potential include H5N1 and H7N9. However, the next pandemic strain might as yet be unidentified and remain so until an outbreak occurs, as was the case with H1N1 in 2009 and 2010.

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Coronavirus, first identified in humans in the mid-1960s, are common viruses that most people get at some point in their lives. Human coronaviruses usually cause mild to moderate upper-respiratory tract illnesses. In 2003, infection with the coronavirus known as SARS-CoV was characterized by high fever, headache, coughing, and breathing difficulties, and was in many patients severe or fatal. Transmission of coronaviruses occurs when people come into contact with infected droplets expelled by coughing, or with contaminated materials and surfaces. The most recently identified high-risk coronavirus is known as MERS-CoV and is currently concentrated in Saudi Arabia with some travel-associated cases outside of the Middle East.

Novel Viral Outbreak

Novel viral outbreaks occur when a previously unknown viral disease is identified. One example is West Nile virus, a mosquito-borne virus that can cause serious health conditions including encephalitis and meningitis. West Nile is most prevalent during peak mosquito season, June 1 to October 31. The City closely monitors suspected cases of the disease in humans and has a vigorous prevention and response program.

Bacterial Outbreaks

In addition to naturally occurring disease outbreaks, there can be outbreaks caused by the use of certain biological agents by terrorists to cause illness or death. For example, anthrax, caused by the bacterium Bacillus anthracis, is a disease commonly found in livestock, but has been manufactured for use as a bioterror weapon. There are three types of diseases of anthrax: cutaneous, inhalation, and gastrointestinal. In New York City, the most likely exposure would come from the intentional release of spores through an act of bioterrorism, though infection from exposure to animal skins or wool might also occur.

As with anthrax, plague outbreaks can occur from either natural or intentional exposure. They are caused by the bacterium Yersinia pestis, and usually found in rodent fleas. Humans can be naturally exposed when bitten by a rodent flea or when handling infected animals. There are three forms of plague: bubonic, septicemic, and pneumonic. Symptoms vary by form but include fever, chills, and headache, with a high rate of death occurring in untreated patients. The intentional release of plague as an act of bioterrorism could lead to significant illness and mortality in New York City residents.

ii. Severity

An outbreak's severity is not only dependent on disease characteristics but also on the availability of countermeasures. Pandemic influenza has two forms of pharmacologic countermeasures: antiviral medications for infected persons and vaccination and antiviral medications to prevent infection in the first place. Coronaviruses, however, currently lack either vaccinations or frontline treatments; therefore, strict enforcement of infection control, especially in healthcare or communal settings, is the primary

method of outbreak prevention. Bacterial outbreaks like anthrax or plague are counteracted by antibacterial treatments.

The extent of an outbreak can be classified as endemic, epidemic, and pandemic. Endemic refers to the usual presence of a disease within a specific population or area. An epidemic is characterized by a sometimes-sudden increase in the number of cases of a disease that exceeds what is normally expected. A pandemic refers to an epidemic that has spread across the region and over several countries.

iii. Probability

Although it is difficult to predict the next disease outbreak, history has shown that outbreaks are not uncommon. Influenza pandemics have occurred every 10 to 60 years, with three occurring in the 20th century (1918, 1957 to 1958, and 1967 to 1968) and one in the 21st century (2009 to 2010). Even though substantial improvements have been made in medicine over the past century, several factors increase the probability of future occurrences: population, growth, increases of populations that do not have access to healthcare, evolution of antibiotic-resistant bacteria, and globalization.

iv. Location

New York City's dense population combined with the fact that it is a major port of entry makes it exceptionally vulnerable to disease outbreaks. Whether natural or intentional, infectious disease outbreaks pose serious threats to the city and could strain the capacity of health care facilities to respond. Furthermore, airports, transit hubs, and mass transit can increase exposure to disease outbreaks because these are locations where people from all over come into contact with each other.

Based on a recent study conducted by DOHMH, some clusters of residents in the city may be more vulnerable to respiratory outbreaks such as pandemic influenza. Using Blumenshine's (2008) conceptual model of pandemic influenza vulnerability, which shows that increased exposure, increased susceptibility, and lack of access to care are all vulnerability indicators (see Figure 1), DOHMH generated individual-level vulnerability scores using micro data from the American Community Survey and the Behavior Risk Factor Surveillance System, and then mapped the overall density of those most vulnerable to a pandemic in New York City.

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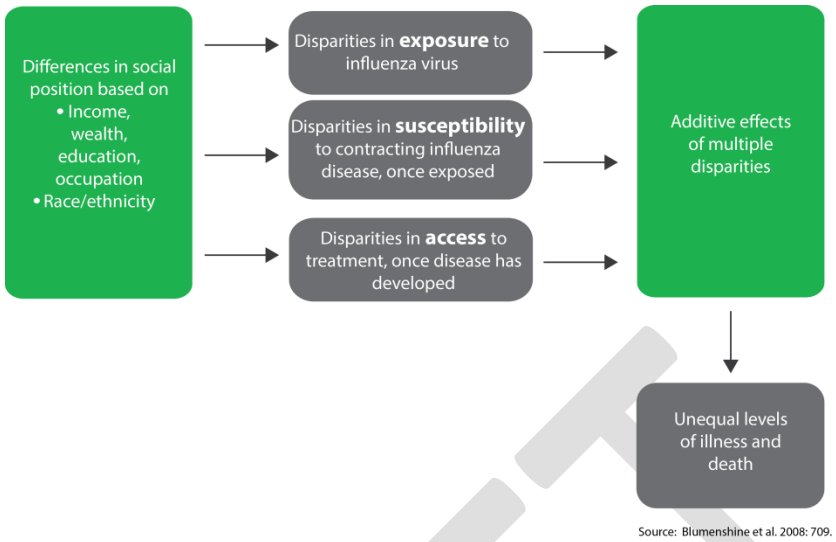

Figure 1: Conceptual Model of Vulnerability during an Influenza Pandemic

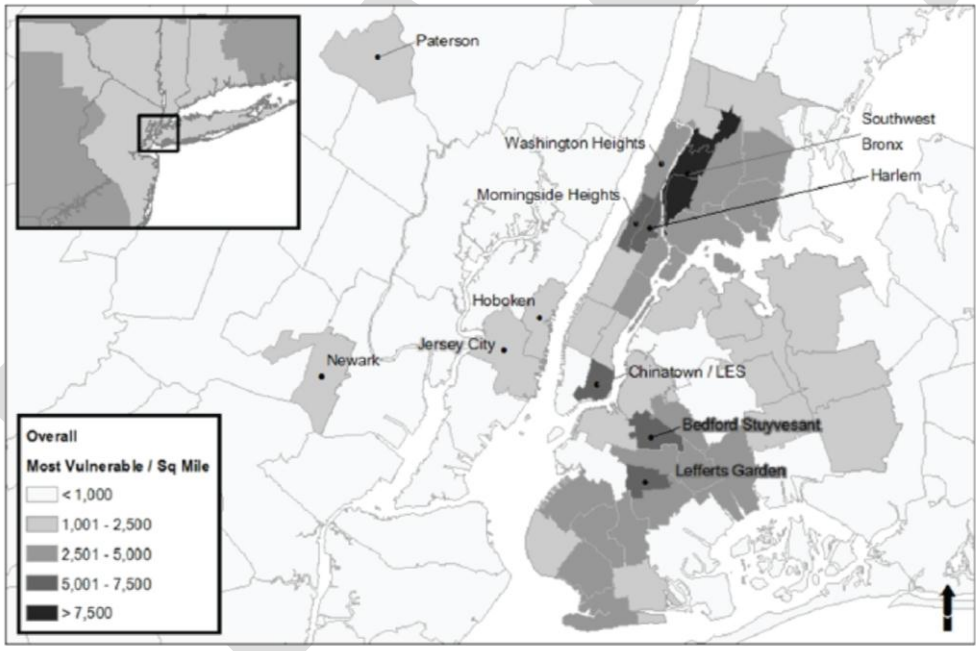

Figure 2: Density of Populations with Vulnerability to Influenza Pandemic

DOHMH identified three tiers of clusters of people who are more vulnerable to pandemic flu outbreaks (see
Figure **2**). Densities of those most vulnerable to pandemic influenza spread (tier one) are highest in the southwest Bronx. The second tier of neighborhoods found vulnerable to pandemic outbreak includes Morningside Heights, Chinatown, Lower East Side, Lefferts

Garden, and Bedford-Stuyvesant. The third tier of neighborhoods vulnerable to the spread of pandemic influenza includes Harlem and Coney Island.

v. Historic Occurrences

Throughout New York City's history there have been disease outbreaks, originating as early as 1668 with the first cases of yellow fever. During the summers of 1795, 1799, and 1803 there were numerous cases of yellow fever that eventually led to the creation of the New York City Board of Health. As the city's water and sanitary conditions improved, disease outbreaks, especially bacterial, were reduced.

A more recent disease outbreak was the 2009 influenza pandemic H1N1. First identified in Mexico in April 2009, it spread to New York City in late April of that year, followed by a global pandemic, which lasted through the spring and into early summer in New York City. DOHMH estimates that as many as one million New Yorkers were infected.

Year	Event	Description
1668	Yellow fever	• First yellow fever epidemic in the city • Symptoms include yellowed complexions and vomitting black bile • Described as an “autumnal bilious fever in infectious form” • Governor Francis Lovelace of New York establishes “General Day of Humiliation” in response to the rapid spread of fever
1799	The Great Epidemic	• Major yellow fever epidemic • Kills 2,086 from late July to November
1805	Yellow fever	• Mayor De Witt Clinton establishes the New York City Board of Health in response to the outbreak • Board of Health orders evacuation of neighborhoods and collects mortality statistics
1819	Yellow fever	• Major epidemic • Board of Health evacuates impacted districts and creates barriers to neighborhoods that led to the initial spread
1832	Cholera	• Outbreak begins on June 26 • Disease spread peaks at 100 deaths per day by July • More than 3,500 deaths occur in the city • 80,000 people flee the city during the epidemic
1848 to 1849	Cholera	• Outbreak begins December 1848 and by June 1849 reaches epidemic level • Board of Health creates makeshift cholera hospitals and convinces police to remove thousands of hogs from crowded tenement areas

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7. DISEASE OUTBREAKS

Year	Event	Description
1866	Cholera	• Outbreak causes 1,137 deaths • Disease spread is limited by the Metropolitan Board of Health and the enforcement of sanitation laws
1900 to 1920	Tuberculosis	• In 1900, tuberculosis (TB) is the leading cause of death among adults in New York City • Department of Health (DOH) opens TB clinics • Death rates are reduced by half by 1920
1907 and 1915	Typhoid fever	• Mary Mallon, a cook nicknamed "Typhoid Mary," is deemed the carrier responsible for the spread of the disease • 53 cases and 3 fatalities in the city
1916	Polio	• Polio reaches epidemic proportions in the summer of 1916 • 8,991 cases and 2,448 deaths in the city
1918	Spanish flu	• Spanish flu pandemic occurs worldwide • DOH staff diminished due to the entry of the United States into World War I, prompting many doctors and nurses to leave the city to join the Red Cross and Army Medical Corps • 12,000 New York City residents die from influenza-related causes
1957 to 1958	Asian flu	• 800,000 cases of Asian flu, representing 10% of New York City's population
1968 to 1969	Hong Kong flu	• Mild flu pandemic results in 33,800 deaths in the United States • Virus is similar to 1957 Asian flu, which provides some immunity • Begins in December during school vacation, which may have limited the spread of the illness
1981 to present	AIDS (Acquired Immune Deficiency Syndrome)	• First 41 cases identified by the Center for Disease Control (CDC) in 1981 • By 1983, health officials learn that disease is spread by sexual contact or sharing hypodermic needles • DOH creates initiatives to limit access to hypodermic needles • By 1986 DOH launches major prevention and treatment programs • In the 1990s, DOHMH provides access to potent antiretroviral therapies, leading to a significant drop in the city's AIDS-related deaths

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7. DISEASE OUTBREAKS

Year	Event	Description
1999	West Nile virus	• Mosquito-borne virus • 62 cases and seven fatalies
2001	Anthrax	• The nation's first anthrax case in New York City • 8 people infected; 1 was the child of a media employee
2009 to 2010	H1N1	• Outbreak lasts from spring 2009 to 2010 • DOHMH estimates that as many as one million New York City residents were infected

Table 1: Selected Disease Outbreaks in New York City 1668 to 2013

B. VULNERABILITY ASSESSMENT

i. Social Environment

Disease outbreaks impact the social environment in many ways, and some groups may be more vulnerable than others. For example, drawing on health disparities, Blumenshine's conceptual model of pandemic influenza vulnerability identifies mechanisms by which income, race, and other social attributes influence exposure, susceptibility, and access to treatment during a pandemic outbreak. DOHMH's vulnerability study builds on this model by determining 10 causes of vulnerability (see Figure 3).

Exposure

Transmission of pandemic flu is typically airborne, but pandemic flu can also spread through direct and indirect contact. Low-income populations may be more vulnerable to pandemic outbreaks because of living conditions (crowded households), dependence on public transportation (they cannot afford alternate modes of travel), or crowded workplaces. Their inability to distance themselves from others increases their chance of exposure. Since frequent contact with infected populations increases the risk of exposure, healthcare providers, care givers, and first responders are also vulnerable.

Susceptibility

Certain populations are more susceptible to contracting pandemic flu. These populations include the very old, the very young, and people with pre-existing conditions such as diabetes, cardiovascular disease, or HIV. Stress levels, environmental conditions, and social behavior also play an important role. For example, high-stress work situations, poor or unsafe housing, or drug addiction and alcoholism can increase the likelihood and severity of infection.

Access to Treatment

Social vulnerability may also be affected by access—or lack of access—to treatment. Populations unable or unwilling to get vaccinations or to obtain care if infected may be more vulnerable. Several studies have shown that African Americans get vaccinated at a

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lower rate than the rest of population (Blumenshine et al). In general, people who do not have health insurance, low-income populations, immigrants, and people with disabilities have less access to treatment. The ability of healthcare facilities to maintain continuity of care is another important factor. Pandemic flu outbreaks can disrupt the continuity of care for those with pre-existing conditions (such as diabetes and HIV) because pandemics impact healthcare workers.

Economic Impacts

A disease with a high mortality or morbidity rate could have catastrophic economic impacts. The loss of the ability to acquire goods and services could affect every household in the state. Furthermore, disease outbreaks sometimes occur in waves, affecting the stability of certain economic sectors and their ability to recover before the next wave hits.

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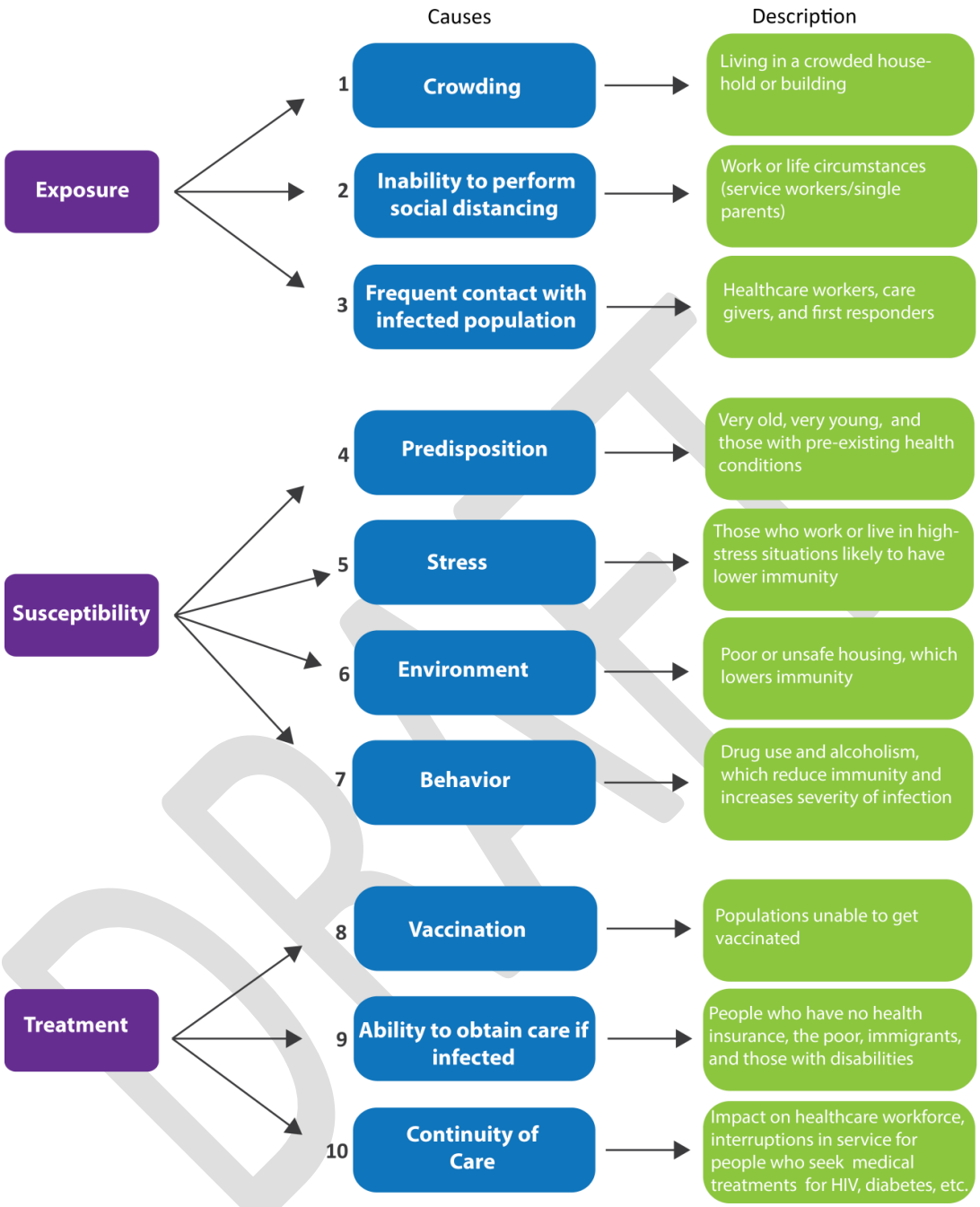

Figure 3: Conceptual Vulnerability Matrix (Source: DOHMH)

ii. Built Environment

In general, a disease outbreak will have little effect on property, with the possible exception that owner absenteeism, neglect, and lack of maintenance due to owner illness may cause property deterioration.

However, a disease outbreak has the potential to affect critical infrastructure. It may contribute to the disruption of basic services, including garbage collection and repairs to infrastructure (power, telephone, cable, etc.), should service workers fall ill. Because infrastructure sectors are interdependent, the failure of one sector may cause the failure of others.

A disease outbreak could have a direct impact on critical facilities. It would affect the operations of healthcare providers, which would, in turn, affect patient care. Increased employee and staff absences could, and most likely would, have an impact on service provision.

vi. Natural Environment

The environmental impacts of disease outbreaks largely depend on the type and severity of the disease. With more catastrophic disease pandemics the necessity for mass burials of animals or humans could impact the environment. In addition, disease outbreaks have the potential to affect the condition of parks and open space, should parks maintenance workers fall ill.

vii. Future Environment

In the future, population increase and density may exacerbate the exposure and susceptibility of people to disease outbreaks. In addition, global travel may amplify the probability of frequent outbreaks due to increased opportunities for exposure and transmission.

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A. Hazard Profile

i. Hazard Description

Drought differs from other hazards in many ways. The National Weather Service (NWS) describes four types of drought: meteorological, agricultural, hydrological, and socioeconomic.

Meteorological, or climatological, drought is defined in terms of the departure from a normal precipitation pattern and the duration of the hazard. This type of drought has a slow onset—it usually takes at least three months to develop—and may last for several seasons or years.

Agricultural drought links meteorological drought to agricultural impacts due to precipitation shortages and soil-water deficits. This type of drought has minimal direct impact on New York City because there is no significant agricultural activity within the city's boundaries.

Hydrological droughts, which often lag behind meteorological and agricultural droughts, involve deficiencies in surface water and sub-surface water supplies. The frequency and severity of hydrological drought is often defined on a watershed basin scale. Although climate is a primary contributor, other factors—such as changes in land use, land degradation, and the construction of dams—all affect the hydrological characteristics of the basin.

Finally, there is socioeconomic drought, which occurs when water shortage begins to affect the population, individually and collectively.

Drought differs from other hazards in that its effects take a considerable time to develop, and the extent of the hazard can linger for prolonged periods after the drought itself has ceased. Moreover, while most definitions of socioeconomic drought associate the hazard with supply, demand, and economic good, the absence of a definitive and universally accepted definition complicates the determination of whether a drought is occurring and the level of its severity. Finally, compared to other natural hazards, the geographical area, impacts, and the duration of drought are difficult to quantify. This is especially true in New York City because its water comes from three upstate sources.

ii. Severity

The New York City Department of Environmental Protection (DEP) has developed the *New York City Drought Management Plan* to guide the City's response to a drought. The current *Drought Management Plan* has three phases: drought watch, drought warning, and drought emergency. Drought emergency is further subdivided into three stages, each with increasingly severe mandated use restrictions. The *Drought Management Plan* establishes guidelines for declaring a watch, warning, or emergency and the appropriate response for each phase. Factors such as prevailing hydrological and meteorological conditions, as well as certain operational considerations, inform the guidelines.

DEP declares a drought watch when there is less than a 50% probability that either of the two

largest reservoir systems—the Delaware (Cannonsville, Neversink, Pepacton, and Rondout reservoirs) or the Catskill (Ashokan and Schoharie reservoirs)—will fill by the following June 1, the start of the water year.

DEP declares a drought warning when there is less than a 33% probability that either the Delaware or the Catskill system will fill by the start of the water year.

DEP declares a drought emergency when there is a reasonable probability that, without the implementation of stringent measures to reduce consumption, a protracted dry period would drain the city's reservoirs. DEP estimates this probability during dry periods in consultation with the New York State Drought Management Task Force and the New York State Disaster Preparedness Commission. Analyses of the historical record, the pattern of the dry-period months, water quality, sub-system storage balances, delivery system status, system construction, maintenance operations, snow cover, precipitation patterns, use forecasts, and other factors inform the estimation.

DEP is currently updating the *Drought Management Plan*, which will be renamed the *Water Shortage and Contingency Plan* and will be ready in early 2014. In addition to addressing water supply problems due to drought, the updated plan will also address issues related to infrastructure failure and planned system repairs.

iii. Probability

Occasional drought is a normal, recurrent feature of virtually every climate in the United States. According to the New York State Department of Environmental Conservation (NYS DEC), New York's average annual precipitation ranges from 28 inches in the Lake Champlain Valley to 60 inches in the Catskills. This precipitation feeds the state's streams, lakes, and coasts

However, even with a temperate, moist climate, normal fluctuations in regional weather patterns can lead to periods of dry weather. The last severe droughts in New York State occurred in the mid-1960s and again in the early and mid-1980s. According to the *National Drought Atlas*, a guide to the severity, frequency, and duration of droughts for the continental United States, weather that brings 62% of normal precipitation or less occurs one year out of 50 in New York City.

iv. Location

The major components of the New York City water system are described in the New York City Hazard Environment section of this report. The fact that important elements of the city's water supply system are located upstate makes the system vulnerable to weather conditions outside its borders. As part of its *New York State Drought Plan*, NYS DEC subdivided New York State into drought management regions. New York City is located in Drought Region IIA; however, most of its watershed lies to the north in Region II (see Figure 1). Based on historic occurrences, droughts tend to occur city-wide.

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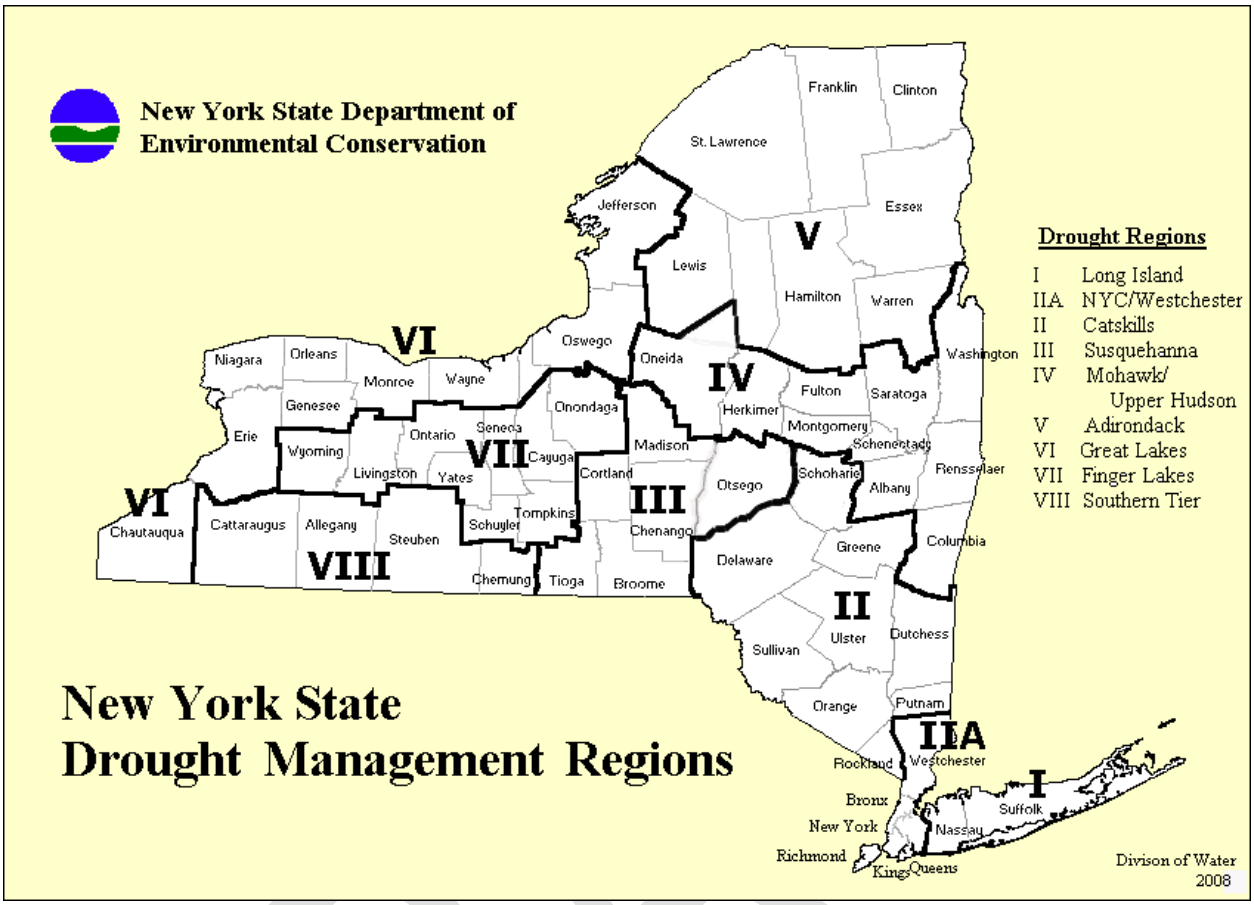

Figure 1: New York State Drought Management Regions (Source: NYS DEC, 2008)

v. Historic Occurrences

Table 1, below, indicates that there were several significant droughts between 1963 and 2003.

Date	Event	Location	Description
1963–1965	Drought emergency	Citywide	• Intense water conservation campaign November 1963 to May 1964 • August 18, 1965, federal government declares water shortage disaster for New York City • New York State's only federal disaster declaration for a drought
1980–1982	Drought emergency	Citywide	• Drought watch issued in October • Drought warning issued in November • Drought emergency put into effect when water storage levels drop to 33% on January 1, 1981 • Downgraded to warning January 18, 1982, and to watch November 11, 1982
1985–1986	Drought emergency	Citywide	• Drought watch issued February 25, 1985, when water storage levels drop to 50% • In span of two months, drought conditions upgraded from drought watch to drought warning to drought emergency • Downgraded to warning November 1985 • Normal conditions restored February 25, 1986 • No damages recorded for this event • New York State Drought Plan revised based on lessons learned from this and earlier 1980s droughts
1989	Drought emergency	Citywide	• Drought watch issued January 17, when water-storage facilities were at 58% • Drought conditions upgraded to drought emergency (Stage II) March 22 • Conditions restored to normal May 15

Date	Event	Location	Description
1991	Drought warning	Citywide	• Drought watch issued September 25, when water-storage facilities were at 53% • DEP subsequently issues drought warning
1995	Drought warning	Citywide	• Drought watch issued July 5, when water-storage capacities fall to 84% • Drought warning issued September 13 • Normal conditions restored November 14
2001–2003	Drought emergency	Citywide	• Drought watch issued December 23, 2001, with water-storage levels at 44% • One month later, DEP issues drought warning • Drought emergency issued April 1, 2002 • Over next eight months, increased precipitation and reduced water consumption to alleviate drought conditions • Normal conditions restored January 2, 2003

Table 1: Droughts in New York City 1963 to 2003

Since 2003, the city has experienced two episodes of abnormally dry weather, formally defined as "under moderate drought conditions." The first of these episodes began on June 29, 2010, and lasted four months, and the second began on March 20, 2012, and lasted two and a half months. However, neither episode was severe enough to be classified as a drought watch, warning, or emergency.

B. Vulnerability Assessment

Each drought produces a unique set of impacts on New York City, depending not only on its severity, duration, and spatial extent but also on ever-changing social conditions. As shown in Figure 2, drought can directly or indirectly affect New York City's social, economic, built, natural, and future environments.

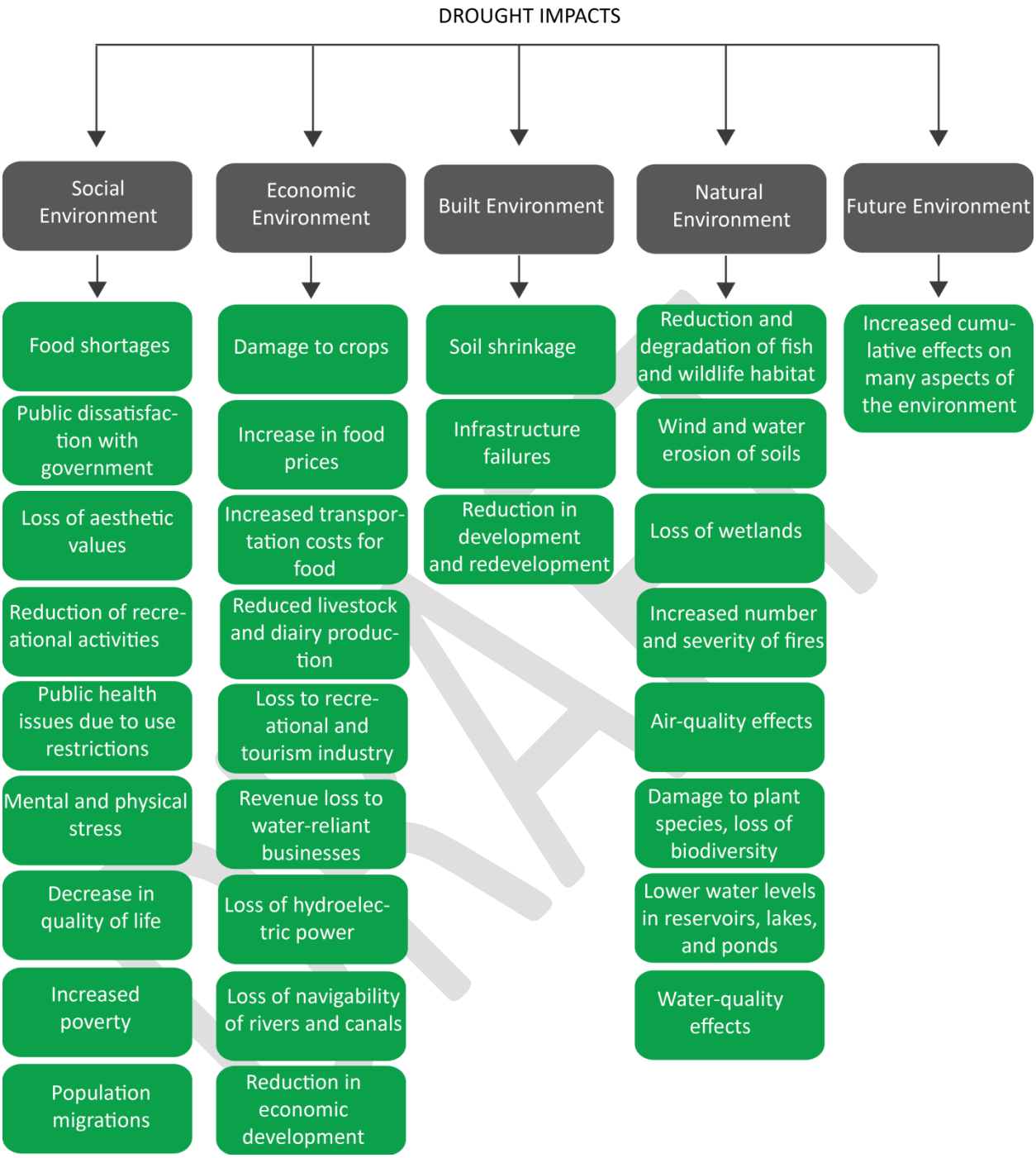

Figure 2: Drought Impacts on Social, Economic, Built, Natural, and Future Environments

i. Social Environment

The impacts of drought on the social environment can be both direct and indirect. Given the prolonged and chronic nature of droughts, there may be indirect health effects that are not readily identified, making it challenging to monitor and plan for these events. However,

vulnerable populations—including the very young, seniors, and low-income populations—are more susceptible to the harmful impacts of a drought.

Severe droughts can adversely affect public health, leading to dehydration, poor air quality, diminished quantity and quality of potable water, recreational risks, compromised sanitation and hygiene, and an increased incidence of illness and disease. Droughts may also compromise the availability of food and nutrition. Limits on growing season and low crop yields, along with increasing food prices, could result in food shortages. This could adversely affect vulnerable populations as they may lack the resources to contend with these drought impacts. In addition, populations with pre-existing health conditions may be more susceptible to illness and the spread of disease.

According to the Centers for Disease Control and Prevention (CDC), prolonged drought can diminish air quality due to increased particulates suspended in the air from dust and wildfires. Wildfires can increase airborne particles that can irritate bronchial passages and lungs, increasing chronic respiratory illnesses and the risk of acute respiratory infection. Both dust and wildfires may also exacerbate conditions for people with chronic respiratory disease such as asthma.

The CDC also advises that decreased rainfall may cause groundwater and surface water to become polluted with viruses, protozoa, and bacteria, increasing the risk of disease outbreaks.

Drought can also have direct and indirect economic impacts. Businesses reliant on water—such as car washes, landscapers, and manufacturers—may be forced to suspend all or a portion of their activities due to reduced water levels and subsequent curtailment of water usage. The indirect impacts associated with drought may be far-reaching.

Accurate loss estimates for drought are not available. The indirect impacts associated with drought are so diffuse that financial estimates of potential damages are not feasible.

ii. Built Environment

In general, drought does not cause structural damage and does not affect infrastructure such as highways, bridges, and electric conveyance systems. Drought can, however, impact water-borne transportation systems, including ferries and barges, due to periods of low water.

Drought can also cause severe soil shrinkage, which can compromise the foundation upon which the infrastructure stands, including retaining walls and bulkheads. (For more information on these types of infrastructure impacts, see Infrastructure Failures section.) However, soil shrinkage only causes real damage if soils shrink and swell as the moisture content decreases and increases. According to the U.S. Geological Survey (USGS), New York City soils typically are not high-swelling in nature. Therefore, there is a very low risk of structural damage associated with drought.

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Droughts can affect green roofs, though. In New York City, green roofs contain vegetation that provides insulation, combats the urban heat island effect, and improves air quality. Droughts impair and imperil plants on green roofs, disrupting their ability to reduce air pollution and the urban heat island effect.

In addition, droughts can affect the functioning of the energy and steam supply systems in New York City. A number of power-generation plants rely on potable water to produce power. In the event of a drought, water use restrictions can cause a disruption or reduction in power supply. The steam system in New York City relies heavily on water at certain times of year. During the winter months, the steam system consumes a peak of 1.6 billion gallons of water per hour. (For more information about power disruptions, see Infrastructure Failures.)

iii. Natural Environment

Drought has a much more severe impact on the natural environment than it does on the built environment. Effects may include loss of wetlands and damage to plant species and biodiversity. For example, New York City's waterfront mainly consists of wetlands that range from approximately 5,600 acres to just over 10,000 acres, located in Jamaica Bay, on Staten Island, and along the Long Island Sound. These wetlands provide wildlife protection and improve water quality. In Jamaica Bay Park alone, 325 species of birds, 50 species of butterflies, and 100 species of finfish inhabit the wetlands.

Droughts can also affect community gardens by threatening plants, thereby disrupting their ability to reduce air pollution and combat the urban heat island effect. There are nearly 500 community gardens in New York City. Like green roofs, these gardens help reduce air pollution and the urban heat island effect, and they also increase access to fresh produce.

Drought can also impact the natural environment by contributing to erosion, wildfires, poor air quality, poor water quality, and soil shrinkage.

iv. Future Environment

Climate change projections indicate future disruptions in precipitation patterns and increasing temperatures. According to the New York City Panel on Climate Change (NPCC), by the 2050s it is more likely than not that late-summer short-duration droughts will increase in New York City.

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9. EARTHQUAKES

A. Hazard Profile

i. Hazard Description

The infrequency of major earthquakes, coupled with relatively low-magnitude events in the past, has led to a public perception that New York City is not vulnerable to a damaging earthquake. While the city does not sit on a major fault system, it is susceptible to earthquakes that originate in or near the city. Population density, critical assets, and aging and interdependent infrastructure amplify the city's risk.

An earthquake is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Most earthquakes originate from faults, or a break in the rocks that make up the earth's crust, along which rocks on either side move past each other. As the rocks move past each other, they occasionally stick, causing a gradual buildup of energy. Eventually, this accumulated energy becomes so great that it is abruptly released in the form of seismic waves. These waves travel away from the earthquake's source (or focus) deep underground, causing the shaking (ground acceleration) at the earth's surface. The point on the earth's surface that is directly above the focus is the epicenter.

Ground acceleration caused by earthquakes has the potential to destroy buildings and infrastructure and can result in loss of life. In addition to these effects of ground acceleration, earthquakes can also trigger landslides and liquefaction under certain conditions. Liquefaction occurs when unconsolidated, saturated soils exhibit fluid-like properties due to the intense shaking and vibrations during an earthquake. Together, ground shaking, landslides, and liquefaction can damage or destroy buildings, disrupt utilities, trigger fires, and endanger public safety. Aftershocks are typically smaller than the main shock, and can continue over weeks, months, or years after the initial earthquake is felt.

ii. Severity

The terms "magnitude" and "intensity" are used to describe the overall severity of an earthquake. An earthquake's magnitude is a measurement of its total amount of energy and is expressed in terms of the Richter scale. Intensity measures the effects of an earthquake at a particular place and is expressed in terms of the Modified Mercalli scale.

Figure 1 compares the Richter scale magnitude and Modified Mercalli Intensity (MMI).

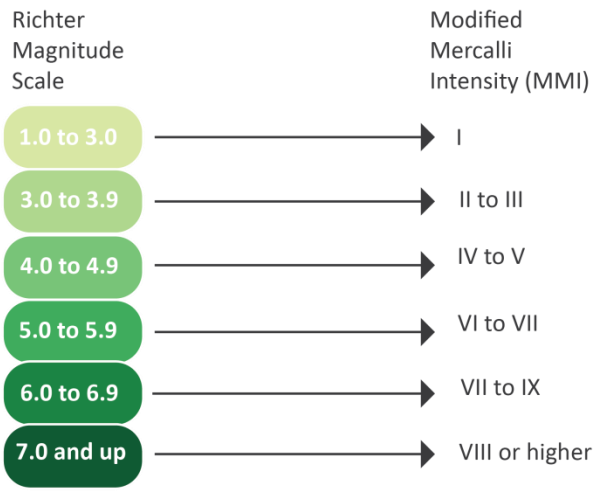


Figure 1: Richter Magnitude and Modified Mercalli Intensity Comparison

Table 1 describes the effects of intensity ratings. According to the National Climatic Data Center, the strongest earthquake near New York City occurred on August 10, 1884. It had a magnitude of 5.2 on the Richter scale and would have had an intensity of VI to VII on the MMI scale.

MMI	Damage/Perception
I	• Not felt except by a very few under especially favorable conditions
II	• Felt only by a few people at rest, especially on upper floors of buildings
III	• Felt quite noticeably by people indoors, especially on upper floors of buildings • Many people do not recognize it as an earthquake • Standing motor cars may rock slightly • Vibrations similar to the passing of a truck
IV	• Felt indoors by many, outdoors by few during the day • At night, some awakened • Dishes, windows, doors disturbed; walls make cracking sound • Sensation like heavy truck striking building • Standing motor cars rocked noticeably
V	• Felt by nearly everyone; many awakened • Some dishes, windows broken • Unstable objects overturned • Pendulum clocks may stop
VI	• Felt by all; many frightened • Some heavy furniture moved • Few instances of fallen plaster • Damage slight

MMI	Damage/Perception
VII	• Damage negligible in buildings of good design and construction • Slight to moderate damage in well-built ordinary structures • Considerable damage in poorly built or badly designed structures • Some chimneys broken
VIII	• Damage slight in specially designed structures • Considerable damage in ordinary substantial buildings with partial collapse • Damage great in poorly built structures • Fall of chimneys, factory stacks, columns, monuments, walls • Heavy furniture overturned
VIII	• Damage slight in specially designed structures • Considerable damage in ordinary substantial buildings with partial collapse • Damage great in poorly built structures • Fall of chimneys, factory stacks, columns, monuments, walls • Heavy furniture overturned
IX	• Damage considerable in specially designed structures • Well-designed frame structures thrown out of plumb • Damage great in substantial buildings, with partial collapse • Buildings shifted off foundations
X	• Some well-built wooden structures destroyed • Most masonry and frame structures destroyed with foundations • Rails bent
XI	• Few, if any masonry or frame structures remain standing • Bridges destroyed • Rails bent greatly
XII	• Total damage • Lines of sight and level are distorted • Objects thrown into the air

Table 1: MMI Scale Rating

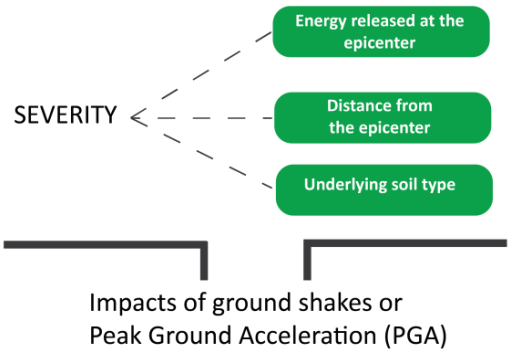


Figure 2: Earthquake Severity Factors

The severity of an earthquake also depends on the amount of energy released at the epicenter, the distance from the epicenter, and the underlying soil type. All these factors affect how much the ground shakes, known as Peak Ground Acceleration (PGA), during an earthquake, and what a building experiences, known as Spectral Acceleration (SA), during an earthquake (see Figure 2).

PGA measures the rate of change in motion of the earth's surface and expresses it as a percent of the established rate of acceleration due to gravity (9.8 m/sec^2). Figure 3 shows that PGA values of 3% to 4% of gravity have the potential to occur in New York City.

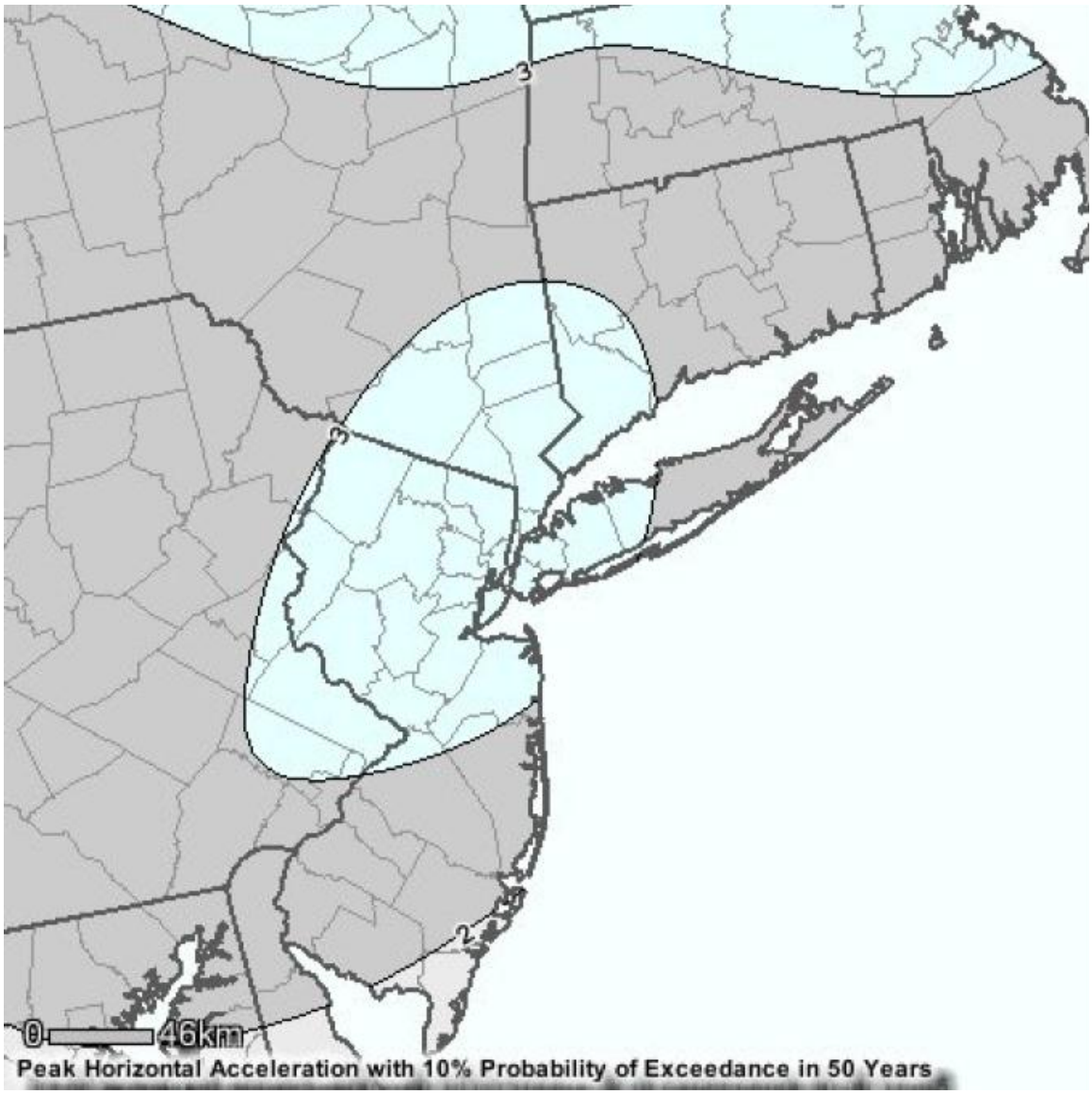


Figure 3: PGA in New York City (Source: National Seismic Hazards Maps, 2008)

An approximate relationship between MMI and PGA is shown in Table 2. The 3% to 4% PGA predicted above would result in an MMI intensity of IV (light perceived shaking and no damage).

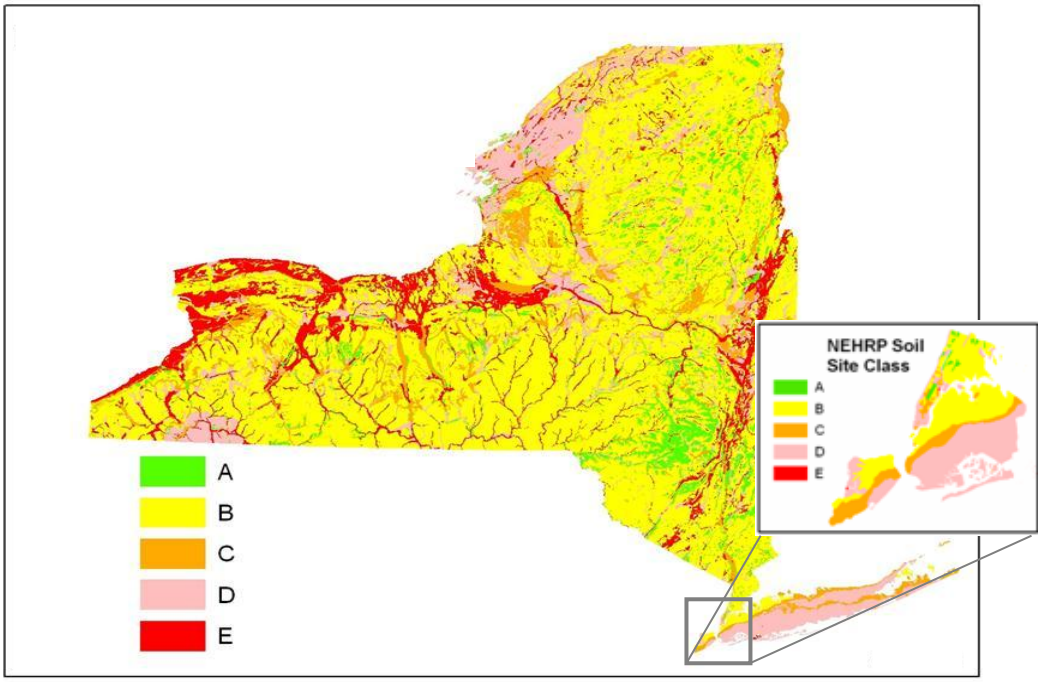
MMI	Acceleration (%g) (PGA)	Perceived Shaking	Potential Damage
I	< .17	Not felt	None
II	.17–1.4	Weak	None
III	.17–1.4	Weak	None
IV	1.4–3.9	Light	None
V	3.9–9.2	Moderate	Very light
VI	9.2-18	Strong	Light
VII	18–34	Very strong	Moderate
VIII	34–65	Severe	Moderate to heavy
IX	65–124	Violent	Heavy
X	> 124	Extreme	Very heavy
XI	> 124	Extreme	Very heavy
XII	> 124	Extreme	Very heavy

Table 2: Approximate Relationship between MMI and PGA

SA is approximately what is experienced by a building during an earthquake, as modeled by a particle mass on a mass-less vertical rod having the same natural period of vibration as the building. SA can be used as a better indicator of damage to specific buildings types and heights.

Soil type can also impact the severity of an earthquake at a given location. This is because seismic waves propagate from the epicenter and travel outward through the bedrock up into the soil layers. As the waves move into the soils, how stiff or soft the soil is affects the wave speed and velocity. In stiff or hard soil the wave generally will travel at a higher velocity. With soft soils, the wave will slow, traveling at lower velocities. With slower waves, the seismic energy is modified, resulting in waves with greater amplitude. This amplification results in greater earthquake damage.

The National Earthquake Hazard Reduction Program (NEHRP) soil classification system describes how soils affect seismic waves. As shown in Figure 4, a map of the NERP soil classifications for New York State, Class A soils (on the map in green) tend to reduce ground motions, whereas Class E soils (shown in red) tend to further amplify and magnify seismic waves. New York City has a variety of NEHRP soil site classes ranging from hard rock to soft soil. Most of New York City is classified as Class B (rock) and Class D (soft to medium clays or sands).



A Very hard rock (e.g., granite, gneisses; and most of the Adirondack Mountains)
B Rock (sedimentary) or firm ground
C Stiff clay
D Soft to medium clays or sands
E Soft soil (including fill, loose sand, waterfront, lake bed clays)

Figure 4: New York State Soil Classifications (Source: NYS OEM 2014)

iii. Probability

The New York State Office of Emergency Management (NYS OEM) created county-specific seismic hazard maps that reflect the soil's ability to affect seismic waves and the resulting SA experienced by a building. The maps are based on the New York State Geological Survey shear-wave tests of the surficial soils. These maps facilitate a better understanding of local seismic hazards by identifying areas of higher vulnerability within the city. Figure 5, a USGS seismic hazard map for New York City, shows that SA values of 25% to 75% of gravity have the potential to occur in New York City. It presents the adjusted USGS 0.2 sec SA with a 2% probability of exceedance within 50 years.

Seismic hazard maps, or PGA maps, project the likelihood of an earthquake at a certain location over a given period. As shown in the USGS seismic hazard map for New York City, (Figure 5) a PGA value of 3% to 4% has a 10% chance of being exceeded over 50 years. Such an earthquake would likely produce light to moderate perceived shaking and little to no physical damage.

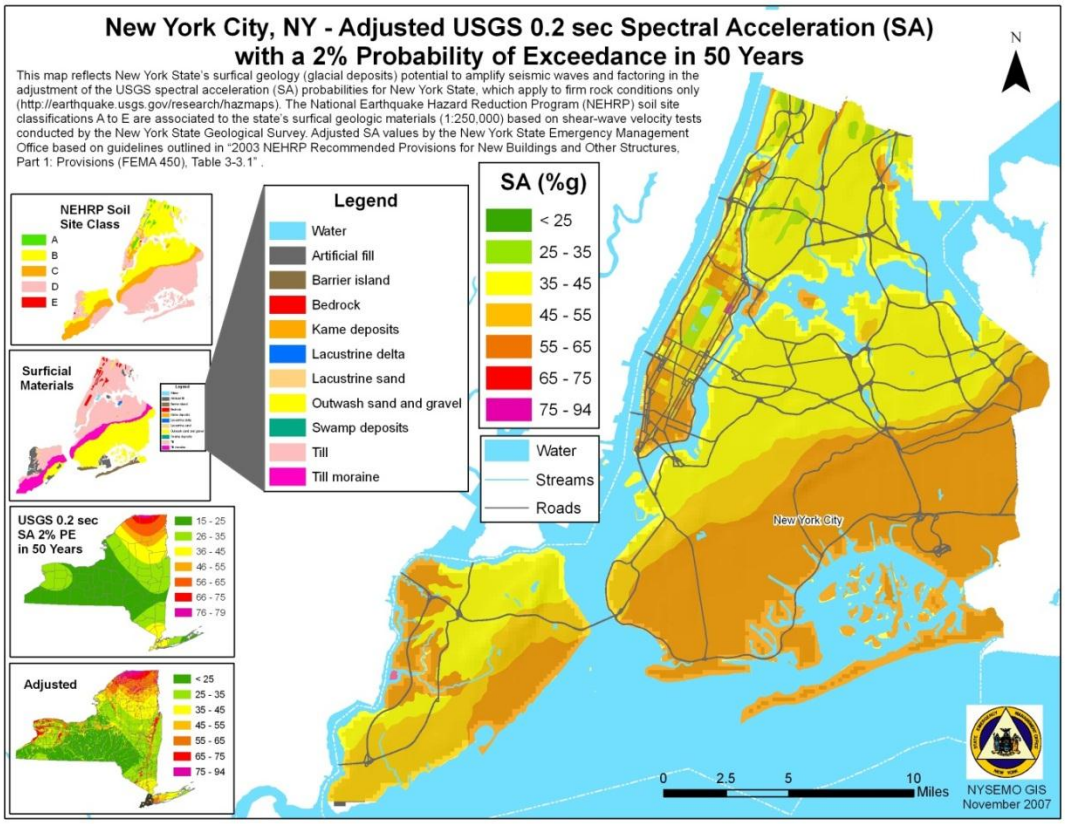


Figure 5: Adjusted USGS 0.2 Sec SA for New York City (Source: NYS OEM, 2011)

According to the New York State Hazard Mitigation Plan (SHMP), New York State can expect a damaging earthquake about once every 22 years, and these events are more likely to occur within one of three regional areas. These regional areas are the North and Northeast third of the state (the North Country/Adirondack Region, including a portion of the Greater Albany-Saratoga region), the Southeast corner (including the greater New York City area and western Long Island), and the Northwest corner (including the city of Buffalo and vicinity). The SHMP references a New York State Geological Survey (NYSGS, study by W. Mitrovonas, entitled "Earthquake Hazard in New York State," which states, "…at present an earthquake of magnitude 3.5 to 4 occurs, on the average every three years somewhere in the State. Such earthquakes do not cause any appreciable damage (except for cracks in plaster, perhaps) but are large enough to be felt strongly by many people near the epicenter."

Although New York City has a low risk of damaging earthquakes, overall seismic risk is higher because of the city's tremendous assets, concentration of buildings, and construction types (most buildings have not been seismically designed). Furthermore, a

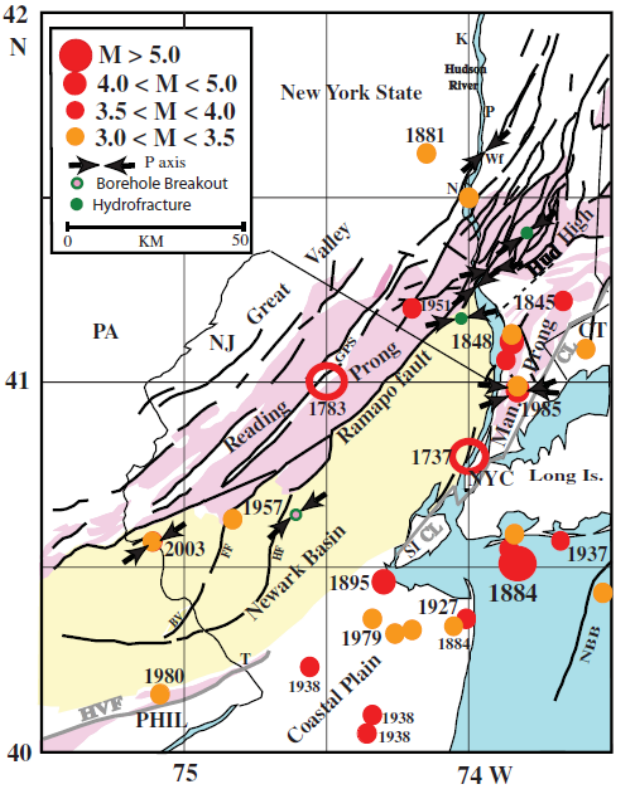


Figure 6: Earthquakes in the Greater New York/Philadelphia area 1667 to 2004, Graded by Magnitude

2001 analysis by the Federal Emergency Management Agency (FEMA) ranks New York City as the 11th most at-risk U.S. city for earthquake damage.

The risk of earthquakes in the New York City area might be greater than once believed. According to a 2008 study by Columbia University's Lamont-Doherty Earth Observatory, there are subtle but active faults in the area. Although New York City is not located along a major fault, the existence of many smaller yet active faults may increase the probability of a large earthquake. The Lamont-Doherty Earth Observatory located hundreds of small events, which included magnitude 3 earthquakes that occurred from 1677 to 2007 (see Figure 6). The smaller earthquakes tended to occur along a series of small, old faults in harder rocky soil. The study asserts that these faults are still active and capable of producing severe earthquakes. According to the study, the probabilities of occurrence in a 50-year period would be 7% (magnitude 6) and 1.5% (magnitude 7).

iv. Location

According to the U.S. Geological Survey (USGS) Earthquake Hazards Program, around 90% of earthquakes occur at the boundaries where the earth's tectonic plates meet, although it is possible for earthquakes to occur entirely within plates. New York City is located well within the North American plate, far from the plate boundary, which is located approximately 2,000 miles east in the Atlantic Ocean. Seismic research is being conducted into the causes of earthquakes in regions far from plate margins. Regardless of where they are centered, earthquakes can affect locations beyond their point of origin.

Earthquakes are possible in any of New York City's counties. However, the risk of earthquakes is not the same throughout the city, as evidenced by higher SA values in certain areas. These areas would likely experience more damage depending on their proximity to an earthquake's epicenter. Figure 7 shows the distribution of historical earthquake epicenters throughout New York State. Even if the greatest damage occurs

outside the metropolitan area, earthquakes that occur in the northeast region can still affect New York City (see Table 3). For example, two earthquakes that recently occurred (one in Virginia in 2011 and one in Canada in 2013) were felt in the city.

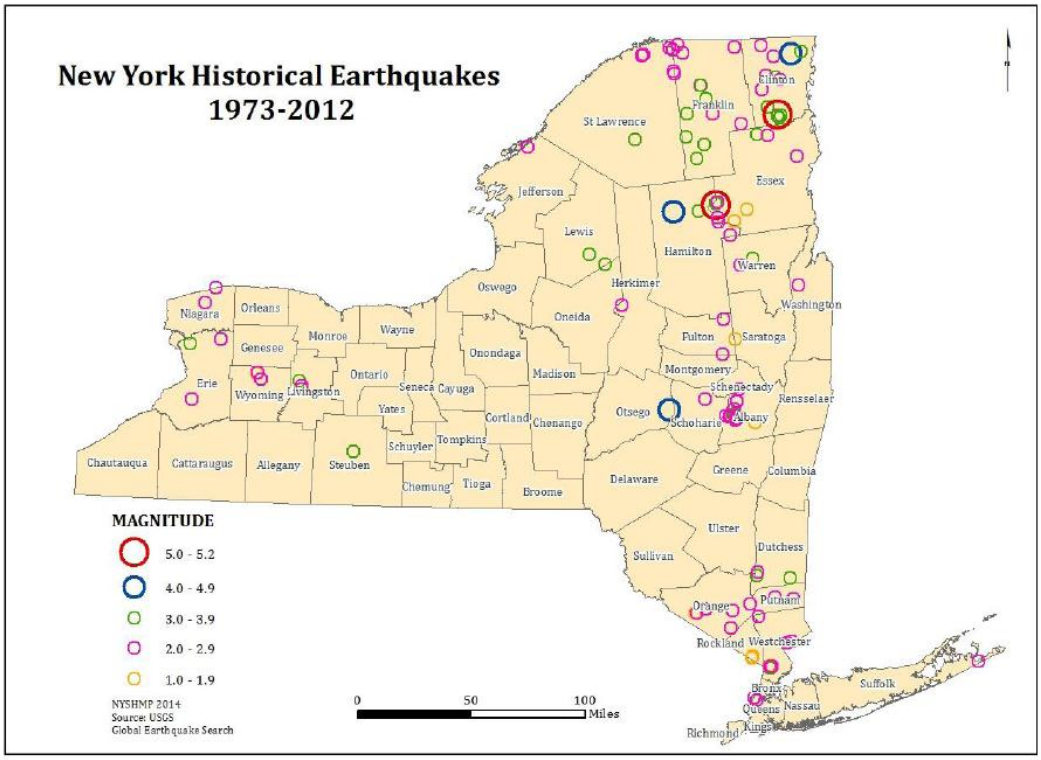


Figure 7: New York State Historical Earthquakes 1973-2012

Areas with large numbers of unreinforced masonry buildings are also vulnerable to earthquakes. This building type is not as sturdy and does not absorb energy as well as other structure types such as wood, steel, or reinforced concrete. Brooklyn has the largest number of unreinforced masonry buildings (see Built Environment, below). According to the New York City Area Consortium for Earthquake Loss Mitigation (NYCEM), 79% of all buildings in Manhattan are unreinforced masonry buildings. Neighborhoods in Lower Manhattan—such as Soho, Greenwich Village, Chinatown, Little Italy, and Noho—have many unreinforced masonry buildings. In addition, both the Upper West Side and Upper East Side have many unreinforced masonry buildings. The 125th Street fault runs from 125th Street and Broadway east, crossing the East River and running between Wards and Randall's Island through an area with large numbers of unreinforced masonry buildings.

v. Historic Occurrences

More than 400 earthquakes with a Richter magnitude greater than 2.0 are on record in New York State between 1700 and 1986, but many more have occurred. Stronger earthquakes are rarer. From 1973 to 2012 there were only two damaging earthquakes in the state with intensity of 5 or greater on the MMI Scale.

Many smaller earthquakes have been felt in New York City. For example, in 2001 an earthquake with a 2.4 magnitude occurred in the Upper East Side near the 125th Street fault. The earthquake only caused minor damage, but it was the first one on record in Manhattan.

Six earthquakes felt in New York City between 1737 and 2013 are described in the table below; all of them have magnitude values of 3.5 and higher on the Richter scale.

Date	Location	Richter Magnitude	Description
December 18, 1737	Citywide	5.2	Bells rang, several chimneys fell
September 2, 1847	Citywide (offshore)	3.5	No reference and/or no damage reported
August 10, 1884	Citywide	5.2	Chimneys and bricks fell, walls cracked
July 9, 1937	Brooklyn	3.5	No reference and/or no damage reported
April 20, 2002	Plattsburgh, NY	5.1	Vibrations felt in New York City
August 23, 2011	Virginia	3.5	Vibrations felt in New York City
May 17, 2013	Quebec	5.1	Vibrations felt in New York City

Table 3: Earthquakes that Affected New York City with a Magnitude of 3.5 or More between 1737 and 2013

B. Vulnerability Assessment

i. Social Environment

Unlike other natural hazards, earthquakes often occur with little or no warning, placing the population at risk. Since earthquakes have not occurred as frequently as other natural hazards, the risk to public safety may be higher since the general public may not be as prepared or know how to respond. A high-magnitude earthquake could cause significant casualties, financial losses, and disruptions in critical facilities and services.

In addition, earthquakes can disrupt emergency and medical services, putting individuals that depend on these services at even greater risk. Some of the long-term health risks that earthquakes pose include post-traumatic stress disorder and other mental health problems such as depression and anxiety.

Earthquakes can impact the economy. They can cause significant economic losses, including losses from repair and loss of rental income. They can displace and disrupt

business operations and utility operations, and they can impair people's ability to generate income due to disruptions brought on by the event.

ii. Built Environment

A building's construction is a key factor in determining how well it can withstand the forces produced by earthquakes. Unreinforced masonry buildings are most at risk because the walls are prone to collapse in an outward fashion. Steel and wood buildings have a greater ability to absorb the energy from an earthquake. Wood buildings with proper foundation ties rarely collapse in earthquakes.

Masonry buildings make up roughly 48% of the all buildings in New York City. The greatest number of masonry buildings are in Brooklyn (178,920), followed by Queens (115,062), the Bronx (54,434), Manhattan (28,762), and Staten Island (8,870). Therefore, it is likely that Brooklyn, Queens, and the Bronx would sustain the most building damage during an earthquake. This estimation is refined further in the HAZUS-MH analysis presented below.

The 1968 Building Code contains seismic provisions that, in effect, require designers to increase the load the building can withstand. Department of Buildings (DOB) has addressed structural vulnerability for earthquakes in the revised 2008 New York City Construction Codes. The Construction Codes not only make buildings stronger, but also more flexible. For example, the soil type and building foundation will be taken into account, and seismic detailing is required to ensure the joints and connections of a building hold up during an earthquake. Inspections are also required during construction to ensure seismic features are built correctly. Furthermore, as they are in the old code, critical facilities—such as firehouses and hospitals—will be designed under the revised code to not only survive an earthquake, but also remain open and functional afterwards. (For more information on the New York City Construction Code, see Risk Assessment Section 3: New York City's Hazard Environment.)

Upstate dams and aqueducts are also a concern and could incur serious damage from an earthquake, affecting the water supply to New York City. In addition, the Indian Point nuclear facility is located 24 miles north of the city and sits above two active seismic zones. These zones are capable of generating a magnitude 6 earthquake, which may increase the risk of harmful radiation exposure.

HAZUS-MH Earthquake Summary

HAZUS-MH was used to estimate losses and structural vulnerability for earthquakes in New York City. HAZUS-MH earthquake scenarios were completed using HAZUS-MH v2.1 (with ArcGIS 10.0). As with all HAZUS-MH modeling represented in this report, default buildings and essential facilities data were replaced with Level II local data. In addition, the local National Earthquake Hazards Reduction Program (NEHRP) soils data was loaded to further improve the accuracy of the results. No modifications were made to the existing HAZUS-MH damage functions relating to earthquake building damage.

For the hazard definition, a set of probabilistic scenarios were modeled to focus on damage to buildings. The probabilistic earthquake model in HAZUS-MH allows for the output of annualized dollar losses (the average annual loss expected based on the probability of occurrence of a wide range of potential earthquake events). In addition, a wider range of output is available for a suite of return periods. This method looks at expected damages based on the probability of occurrence in a given year (for example, a 100-year return period correlates to an event that has a 1% chance of occurring in any given year). Potential damages were calculated for return periods of 100, 250, 500, 1,000, and 2,500 years (see Table 4 and Table 5).

Return period (years)	Chance of occurrence in any given year (%)
100	1
200	0.5
250	0.4
500	0.2
1,000	0.1
2,500	0.04

Table 4: Return Periods for Probabilistic Modeling for Earthquakes

As is the case with every HAZUS-MH model, there are limitations to the data generated. The overall damage state categories for the HAZUS-MH earthquake module are None, Slight, Moderate, Extensive, and Complete. Included below is a graphic depiction of structural damage states (see Figure 8).

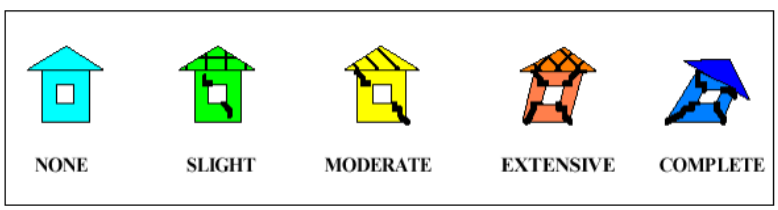


Figure 8: HAZUS-MH Earthquake Damage States (Source: HAZUS-MH Earthquake User Manual Figure 9.17)

Recurrence Interval	Construction Type	Total Buildings	Slight	Moderate	Extensive	Complete	Total Damaged	% of Buildings Damaged
100-year	Unreinforced Masonry	189,362	5	1	0	0	6	0.00%
	Other Construction	884,025	4	1	0	0	5	0.00%
	Total	1,073,387	**9**	**2**	**0**	**0**	**11**	**0.00%**
250-year	Unreinforced Masonry	189,362	3,140	1,101	129	24	4,394	2.32%
	Other Construction	884,025	2,664	446	37	4	3,151	0.36%
	Total	1,073,387	**5,804**	**1,547**	**166**	**28**	**7,545**	**0.70%**
500-year	Unreinforced Masonry	189,362	11,265	4,787	796	88	16,936	8.94%
	Other Construction	884,025	14,750	2,723	220	1	17,694	2.00%
	Total	1,073,387	**26,015**	**7,510**	**1,016**	**89**	**34,630**	**3.23%**
1,000-year	Unreinforced Masonry	189,362	21,284	11,106	2,476	360	35,226	18.60%
	Other Construction	884,025	45,333	10,892	1,148	30	57,403	6.49%
	Total	1,073,387	**66,617**	**21,998**	**3,624**	**390**	**92,629**	**8.63%**
2,500-year	Unreinforced Masonry	189,362	35,559	25,856	8,526	2,058	71,999	38.02%
	Other Construction	884,025	123,753	43,713	7,389	512	175,367	19.84%
	Total	1,073,387	**159,312**	**69,569**	**15,915**	**2,570**	**247,366**	**23.05%**

Table 5: Earthquake Damage by Return Period

Definitions of structural damage states for a single building class (in this case, Type W1-wood, light frame) are included here for reference:

Slight: Small plaster or gypsum board cracks at corners of door and window openings and wall-ceiling intersections; small cracks in masonry chimneys and masonry veneer.

Moderate: Large plaster or gypsum board cracks at corners of door and window openings; [[small diagonal cracks across shear wall panels (stucco and gypsum)]]; large cracks in brick chimneys; toppling of tall masonry chimneys.

Extensive: Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations; partial collapse of room-over-garage or other soft-story configurations; small foundations cracks.

Complete: Structure may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse due to cripple wall failure or the failure of the lateral load resisting system; some structures may have slipped and fallen off foundations; large foundation cracks.

Table 6 and Table 7 describe the potential impact of a variety of earthquake scenarios if the epicenter were located at the historic August 10, 1884 location in New York City. This model was taken from the NYCEM study published in 2003.

Richter Scale	Building Damage (billion)	Income Loss (billion)	Total (billion)	Hospitalization (people)	Shelter Required (people)	Fires	Buildings Completely Damaged	Debris (million tons)
5	$4.4	$0.4	**$4.8**	24	2800	500	45	1.6
6	$28.5	$10.8	**$39.3**	2,296	197,705	900	2,600	31.9
7	$139.8	$57.1	**$196.8**	13,171	766,746	1,200	12,800	132.1

Table 6: Summary of Deterministic Results of NYCEM Study (Source: NYCEM, 2003)

Return Period	Building Damage (billion)	Income Loss (billion)	Total (billion)	Hospitalization (people)	Shelter Required (people)	Fires	Debris (million tons)
100-year	$0.1	$0.1	**$0.2**	0	0	0	0.2
500-year	$6.1	$2.0	**$8.1**	28	575	50	3.1
2,500-year	$64.3	$20.4	**$84.8**	1,430	84,626	900	34.0
Annualized Losses	$0.1	$0.1	**$0.2**	N/A	N/A	N/A	N/A

Table 7: Summary of Probabilistic Results of NYCEM Study (Source: NYCEM, 2003)

iii. Natural Environment

Earthquakes can severely damage the natural environment, including loss of aesthetic value, due to destruction of trees and parks. They can also have secondary impacts—including fires caused by gas pipe explosions, broken water pipes, hazardous waste releases, or landslides—that could harm the natural environment.

iv. Future Environment

Earthquakes can compromise infrastructure, and New York City's aging infrastructure may amplify the structural impacts of earthquakes in the future.

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A. Hazard Profile

i. Hazard Description

Extreme temperatures, both hot and cold, have a significant effect on human health and infrastructure in New York City.

Extreme Heat

Extreme heat is one of the leading weather-related killers in the United States. Extreme heat events are most common between June and August when temperatures that are significantly above average are sustained for a prolonged period; these events may also occur in May or September, although this is rare. A heat wave is defined as three or more consecutive days when high temperatures reach 90°F or higher.

The effects of extreme heat are exacerbated by high levels of humidity (the amount of moisture in the air). The higher the temperature, the more moisture the air can hold. High humidity lowers the body's ability to effectively cool itself, and can make the temperature feel hotter than it actually is. The combined effect of the temperature and humidity is known as the heat index, or the apparent "feels like" temperature.

New York City receives advisories from the National Weather Service (NWS) when the predicted heat index is greater than 100°F for one or more days, or the predicted heat index is 95°F or greater for two or more days. These advisories are based on historical weather analysis and mortality data analysis conducted by the New York City Department of Health and Mental Hygiene (DOHMH). Based on these advisories and consultation with the NWS, the City activates its Heat Emergency Plan, which outlines the coordinated response to mitigate the effects of heat and humidity on critical infrastructure, at-risk populations, and New York City operations. When the heat index is predicted to be dangerously high, the City also opens cooling centers in air-conditioned public community centers, senior centers, and public libraries to offer heat relief.

The built environment of New York City greatly contributes to the phenomenon of the "urban heat-island effect". Heat islands develop in areas with extensive built surfaces (concrete, asphalt, and metal). Incoming solar radiation is trapped during the day and is then re-radiated at night. This slows the cooling process, keeping nighttime air temperatures higher than in more rural surrounding areas. Other by-products of the city's activities—such as exhaust fumes, burning furnaces, heating units, smokestacks, and even New York City's dense population—contribute to this phenomenon. In addition, the city's numerous tall buildings often block the cooling winds from the Atlantic Ocean. In infrared satellite photographs of New York City, particularly at night, the city appears as a distinct heat island, as much as 20°F warmer than the surrounding suburbs.

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In many cases, extreme heat events are also associated with poor air quality. High humidity and poor air quality are common in New York City during the summer months, when high atmospheric pressure traps hazy and humid air and pollutants near the ground.

Extreme Cold
An extreme cold event typically involves an extended period with temperatures at or below 32°F. In New York City, extended periods of sub-freezing temperatures are most common between December and March. As the temperature drops and wind speed increases, heat can leave the body more rapidly. This phenomenon, known as the wind-chill effect, can exacerbate the impact of an extreme cold event.

ii. Severity

Extreme heat
The NWS uses a heat index (see Table 1) to determine what effects the temperature and humidity will have on the population (see Table 2). The heat index values are calculated in the shade, however, and exposure to full sunshine can increase the apparent temperature by up to 15 additional degrees.

To aid in the prediction of and response to extreme heat events, the NWS has worked with the New York City Office of Emergency Management (OEM) and DOHMH to craft standards for products used in New York City's Heat Emergency Plan. NWS provides alerts to New York City when heat indices approach hazardous levels (see Table 3). Upon issuing an extreme heat advisory, the NWS does the following:

- Includes heat index values and city forecasts
- Issues special weather statements including who is most at risk, safety rules for reducing risk, and the extent of the hazard and heat index values
- Assists state/local health officials in preparing civil emergency messages

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Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution Extreme Caution Danger Extreme Danger

Table 1: NWS Heat Index (Source: NWS, 2013)

Category	Heat Index	Health Hazards
Extreme Danger	**130°F-Higher**	**Heat stroke/sunstroke is likely with continued exposure**
Danger	**105°F-129°F**	**Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity**
Extreme Caution	**90°F-105°F**	**Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity**
Caution	**80°F-90°F**	**Fatigue possible with prolonged exposure and/or physical activity**

Table 2: Health Hazards Associated with Heat Index Values (Source: NWS, 2013)

Product	Criteria
Heat Advisory	Issued within 24 hours prior to onset of any of the following conditions: • Heat index of 100°F-104°F for any period • Heat index of 95°F-99°F or greater for two consecutive days
Excessive Heat Watch	Issued 24-48 hours prior to onset of the following condition: • Heat index of at least 105°F for at least two consecutive hours
Excessive Heat Warning	Issued within 24 hours of onset of the following condition: • Heat index of at least 105°F for at least two consecutive hours

Table 3: NWS Extreme Heat Products for the New York City Region (Source: NWS, 2013)

Extreme Cold

The NWS created a wind-chill chart (see Table 4) that measures apparent temperature felt on exposed skin due to the combination of air temperature and wind speed. When conditions warrant, the NWS issues wind-chill products for New York City (see Table 5). Although rare, these conditions have occurred throughout New York City's history (see Table 6).

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Table 4: NWS Wind-Chill Chart (Source: NWS, 2013)

Product	Description
Wind Chill Advisory	Issued when wind-chill values are expected to fall to between -15°F and -24°F
Wind Chill Warning	Issued when wind-chill values are expected to fall to -25°F or colder

Table 5: NWS Wind-Chill Products for the New York City Region (Source: NWS, 2013)

iii. Probability

Extreme Heat

Official temperature readings for New York City are taken at Belvedere Castle in Central Park, although temperatures vary throughout the City. Current averages are calculated for the baseline period 1971-2000. Based on data from the New York City Panel on Climate Change (NPCC), New York City currently averages 18 days per year with temperatures at or above 90°F. The city can also expect an average of two heat waves per year with an average duration of four days. Based on historic data from NWS, the annual number of days with high temperatures of 90°F or higher has been increasing since the late 19th century (see Figure 1). The number, duration, and intensity of heat waves and days at or above 90°F are expected to continue to increase in the future as a result of climate change (see Future Environment, below).

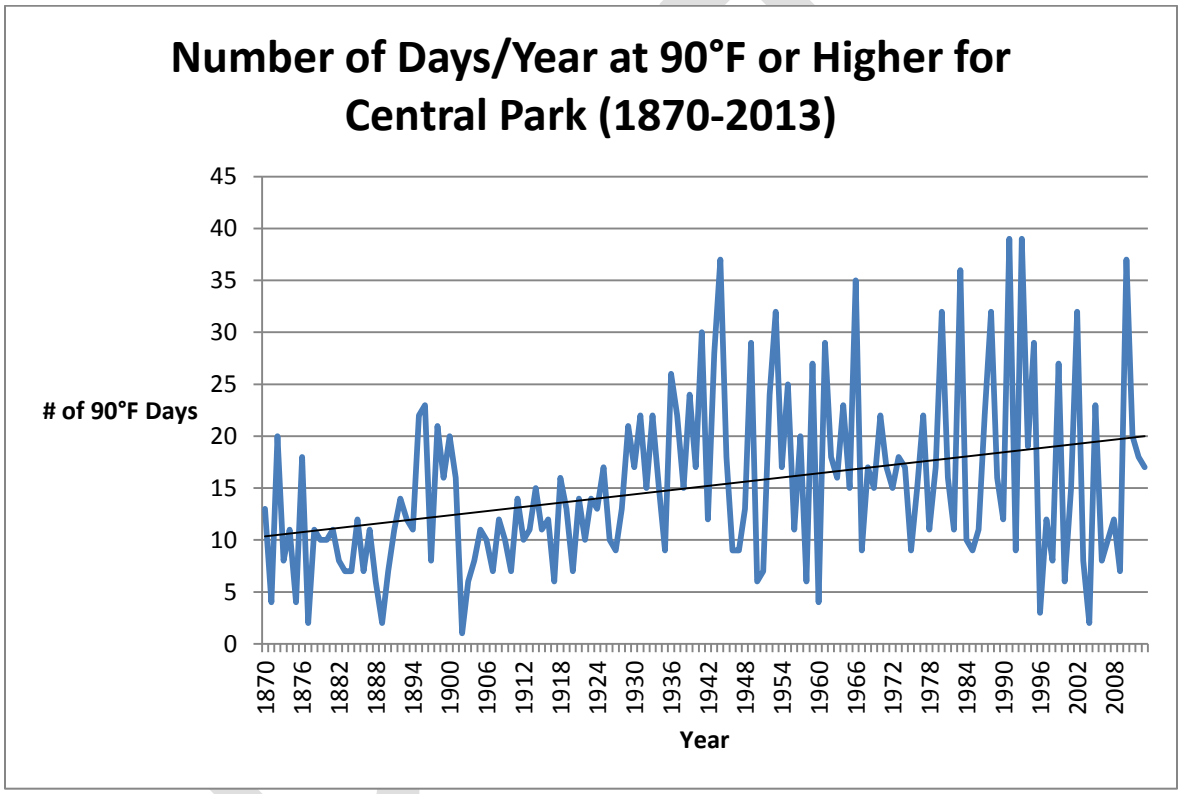


Figure 1: Number of Days with Temperatures of 90°F or Higher for Central Park 1870 to 2013 (Source: NWS, 2013)

Extreme Cold

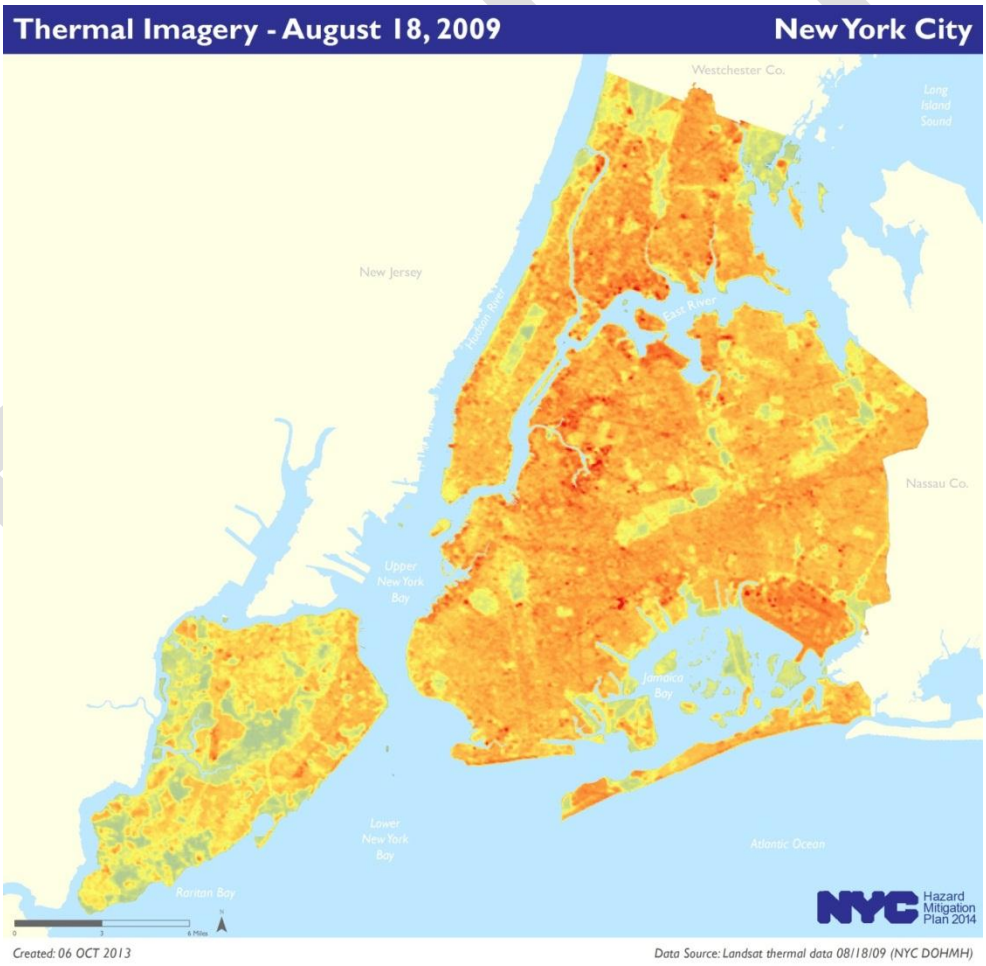
According to the NPCC, using the baseline period 1971-2000, the city currently experiences an average of 72 days per year with minimum temperatures at or below 32°F. This number is expected to decrease in the future as a result of climate change (see Future Environment, below).

iv. Location

Extreme Heat

Extreme heat affects all of New York City, although some locations are more vulnerable than others. For example, sea breezes keep areas near the ocean shoreline cooler during the summer months. Thus, places like John F. Kennedy International Airport (JFK) and the Rockaway Peninsula experience fewer days at or above 90°F annually than locations farther from the ocean, such as Central Park and LaGuardia Airport (LGA).

In addition to keeping all of New York City warmer than surrounding areas, the urban heat island effect also makes some city neighborhoods warmer than others. Not surprisingly, the warmest neighborhoods typically have the densest development (highest concentrations of heat-trapping built structures) and the least vegetation. Figure 2 is a thermal image of New York City, taken on August 18, 2009, one of the hotter days of that year, and Figure 3 displays the city's vegetative cover. Comparing the two images reveals that hotspots are generally areas that lack vegetation. Such areas are of greatest vulnerability during extreme heat events.



*Warmer locations are orange and red, while cooler areas are green and yellow.

Figure 2: New York City Thermal Imagery Taken August 18, 2009 (Source: DOHMH)

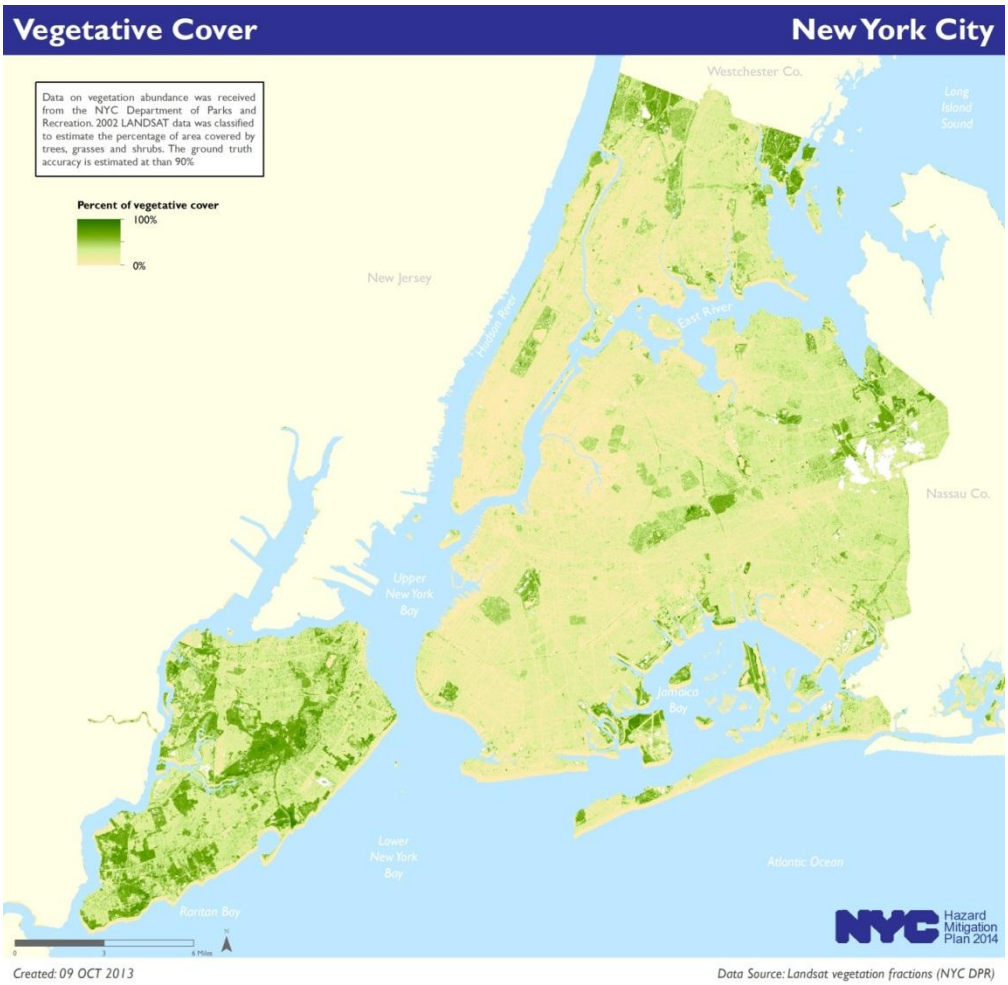


Figure 3: New York City Vegetative Cover (Source: OEM)

Extreme Cold

There is generally less variation across the city with extreme cold events than there can be with extreme heat events. In general, all of New York City experiences a moderation of cold temperatures due to the combination of the urban heat island effect and proximity to the ocean. Areas along the immediate ocean shoreline are often slightly warmer than areas several miles inland during the colder months of the year. However, wind chill temperatures along the immediate coast may be lower than that of areas several miles inland due to higher winds near the water, even if the actual air temperature is higher. Lower-density neighborhoods of the City with greater natural cover and less asphalt may also be a few degrees colder due to the urban heat island effect, although it is less pronounced during the colder months.

v. Historic Occurrences

Table 6 describes instances of extreme temperatures in New York City since 1995. Note that thresholds for the activation of the City's Heat Emergency Plan were adopted in 2007 and require the issuance of at least a heat advisory from NWS. For extreme heat events in 2007 or later, Table 6 only includes those for which these criteria were met.

Start	Event	Location	Description
July 13, 1995	Extreme heat	Citywide	• Temperatures rise to a record high of 102°F in Central Park • 7 people die, and hundreds more are treated for heat-related illness
July 4, 1999	Extreme heat	Citywide	• 3 consecutive days of hot, humid temperatures • On July 4, temperatures reach the mid-to-upper 90s with heat indices from 100 to 105°F • 31 deaths reported
January 17, 2000	Extreme cold	Citywide	• Temperatures drop to 3°F in Central Park and do not rise above 20°F for 2 days • Strong, gusty northwest winds combine with well-below-normal temperatures to produce wind-chill values of -15°F to -30°F • 3 deaths reported
January 27, 2000	Extreme cold	Citywide	• Strong winds combine with temperatures in the teens and single digits to produce wind-chill values of -30°F at JFK and -28°F at LGA • No deaths reported
August 5, 2001	Extreme heat	Citywide	• 6 consecutive days of temperatures at or above 90° F in Central Park • High temperatures in Central Park reach 103°F on August 9, with heat indices between 105 and 110° F • OEM opens cooling centers throughout the city • 4 deaths reported

Start	Event	Location	Description
July 2, 2002	Extreme heat	Citywide	• Temperatures rise into the mid and upper 90s across the region • Overnight low temperatures remain in the lower 80s • On July 4, the temperature reaches 98°F at LGA, setting a new record • Heat indices from 100 to 105°F • OEM opens cooling centers throughout the city • No deaths reported
July 29, 2004	Extreme heat	Citywide	• 8 consecutive days of temperatures at or above 90°F in Central Park • High temperatures in the mid-to-upper 90s with heat indices as high as 100 to 105°F on July 29 • No deaths reported
July 31, 2006	Extreme heat	Citywide	• 4 consecutive days with temperatures at or above 90°F in Central Park • Temperatures 95°F to 100°F with heat indices 105 to 115°F • OEM opens 383 cooling centers throughout the city • 40 heat stroke deaths and roughly 100 excess natural cause deaths reported • Scattered power outages reported
February 4, 2007	Extreme cold	Citywide	• Subfreezing temperatures for 5 consecutive days • Temperature drops into the single digits with a wind chill of -5°F to -10°F on February 5 • 11 deaths reported during and following this period
March 6, 2007	Extreme cold	Citywide	• Daily temperatures below freezing for 2 consecutive days, averaging 19 degrees below normal for 4 consecutive days • Temperature drops to 11°F with a wind chill of -6°F in Central Park on March 6 • 1 death reported

Start	Event	Location	Description
June 7, 2008	Extreme heat	Citywide	• 4 consecutive days with temperatures at or above 90°F in Central Park • Temperatures in the mid-90s with heat indices around 100°F • OEM activates Heat Emergency Plan and opens cooling centers throughout the City • 10 heat-stroke deaths reported in summer 2008
August 16, 2009	Extreme heat	Citywide	• 4 consecutive days with temperatures at or above 90°F in Central Park • Heat indices reach the mid-90s • OEM activates Heat Emergency Plan and opens cooling centers throughout the City
June 27, 2010	Extreme heat	Citywide	• 3 consecutive days with temperatures at or above 90°F in Central Park • Heat indices reach the upper 90s • OEM activates Heat Emergency Plan and opens 488 cooling centers throughout the City
July 4, 2010	Extreme heat	Citywide	• 4 consecutive days with temperatures at or above 90°F, with a maximum of 103°F and heat index values between 105°F and 110°F in Central Park on July 6 • OEM activates Heat Emergency Plan and opens 480 cooling centers throughout the City • 10 heat-stroke deaths reported
July 16, 2010	Extreme heat	Citywide	• 4 consecutive days with temperatures at or above 90°F • Heat indices 100°F to 105°F on July 16 • OEM activates Heat Emergency Plan and opens 453 cooling centers throughout the City
August 4, 2010	Extreme heat	Citywide	• 3 consecutive days with temperatures at or above 90°F in Central Park • Heat indices reach the upper 90s • OEM activates Heat Emergency Plan and opens 436 cooling centers throughout the City

Start	Event	Location	Description
July 21, 2011	Extreme heat	Citywide	• 4 consecutive days with temperatures at or above 90°F, • Maximum temperature of 104°F with heat index of 115°F on July 2 in Central Park • OEM activates Heat Emergency Plan and opens 504 cooling centers throughout the City • 30 heat-stroke deaths reported
June 20, 2012	Extreme heat	Citywide	• 3 consecutive days with temperatures at or above 90°F • Temperatures in the mid-90s with heat indices in the upper 90s in Central Park • OEM activates Heat Emergency Plan and opens more than 400 cooling centers throughout the City
June 29, 2012	Extreme heat	Citywide	• 3 consecutive days with temperatures at or above 90°F and heat indices as high as 100°F in Central Park • OEM activates Heat Emergency Plan and opens cooling centers throughout the City
July 4, 2012	Extreme heat	Citywide	• 4 consecutive days with temperatures at or above 90°F in Central Park • Temperatures in the mid-to-upper 90s with heat indices in the upper 90s in Central Park • OEM activates Heat Emergency Plan and opens cooling centers throughout the City
July 16, 2012	Extreme heat	Citywide	• 3 consecutive days with temperatures at or above 90°F at Central Park • Temperature reaches 100°F in Central Park and 101°F at LaGuardia Airport on July 18, with heat index reaching or exceeding 105°F at both locations
July 4, 2013	Extreme heat	Citywide	• 3 consecutive days with temperatures at or above 90°F and heat indices above 95°F in Central Park

Start	Event	Location	Description
July 14, 2013	Extreme Heat	Citywide	• 7 consecutive days with temperatures at or above 90°F in Central Park • Maximum of 98°F in Central Park on July 18, with heat indices 100°F to 105°F • July 17 through July 20 set daily records for highest minimum temperature, not dropping below 80°F at night • OEM activates Heat Emergency Plan and opens cooling centers throughout the City

Table 6: Extreme Temperatures in New York City 1995 to 2013

B. Vulnerability Assessment

i. Social Environment

Extreme temperatures cause more fatalities in the United States than other natural hazards, with an average of 144 deaths per year between 2003 and 2012 (see Figure 4). However, deaths from extreme heat (117) are significantly higher than they are from cold (27). In New York City, each year there are on average 150 hospital admissions and 450 emergency room visits due to heat-related illnesses during the warm season months (May to September), and 185 hospital admissions and 35 emergency room visits for hypothermia and illness related to cold exposure during cold season months (October to April).

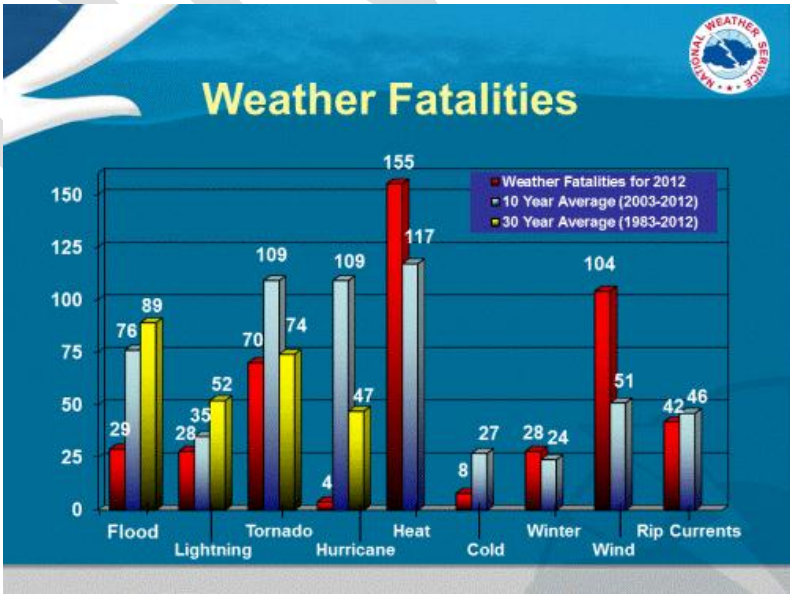


Figure 4: Annual Weather Fatalities in the United States (Source: NOAA, 2013)

Extreme Heat

Prolonged exposure to extreme heat may lead to serious health problems, including dehydration, heat exhaustion, and, in severe cases, heat stroke. Symptoms of heat exhaustion include confusion, dizziness, fatigue, nausea, headaches, and muscle cramps. If proper action is not taken, heat exhaustion may turn into heat stroke.

Heat stroke occurs when the body is no longer able to regulate its internal temperature, resulting in a body temperature of greater than 105°F. Common symptoms include seizures, disorientation, loss of consciousness, and complications involving the central nervous system. Heat stroke can cause permanent damage to the brain and other vital organs and in many cases can result in death.

If extreme heat is associated with poor air quality, it can also result in a higher rate of respiratory problems among people with pre-existing health conditions such as asthma. Chronic exposure to airborne pollutants increases the risk of developing cardiovascular and respiratory diseases as well as lung cancer.

During heat waves, overall mortality rates often increase above what would ordinarily be expected on normal summer days. For example, in 2006 there were approximately 100 excess natural cause deaths attributed to a severe heat wave that also caused 40 heat-stroke deaths. Furthermore, heat exposure can aggravate underlying chronic conditions, such as cardiovascular disease.

New York City's urban environment exacerbates hazardous conditions resulting from extreme heat. For example, stagnant atmospheric conditions during the summer can contribute to poor air quality and increase the rate of heat-related illness and death. Consequently, people living in New York City are at greater risk from the effects of a heat wave than those living in less urbanized areas. Between 1997 and 2010, 152 heat-stroke deaths were reported by the New York City Office of Chief Medical Examiner (OCME) and Bureau of Vital Statistics. DOHMH further estimates that deaths due to secondary impacts of heat increased by an average of 6.5% during 12 prolonged heat waves in this period, accounting for approximately 1,090 additional deaths. Table 7 lists the number of annual heat-related deaths and hospital visits in New York City between 2000 and 2011.

Year	Deaths	Hospitalizations
2000*	N/A	109
2001	13	202
2002	16	216
2003	6	151
2004	1	53
2005	7	169
2006	50	315
2007	1	87

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Year	Deaths	Hospitalizations
2008	10	149
2009	2	53
2010	11	243
2011*	34	N/A
Total	151	1747

* Data was not available for deaths in 2000 or for hospital visits in 2011.

Table 7: Annual Heat-Related Deaths and Hospital Visits in New York City 2000 to 2011 (Source: DOHMH).

Extreme Cold

Extreme cold can be dangerous and result in serious health issues. When exposed to cold temperatures for an extended period, the body loses heat faster than it can generate it. This causes the body's internal temperature to drop, resulting in hypothermia. Early symptoms of hypothermia include shivering, fatigue, loss of coordination, and disorientation. If continued untreated, this condition becomes more serious, with recognizable symptoms including blue skin, dilated pupils, slow pulse and breathing, or loss of consciousness. Hypothermia can have serious impacts on the brain and can often affect the victim's ability to move or think clearly.

Another serious condition brought on by extreme cold is frostbite, a freezing of the body's outer tissue. This most commonly occurs in the outer extremities like the nose, ears, cheeks, chin, fingers, and toes. Some symptoms of frostbite include numbness, tingling or stinging, aching, and discoloration of the skin. Frostbite can cause permanent damage to the body tissue and in severe cases may result in the need for amputation.

Cold exposure can also exacerbate underlying chronic illnesses, such as asthma and other respiratory diseases. Icy conditions and hazardous weather may also result in falls and other injuries.

Vulnerable Populations

Although the health impacts of extreme temperatures can affect anyone who experiences prolonged exposure, certain populations are particularly at risk. Below are some groups that are especially vulnerable to the impacts of both extreme heat and extreme cold (for more information on vulnerable populations, see Risk Assessment Section 4: New York City's Hazard Environment).

- The elderly (specifically those age 65 and older)
- Infants and children under age five
- People with pre-existing medical conditions (including heart disease, diabetes, or respiratory problems such as chronic asthma)
- People who are obese (for extreme heat) or underweight (for extreme cold)
- People living in poverty (for poverty thresholds refer to the U.S. Census Bureau and Risk Assessment Section 4: New York City's Hazard Environment)
- People without air conditioning
- People who do not speak English as a native language

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- Women who are pregnant
- Outdoor workers (due to prolonged exposure and, in some cases, heavy physical exertion)
- The homeless (due to prolonged exposure and inadequate protection from the elements—both the New York City Heat and Winter Weather Emergency Plans include strategies for outreach to the homeless population)

Secondary impacts to the population may result from power outages brought on by the heat (see Built Environment section, below). During power outages, people living in healthcare facilities, such as senior living centers and adult care facilities, without backup power are also at increased risk. Additionally, people who rely on prescription medications are at increased risk if pharmacies are out of service due to an outage.

ii. Built Environment

A large portion of New York City's utility and transportation infrastructure is vulnerable to damage during extreme heat and cold events. Although buildings in New York City are generally not as susceptible, long-term exposure to extreme temperatures can cause damage to certain types of older, less heat- or cold-resistant building materials.

Extreme Heat

Extreme heat can cause pavement on roads and bridges, or railroad tracks, to crack or buckle, resulting in service disruptions and potentially hazardous travel conditions.

When temperatures rise above 90°F during summer months, demand for electricity also rises as people increase their usage of air conditioners and fans. The heat itself can also cause transmission lines to sag, overheat, or short out. This combination of factors stresses the electrical generation, transmission, and distribution infrastructure, which in turn increases the likelihood that sections or components of the electrical system will fail, causing power outages. Such outages may impair building functions such as air conditioning and refrigeration of food and certain types of medications. Increased power demand may also result in higher emissions of greenhouse gases from power-generating facilities, contributing to climate change.

Some people illegally open fire hydrants for use as sprinklers during hot weather. The resulting drop in system water pressure can reduce firefighting capabilities and create potentially life-threatening situations for the public. Hydrant spray caps reduce the discharge of open hydrants from approximately 1,000 gallons per minute to 25 gallons per minute. FDNY distributes hydrant spray caps to the public to prevent water waste.

Extreme Cold

During the winter months, freezing temperatures and repeated freeze-thaw cycles can cause potholes, which may damage vehicles. Hazardous travel conditions may result if potholes are not tended to immediately. Frozen pipes, a common occurrence during extreme cold events, can cause service interruptions in water supply, gas supply, and drainage. To limit these effects,

utility providers monitor conditions, perform routine maintenance, and address problems as they arise.

iii. Natural Environment

Extreme temperatures are naturally-occurring weather events (human activities and the built environment exacerbate the problem but do not cause it). Thus, it is difficult to determine whether or not the temperatures themselves have any direct impacts on the natural environment. There can, however, be impacts on the natural environment that are related to secondary hazards associated with extreme heat events, such as poor air quality and drought. Extreme temperatures, particularly heat, also cause an increase in energy usage, which contributes to higher emissions of pollutants and greenhouse gases during these periods. Long-term temperature changes can cause shifts in habitat and, potentially, extinctions of certain types of local species adapted to colder weather. However, it is still uncertain what effect short-duration extreme temperature events have, if any.

iv. Future Environment

Scientists predict that extreme heat events in New York City will increase in frequency, intensity, and duration in the future, while extreme cold events will decrease in frequency, intensity, and duration. Table 8, created by the NPCC, illustrates this projected change through the middle of the 21st century. These projections are relative to the baseline period of 1971-2000, and include a low value estimate (10th percentile), a middle range (25th-75th percentile), and a high value estimate (90th percentile). According to the middle-range and high-end projections, New York City should expect, on average, up to an additional 8 to 15 days at 90°F or above by the 2020s, and up to an additional 21 to 39 days at 90°F or above by the 2050s (representing more than a 100% increase).

Furthermore, up to one to two additional heat waves per year are projected by the 2020s, and up to three to five additional heat waves per year are projected by the 2050s. These heat waves are expected to last one to two days longer on average. As the climate warms, extreme heat events are also expected to become more common during peripheral summer months like May and September.

Extreme cold events, on the other hand, are expected to decrease. According to the middle-range and high-end NPCC projections, the annual average number of days with minimum temperatures below 32°F is expected to decrease by 12 to 20 days by the 2020s and 20 to 30 days by the 2050s.

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		2020s			2050s		
	Baseline (1971 - 2000)	Low-estimate (10th percentile)	Middle range (25th to 75th percentile)	High-estimate (90th percentile)	Low-estimate (10th percentile)	Middle range (25th to 75th percentile)	High-estimate (90th percentile)
Number of days/year with maximum temperature at or above 90°F	18	24	26 to 31	33	32	39 to 52	57
Number of heat waves/year	2	3	3 to 4	4	4	5 to 7	7
Average heat wave duration (in days)	4	5	5 to 5	5	5	5 to 6	6
Number of days/year with minimum temperature at or below 32°F	72	50	52 to 58	60	37	42 to 48	52

Table 8: Quantitative Changes in Extreme Temperature Events (Source: NPCC, 2013)

The combination of more heat waves and changing demographics (such as the growth of the elderly population) is likely to result in higher rates of temperature-related mortality and illness in the future. A recent study (Li et al. 2013) projects that the number of heat-related deaths in Manhattan will increase at a relatively sharp rate throughout the 21st century while cold-related deaths will decrease at a more modest rate, resulting in a net increase in total mortality related to extreme temperatures. Relative to the 1980s, the study predicts a 37% to 49% increase in heat-related deaths and an 11% to 15% increase in temperature-related deaths by mid-century. By the end of the century, heat-related deaths are predicted to increase 50% to 91%, while total temperature-related deaths are expected to increase 16% to 31%.

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A. HAZARD PROFILE

i. Hazard Description

Floods are the natural disasters that occur most frequently in the United States. One in three federal disaster declarations is related to flooding, and many of them affect heavily populated coastal communities—including New York City.

Flood Characteristics

Flood events, the temporary inundation of normally dry land, can vary significantly in their causes, rates of development, duration, and geographic scale. Floods can be caused by excess water from oceans, rivers, groundwater, rainfall, or sewers and are commonly induced by a rain or storm event. Seasonal and intra-annual variations in tidal and hydrological cycles, along with effects attributed to climate change (such as sea level rise, intense precipitation, and more frequent, severe storms), can also contribute to flooding. Some floods develop gradually, over a period of hours or days, such as those that can occur during hurricanes or other coastal storms. Other floods happen more quickly, sometimes in a matter of minutes, and are associated with a sudden event such as a thunderstorm. Similarly, the duration of a flood depends on many factors including paths for water to exit the flooded area, such as land gradients, waterways, sewers, or percolation into soils. A flood can be site-specific, impacting a single building or component of a piece of infrastructure; local, impacting a block or neighborhood; or regional, affecting an entire river basin or stretch of coastline.

Flood Types

There are four types of flood events that can affect New York City:

- Coastal Flooding
- Tidal Flooding
- Riverine Flooding
- Inland Flooding

Coastal Flooding

Coastal floods affect areas along the open ocean, bays, rivers, streams, or estuaries of tidal influence. In New York City, coastal floods are most commonly caused by storm surge from a strong coastal storm, such as a hurricane or other tropical storm or a nor'easter.

Storm surge is the increase in water levels brought about by the low pressure and wind field of a storm. When a storm approaches land, the storm surge "piles" up at the edge of the water body, raising water levels and leading to coastal flooding. The height of the surge can be measured by taking the difference between the observed storm tide and the astronomic (or normal) tide (see Figure 1). The geography of New York Harbor amplifies the impacts of a storm surge. The New York Bight—the 90-degree angle formed by the shorelines of Long Island and New Jersey—serves as a funnel directing storms towards New York City.

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Storm surge can cause "stillwater" flooding, or a rise in water levels without significant waves, or it can result in flooding accompanied by waves. With or without waves, coastal flooding can cause erosion and structural damage and create hazardous conditions. The salt or brackish water that comes with coastal flooding can ruin mechanical and electrical equipment and harm vegetation. Sea level rise is projected to exacerbate coastal flooding hazards (See Future Environment).

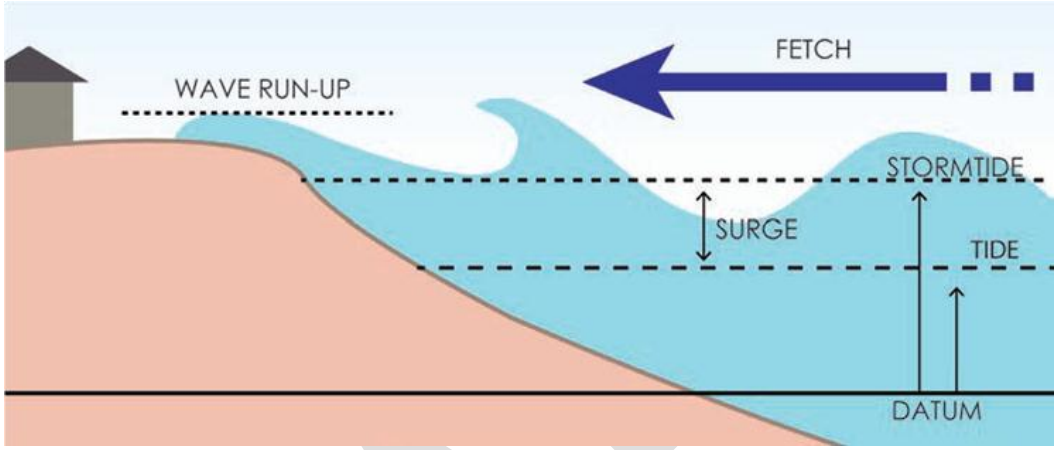

Figure 1: Storm Surge Height, Wave Run Up, Storm Tide, and Tide

Tidal Flooding

Sea levels fluctuate daily due to gravitational forces and the orbital cycles of the moon, sun, and earth. Each day there are two high tides and two low tides. These daily high tides are at their highest twice a month, during what is known as "spring tides," when the earth, sun, and moon are in a straight line.

Flooding from high tides affects some low-lying sections of the city today. The neighborhoods that are lowest-lying with extensive shoreline exposures are particularly vulnerable to tidal flooding. As sea levels rise, these neighborhoods can be expected to flood more frequently, while other low-lying neighborhoods that do not currently flood regularly with the tides will start to do so, in the absence of other measures. Regular tidal flooding could result in significant disruptions to neighborhoods and also bring about gradual erosion.

Riverine Flooding

Riverine flooding occurs when freshwater rivers and streams exceed local flow capacity and water spills over their banks. Flooding from large rivers usually results from large-scale weather systems that generate prolonged rainfall over expansive areas. These same weather systems may cause flooding of smaller basins that drain into major rivers, contributing to riverine flooding. Narrow rivers and streams are susceptible to flooding from more localized weather systems that bring intense rainfall over small areas. While riverine flooding is the most common type of flood event across New York State, it occurs less frequently and severely in New York City, where most freshwater rivers and streams are short and drain small areas.

Inland Flooding

Inland floods—commonly called "flash floods"—can be caused by short-term, high-intensity rainfall, often associated with sudden small-scale thunderstorms or hurricanes and other large-scale storms. Inland floods can also be caused by moderate rainfall over several days, typically brought on by weaker storms that drift slowly or stall over an area.

Inadequate drainage—due to condition or design capacity of the sewer and stormwater management infrastructure, along with natural drainage conditions and the surface characteristics of an area—can also contribute to inland flooding. In New York City, impervious surfaces—such as buildings, streets, sidewalks, and parking lots—reduce the amount of rainfall absorbed into the ground and can increase surface run-off volumes into the city's aging drainage infrastructure, increasing the likelihood of inland flooding. This effect is most pronounced in low-lying areas with limited natural drainage capacity, including parts of the city that once were marshes or creeks but were filled in years ago.

ii. Severity

Flood severity depends on flood type, cause, duration, and existing conditions, such as drainage design capacity and pathways for water to exit. The National Weather Service (NWS) categorizes flooding as minor, moderate, and major.

Category	Description
Minor	• Minimal or no property damage • Possibly some public inconvenience
Moderate	• Inundation of secondary roads • Transfer to higher elevation necessary to save property • Some evacuation may be required
Major	• Extensive inundation and property damage • Often involves the evacuation of people and the closure of both primary and secondary roads

Table 1: National Weather Service Flood Categories

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iii. Probability

Probability analysis helps determine the likelihood of a flood occurring in any given year and is a critical first step in developing flood mitigation practices. The foundation for flood probability analysis is an examination of the frequency of past flood events of different intensities and their recurrence intervals. The relationship between the probability of a flood and its impact on an area is complex and can range from low probability, high impact (as illustrated by Hurricane Sandy) to high probability, low impact (as demonstrated by monthly high-tide flooding).

The City relies on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) to determine flood risk probability for coastal and riverine flooding. These maps represent the federal government's official assessment of flood risk in an area. FIRMs indicate the geographic extent and height of a flood that has a 1% chance of occurring each year, referred to as the 100-year flood, and the extent and height of a flood that has a 0.2% annual chance (the 500-year flood). Mandatory flood insurance purchase and floodplain management standards apply to the 100-year flood zone. However, the terms "100-year" and "500-year" can be misleading, and perhaps even provide a false sense of security. A 100-year flood is not the flood that happens once every 100 years. Rather, it is the flood that has a 1% or greater chance of occurring in any given year. Experiencing a 100-year flood does not decrease the chance of a second 100-year flood occurring that same year or any year that follows. Even the 1% concept can be misleading—because when the years add up so does the probability. For example, a 100-year flood today, without considering future impacts from sea level rise or climate change, has a 26% chance of occurring at least once over the life of a 30-year mortgage. Similarly, a 100-year flood today has a 45% chance of occurring over the 60-year life of a power substation.

FEMA's FIRMs subdivide the 100-year floodplain, also referred to as the Special Hazard Flood Area (SHFA), into flood zones. These zones are geographic areas classified according to levels of flood risk and/or type of flooding (see Table 2).

Flood Zone Category	*Description*
V/VE*	Areas along coasts subject to inundation by a 1% annual chance flood with additional hazards associated with storm-induced waves over 3 feet high.
Coastal A	Areas landward of a V Zone or landward of an open coast without a mapped V-Zone subject to inundation by a 1% annual chance flood with additional hazards associated with storm-induced waves of 1.5 to 3 feet high. (These zones are not mapped in the 2007 effective FEMA FIRMs, but are included in the Preliminary Work Maps (PWMs) and will be included in future FEMA FIRMs for the New York Region.)
A/AE*	Areas subject to inundation by a 1% annual chance flood without wave action. Mandatory flood insurance purchase and floodplain management standards apply.
B/X (shaded)	Areas of moderate flood hazard subject to inundation by a 0.2% annual chance flood. Also called the 500-year flood zone.
*"E" indicates on the FIRMs that there is a base flood elevation determined.	

Table 2: Firm Flood Zone Categories

Coastal and Riverine Flooding

The coastal and river flood risk probability is determined by a number of factors, including severe weather events, like hurricanes, and regular high tide. The Federal government's official assessment of flood risk in a particular community is represented in FEMA Flood Insurance Rate Maps (FIRMs) which designate special flood-hazard areas and risk-premium zones. The 100-year floodplain, also referred to as the Special Flood Hazard Area (SFHA), identifies locations that have a one-percent or greater chance of experiencing coastal or riverine flooding in any given year and is broken down into subzones. The flood zones shown on the FIRMs are geographic areas classified according to levels of flood risk, with each zone reflecting the severity and/or type of flooding (See Table 2). Special flood hazard areas identify the probability of a coastal or riverine flood event is likely to increase in the future due to sea level rise and other climate change related factors. However, FIRMs do not include sea level rise projections, and therefore do not reflect full future coastal and riverine flooding risk.

The probability of coastal or riverine flooding is likely to increase in the future due to sea level rise and other climate change-related factors (see Future Environment, below). However, FIRMs do not include sea-level-rise projections and therefore may not reflect full future coastal and riverine flooding risk.

Tidal Flooding

The probability of tidal flooding is linked to both the lunar cycle and proximity to a tidal area. Low-lying sections of New York City have the highest probability of experiencing regular floods from high tides, with many areas already experiencing regular flooding today. As sea levels rise, the lowest-lying areas of the city will gradually become more vulnerable to regular flooding from daily and monthly high tides.

Inland Flooding

Inland floods can strike with little or no warning and are unrelated to the 100-year floodplain designation. Slow-moving thunderstorms repeatedly moving over the same area or a hurricane or other coastal storm can produce intense rainfalls leading to several inches of rain in a matter of seconds or hours. The heavy downpours can overwhelm New York City's sewer system and cause flooding and backups. Over the last several years, storms and precipitation events of great magnitude have been occurring more frequently than they did in the past. For instance, on June 7th 2013, the remnants of Tropical Storm Andrea brought 4.16 inches of rain to Central Park—an amount close to the total rain (4.41 inches) that typically falls during the entire month of June. The flooding that resulted forced officials to suspend subway service in northern Manhattan.

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iv. Location

New York City's 520 miles of waterfront are incredibly diverse, and each area faces different levels and types of flood risk. Low-lying areas, such as Staten Island's East Shore, southern Brooklyn and Queens, and portions of Lower Manhattan and Red Hook, Brooklyn, are particularly vulnerable to flooding from storm surge and sea level rise, but as shown in Figure 2 through Figure 6, all five boroughs have 100-year floodplain designations.

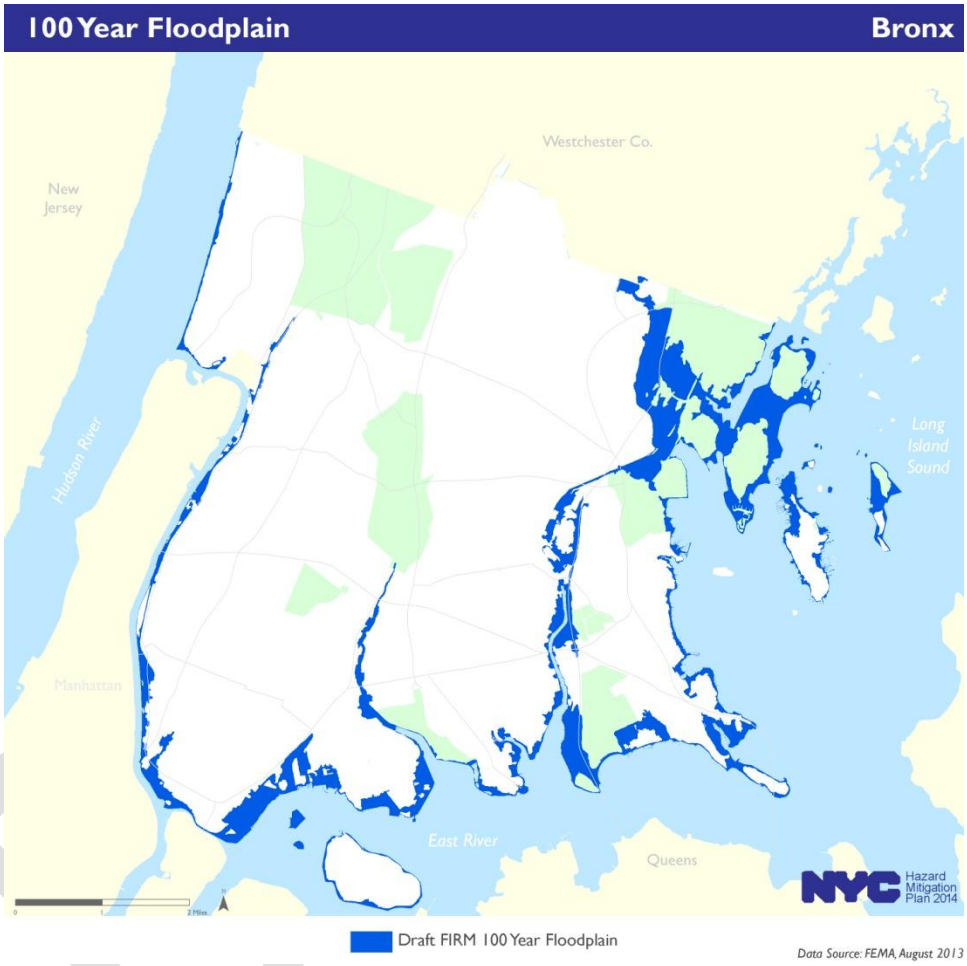

Figure 2: Bronx 100-Year Floodplain

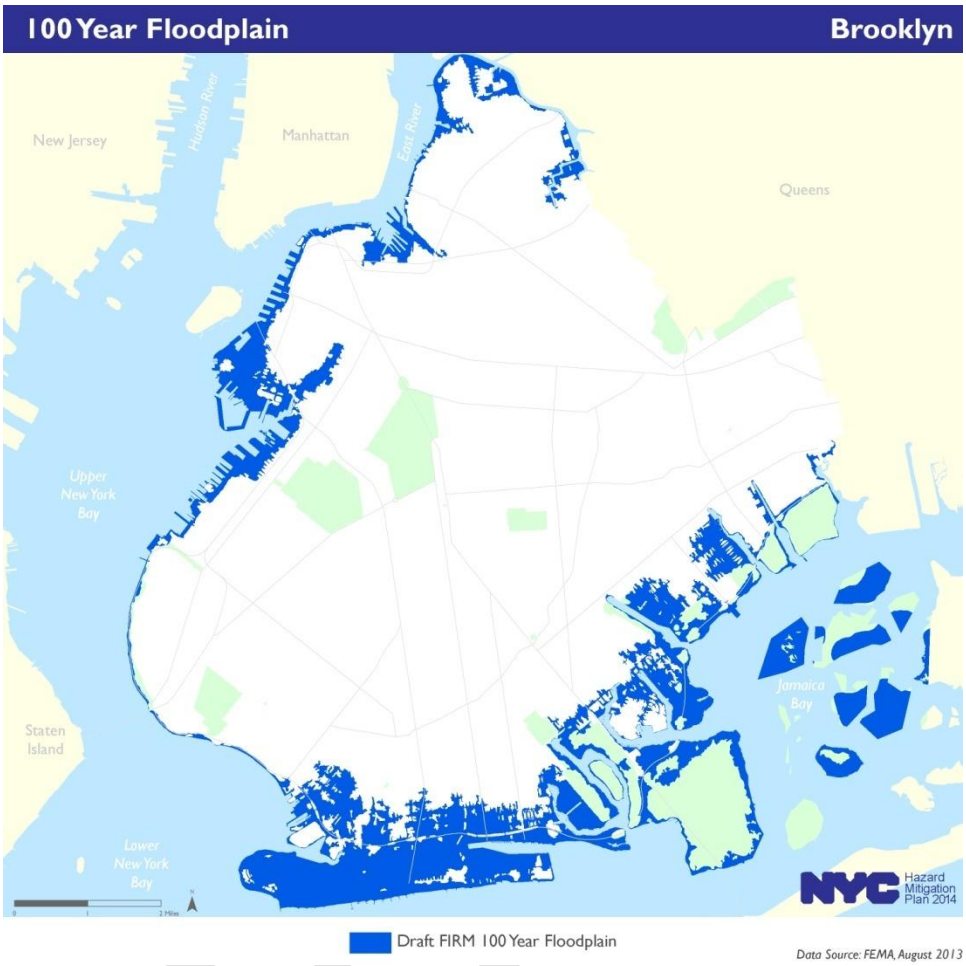

Figure 3: Brooklyn 100-Year Floodplain

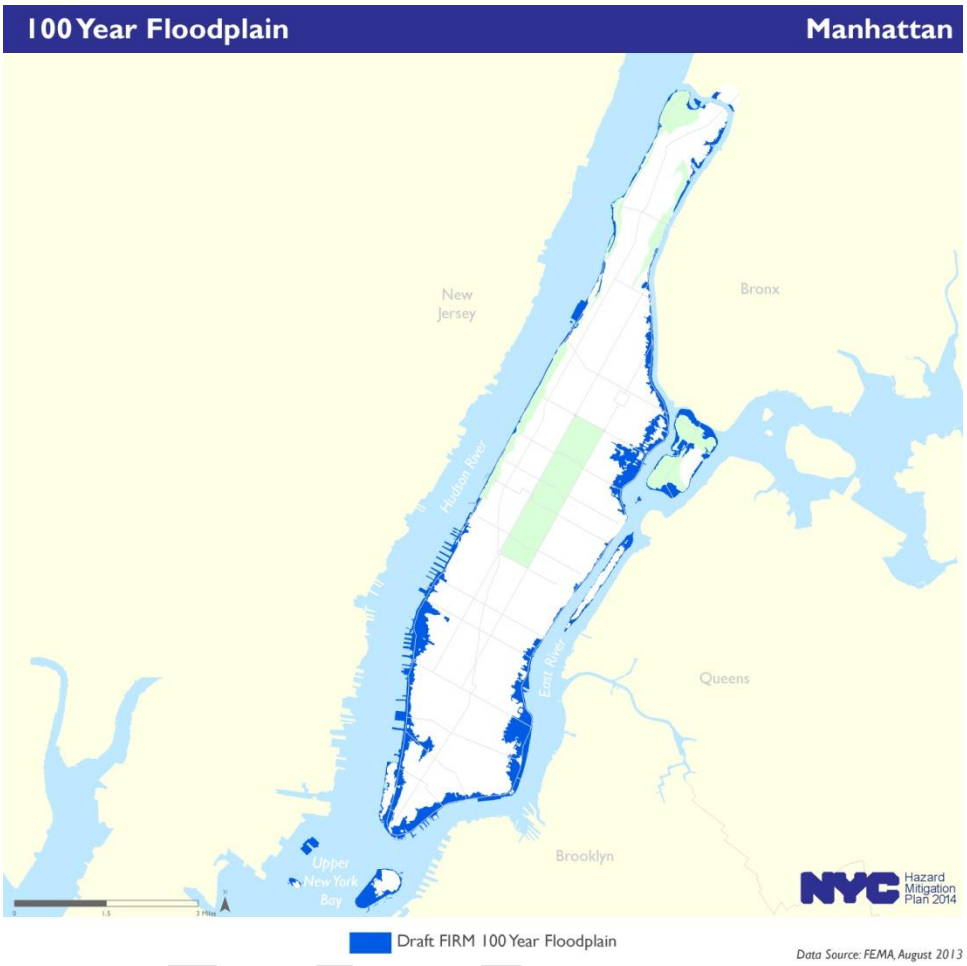

Figure 4: Manhattan 100-Year Floodplain

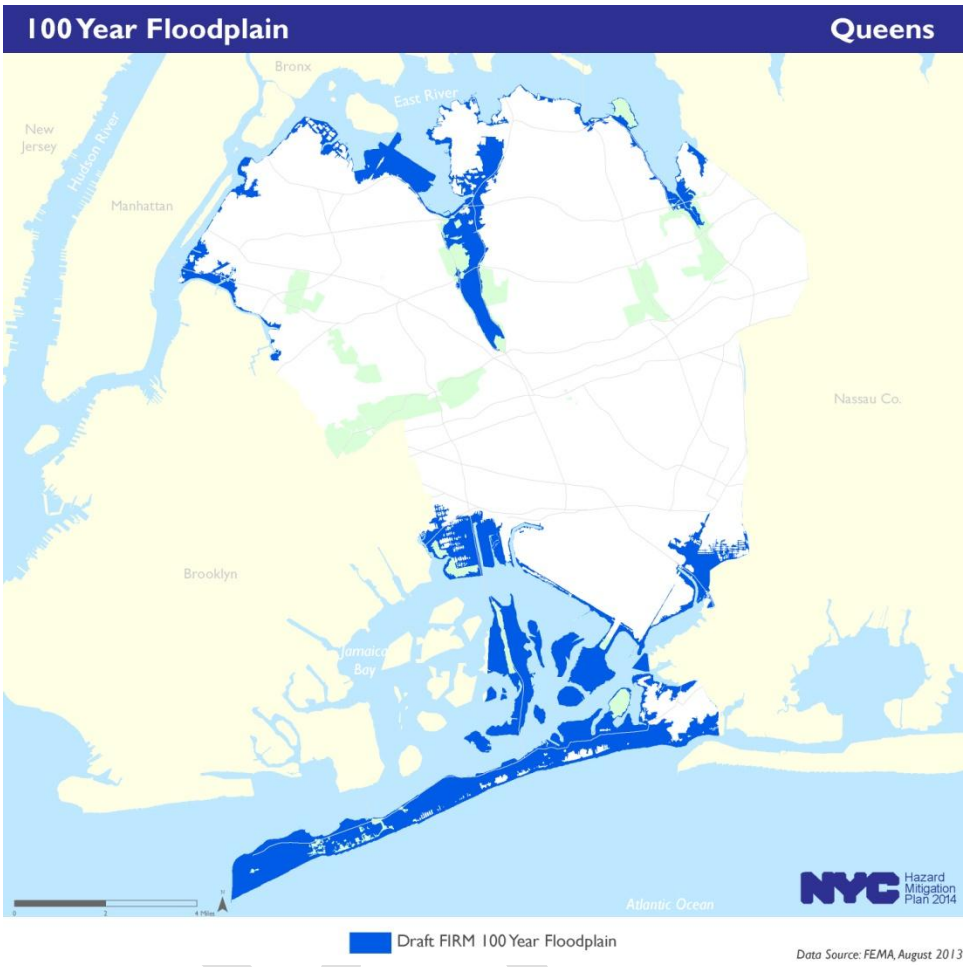

Figure 5: Queens 100-Year Floodplain

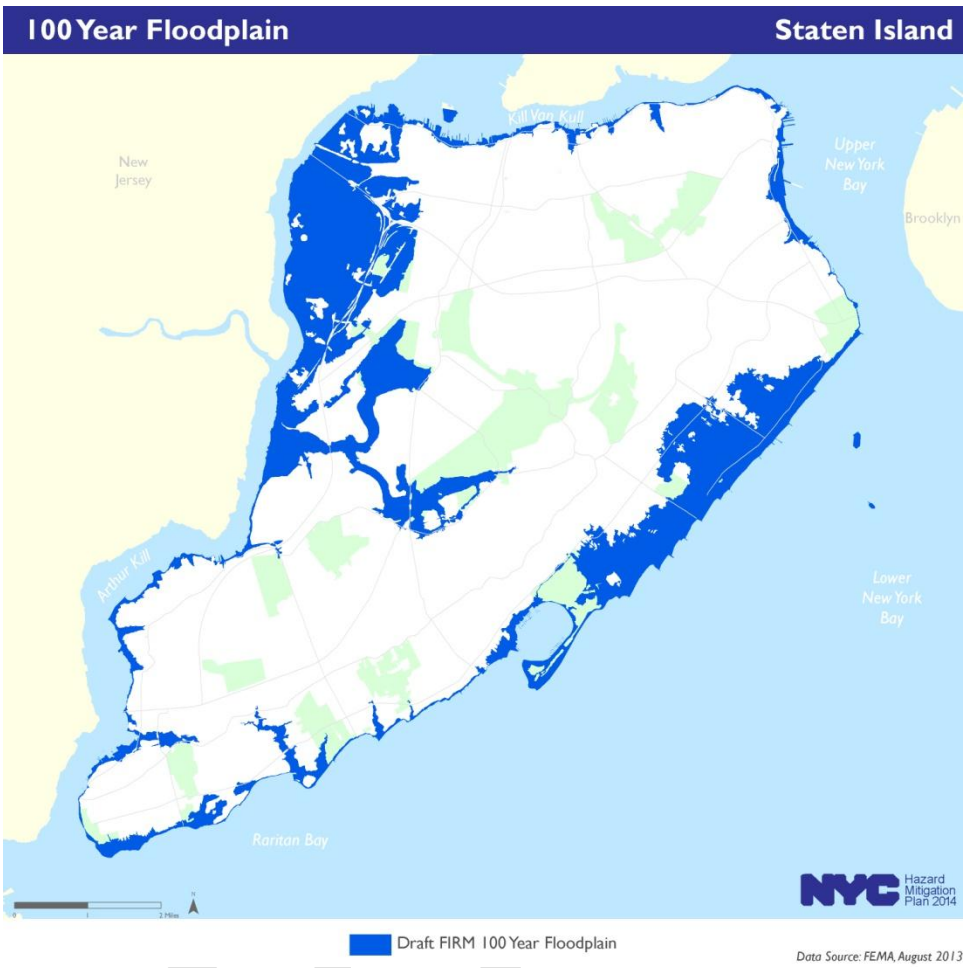

Figure 6: Staten Island 100-Year Floodplain

Coastal Flooding

All 520 miles of New York City's shoreline are affected by coastal flooding, though the height of flooding and the extent of the flood zone inland vary widely across the city.

In the lowest-lying areas of the city, where slopes towards the coast are gradual, flood heights are high and the flood zone extends far inland; these areas include those around Jamaica Bay in southern Brooklyn and southern Queens, the West and East Shores of Staten Island, portions of Lower Manhattan and Brooklyn along the New York Harbor, and sections of east Harlem and the South Bronx along the Long Island Sound. In other areas, where slopes rise quickly upland from the coast, flood heights are lower and the flood zone does not extend significantly inland; these areas include the North Shore of Staten Island, Bay Ridge and Sunset Park in Brooklyn, and the North Shore of Queens.

Wave forces most directly affect sections of Queens, Brooklyn, and Staten Island along the Atlantic Ocean. These areas include Coney Island and the Rockaway Peninsula, as well as areas of the Bronx along the Long Island Sound. As in much of the rest of the city, on the Rockaway Peninsula and around Jamaica Bay, the shoreline configuration has changed considerably over the past 50 years due to sediment movement, dredging, and filling. These changes affect wave propagation, particularly in areas such as Rockaway Point and Rockaway Inlet, where the configuration of the point controls the direction of incoming waves.

Inundation of low-lying coastal areas in the city, such as Staten Island's East Shore and southern Brooklyn and Queens, is primarily the result of storm surges, wave setup, and wave run-up, which occur during hurricanes and nor'easters.

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Though Hurricane Sandy was an exceptional event, with its record-high water level of 14.06 feet above Mean Lower Low Water and extensive flooding beyond the 500-year floodplain, it provides insight into the potential impact of coastal flooding across the city (See Figure 7). For more information on the combined effects of wind and storm surge on New York City, see Risk Assessment Section 6: Coastal Storms.

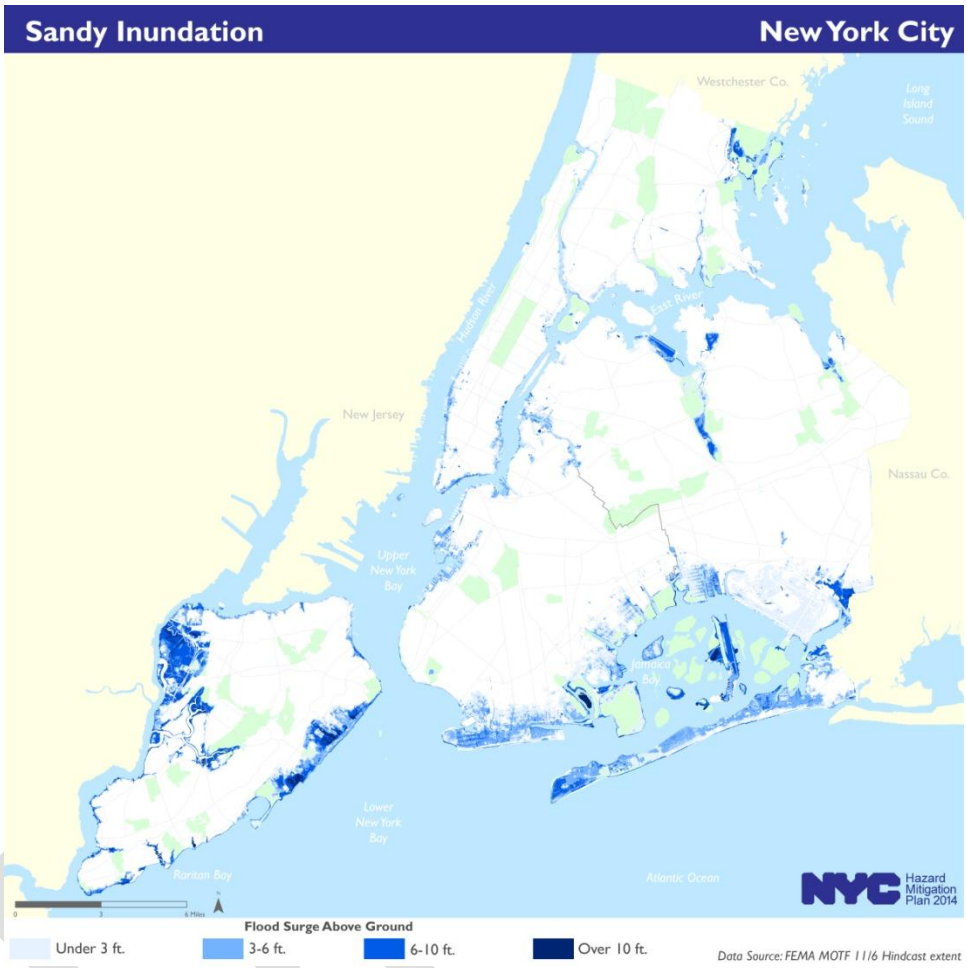

Figure 7: Sandy Inundation Area

Tidal Flooding

Low-lying neighborhoods throughout the city are vulnerable to regular flooding from high tides that result from the normal lunar cycle. As sea levels rise, these low-lying neighborhoods will gradually become more vulnerable to regular flooding from daily and monthly high tides if steps are not taken to prevent water from overtopping the shoreline. The risk of regular tidal flooding will be most pronounced in neighborhoods around Jamaica Bay in southeastern Queens, particularly Broad Channel and Hamilton Beach, and on portions of the bay side of the Rockaway Peninsula, which have some of the lowest-lying topography in the city.

Riverine Flooding

Riverine freshwater flooding affects only a small portion of flood-prone areas in New York City. Staten Island and the Bronx are the boroughs most vulnerable to riverine flooding given the

watershed characteristics in those boroughs. In the Bronx such flooding can come from the Bronx and Hutchinson Rivers, and on Staten Island from stream and river networks along the South shore and Mid-Island.

Inland Flooding

In New York City, areas prone to inland flooding often have low-lying topography, higher levels of impervious surfaces, and issues with drainage design capacity and condition. Certain neighborhoods—particularly those located on historically filled wetlands or with limited drainage infrastructure—have been subject to inland floods for many years.

In recent years more intense rainfall events have caused inland flooding in a broader range of communities. For example, in Staten Island and parts of the Bronx, inland flooding has increased from heavy or rapid precipitation that overwhelms the flow capacity of rivers, streams, and local storm sewers. Parts of the city that have antiquated or not fully built-out storm sewer systems—sections of southern Brooklyn (such as areas in Sheepshead Bay) and southern Queens including portions of Broad Channel, Edgemere, Bayswater, Far Rockaway, Rockaway Beach, and Arverne, as well as surrounding neighborhoods in southeastern Queens, such as Rosedale and Jamaica—currently experience street flooding during heavy rainfalls. Such flooding may be exacerbated if rainfall intensity increases with climate change.

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National Flood Insurance Program

Data from the National Flood Insurance Program (NFIP), which is administered by FEMA, helps to indicate the location of potential flood events. Through the program, which requires flood insurance for structures that carry a federal mortgage located within FEMA's effective 100-year floodplain, FEMA collects a vast quantity of information on insured structures, including the number and location of flood insurance policies, number of claims per insured property, dollar value of each claim, and "repetitive loss" (RL) claims—those for which a policyholder submits two or more claims after flood events within any rolling 10-year period and receives payments of $1,000 or more.

Figure 8 through Figure 10 spatially present several types of NFIP insurance data for each borough of New York City. Since 1976 there have been almost 43,000 claims. From 2012 to 2013, the city had 30,200 NFIP policies amounting to $39 million in premiums in the city. As of July 2013, there have been 16,400 claims filed since Hurricane Sandy, totaling in $980 Million in payouts.

If a policy holder submits two or more claims after flood events within any rolling 10-year period, and received payments of $1,000 or more from NFIP, this property is considered a Repetitive Loss (RL) structure. As of July 2013, New York City had a recorded 4,100 RL policies amounting to $200 million in payouts. Such properties are a high priority for flood mitigation.

A Severe Repetitive Loss property is one covered by NFIP and:

- Has at least four claim payments over $5,000 each that cumulatively exceed $20,000;
- Has at least two separate claim payments where the amount exceeds the market value of the building; and
- Has at least two claims that occurred within a 10-year period and greater than 10 days apart.

As of April 2012, there were 14 Severe Repetitive Loss properties, amounting to 1.3 million in payouts.

In July 2012, the U.S. Congress passed the Biggert Waters Flood Insurance Reform Act, which calls on FEMA and other agencies to make a number of changes to the way the NFIP is run. Some of these changes have been put in place, and others will be implemented in the coming months. The legislation requires the NFIP to raise rates to better reflect true flood risk, and make the program more financially stable. The changes will mean premium rate increases for some policyholders over time.

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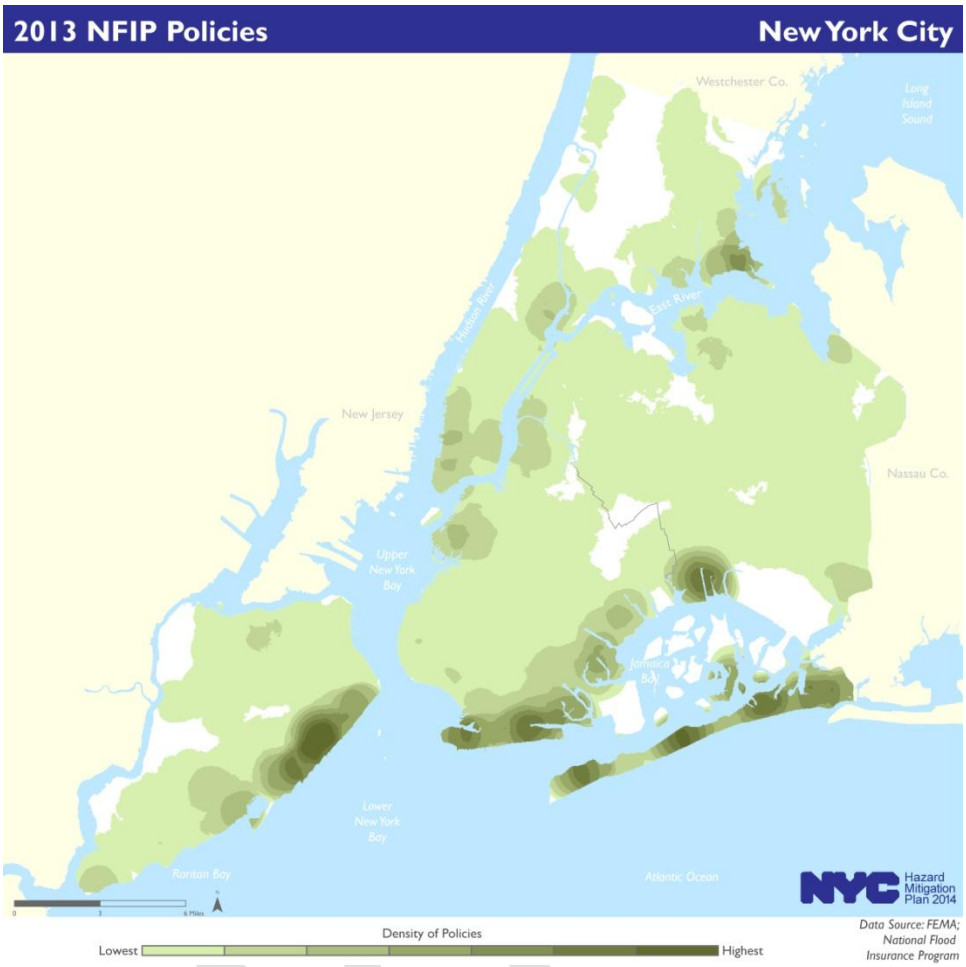

Figure 8: NFIP Policies

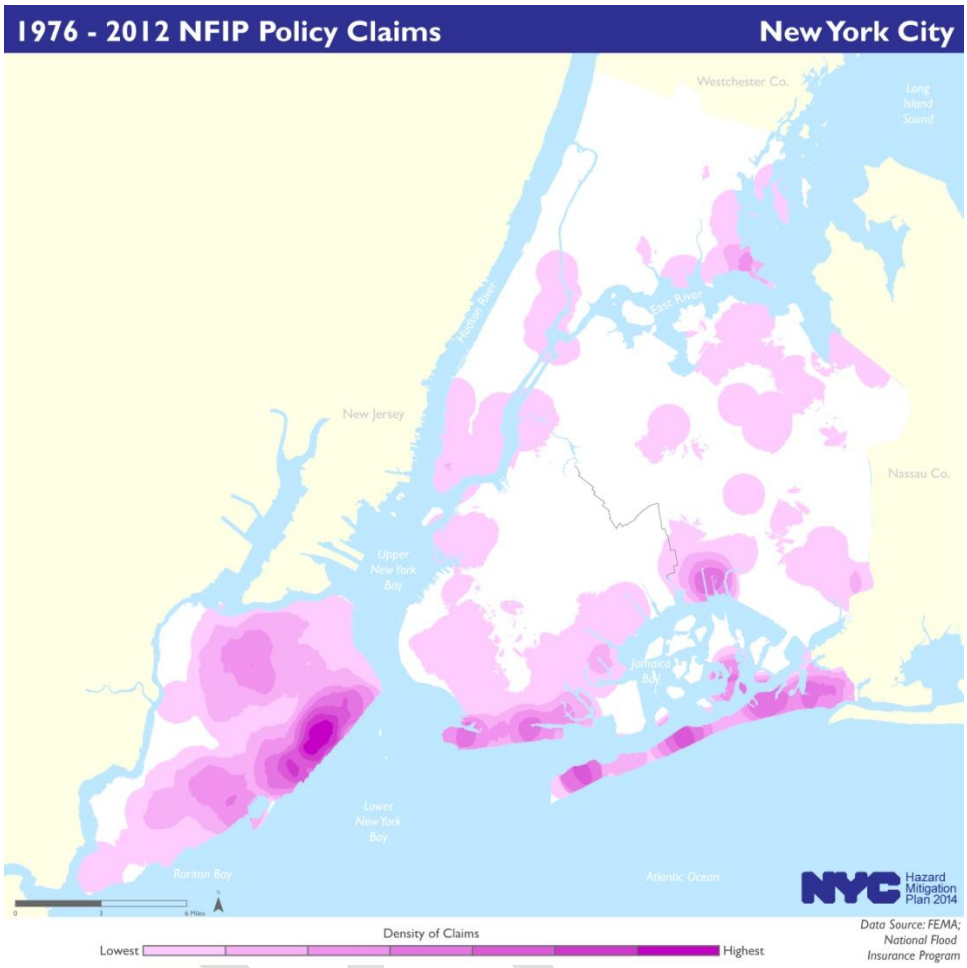

Figure 9: NFIP Policy Claims

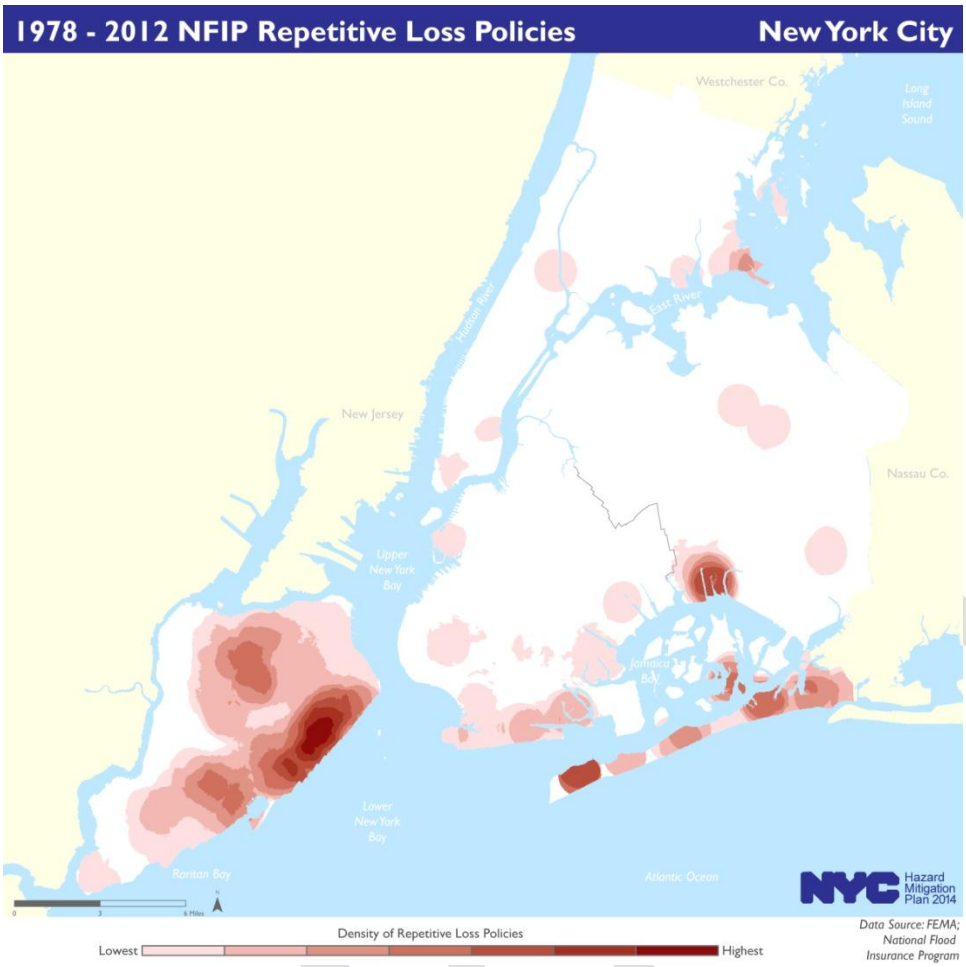

Figure 10: NFIP Repetitive Loss Properties

Historic Occurrences

New York City has suffered from numerous floods over the last decade. Table 3 includes select flooding events from 1993 to 2013.

Date	Event	Location(s)	Description
August 16, 1993	Inland flood	Manhattan	Widespread rain embedded with thunderstorms Floodwaters partially cover cars, stranding several people on their car roofs
June 29, 1994	Inland flood	Citywide	Torrential rains of nearly 2.5 inches produce substantial road and highway flooding Many basements flooded
June 22, 1995	Inland flood	Brooklyn, Queens	No information available

Date	Event	Location(s)	Description
July 1, 1995	Inland flood	Staten Island	Several homes damaged 3 people injured at a movie theater when ceiling tiles fall because of standing water on the roof
July 17, 1995	Inland flood	Bronx, Manhattan, Queens	Rainfall of 2 to 4 inches Many roadways closed
July 23, 1995	Inland flood	Bronx, Queens	No information available
October 21, 1995	Inland flood	Manhattan, Queens	No information available
November 14, 1995	Coastal flood	Queens	No information available
January 12, 1996	Inland flood	Citywide	No information available
January 27, 1996	Inland flood	Queens	No information available
April 16, 1996	Inland flood	Citywide	No information available
June 3, 1996	Inland flood	Citywide	No information available
July 3, 1996	Inland flood	Queens, Staten Island	Cars trapped in floodwaters on the Long Island Expwy. Serious road flooding reported along Richmond Pkwy.
July 8, 1996	Inland flood	Manhattan	High winds, large hailstones, and torrential rain
July 13, 1996	Flood	Brooklyn	Tropical Storm Bertha, serious, widespread flooding is reported along the Brooklyn-Queens Expwy.
July 31, 1996	Inland flood	Brooklyn, Queens, Staten Island	2 to 5 inches of rain in 3 hours Several houses damaged in mudslides at Richmond town, Staten Island Serious widespread flash flooding of roads and numerous basements flooded across Brooklyn and Queens
September 8, 1996	Inland flood	Bronx, Brooklyn, Staten Island	Thunderstorms produce torrential rain Significant flash flooding of low- lying and poor drainage areas, including many streets
October 19, 1996	Inland and coastal flood	Citywide	Heavy rains 3 to 5 inches of rainfall with isolated higher amounts Serious flooding of basements and first floors causes damage to 226 homes in Flushing and 70 homes in Springfield Gardens in Queens Numerous cars damaged in floodwaters
January 10, 1997	Coastal flood	Queens	Tidal flooding along Rockaway Blvd. in Brookville Moderate tidal flooding reported at Howard Beach

11. FLOODING

Date	Event	Location(s)	Description
November 2, 1997	Inland flood	Staten Island	Police scuba divers use rubber raft to rescue people from submerged car on Arthur Kill Road in Greenridge
January 23, 1998	Inland flood	Citywide	Heavy rainfall of 2 to just over 4 inches
March 9, 1998	Inland flood	Citywide	Widespread heavy rainfall including thunderstorms Many low-lying and poor drainage areas, including streets, are flooded
August 17, 1998	Flood	Bronx, Manhattan, Queens, Staten Island	Rainfall rates of up to 2 inches per hour LaGuardia Airport has 3.54 inches of rain
January 3, 1999	Inland flood	Citywide	People require rescue from flooded basement apartments in Springfield Gardens, Queens Water rises within 6 inches of ceilings in several apartments
January 15, 1999	Flood	Staten Island	Heavy rain falls on frozen ground with partially clogged storm drains Up to 2 feet of water collects in many streets in South Beach
August 26, 1999	Flood	Bronx, Manhattan, Queens	Flash flooding cripples public transit during the morning rush hour Subway service is severely disrupted as 3 to 5 feet of water collects at some subway stations 52 inches of water measured at the 6 station at Cypress Avenue in the Bronx A 10- to 20-foot section of the northbound platform for the 6 line at 28th Street crumbles and washes away Metro-North Railroad forced to close in Mott Haven in the Bronx
September 16, 1999	Flood	Citywide	Remnant of Hurricane Floyd Maximum rainfall rates of 1 to around 2 inches per hour for at least 3 consecutive hours 5.02 inches in Central Park
July 3, 2000	Inland flood	Brooklyn, Queens, Staten Island	Rainfall rates of up to an estimated 4 inches per hour for less than 1 hour Significant ponding of water traps people in two cars near the Verrazano-Narrows Bridge Significant low-lying and poor drainage flooding on Cross Island Parkway near Whitestone Bridge

Date	Event	Location(s)	Description
August 11, 2000	Inland flood	Bronx, Queens	Slow-moving thunderstorms produce rainfall rates estimated at around 2 inches per hour, causing significant flooding of low-lying and poor drainage areas In the Bronx, cars are submerged in rising water, trapping many people NWS radar estimates 2 to 3 inches of rainfall from 2:30 AM to 3:30 AM, with up to 5 inches during the preceding 24 hours
August 27, 2000	Inland flood	Staten Island	Heavy showers move very slowly east across northern Staten Island NWS radar estimates rainfall rates of 1.5 to 2 inches per hour for at least 2 consecutive hours Estimated rainfall of 3.5 to 4 inches results in serious widespread flooding of low-lying and poor drainage areas
August 28, 2000	Inland flood	Queens	NWS radar estimates rainfall rates of 1.5 to 2.0 inches per hour Total precipitation of 3.5 to 4 inches Serious widespread flooding on Cross Island Pkwy. in Whitestone Up to 5 feet of water ponds on streets in Bay Terrace
September 3, 2000	Inland flood	Queens	Nearly stationary thunderstorms produce torrential rain People have to be rescued from submerged cars on Northern Blvd. Several residential basements in poor drainage areas are flooded
June 17, 2001	Inland flood	Bronx, Brooklyn, Manhattan, Queens	Remnants of Tropical Storm Allison Rainfall rates of up to 3 inches per hour Numerous reports of street and highway flooding
June 23, 2001	Inland flood	Manhattan, Staten Island	Several people require rescue from their cars on Staten Island Large segment of West Side Highway between 100th and 120th Streets in Manhattan closed
August 13, 2001	Inland flood	Brooklyn, Manhattan, Queens	Rainfall rates of more than 2 inches per hour in portions of northern Queens Highly localized rainfall of 5 inches or more Several healthcare facilities flood, including one area hospital and seven area nursing homes
June 26, 2002	Flood	Bronx	Widespread flash floods with thunderstorm

Date	Event	Location(s)	Description
August 16, 2002	Flood	Bronx, Manhattan, Queens	3 feet of water on Major Deegan Expwy. at Cross Bronx Expwy. interchange, which requires police rescues Shutdown of the Henry Hudson Parkway from 96th Street to 125th Street Significant flooding in Far Rockaway
September 2, 2002	Inland flood	Brooklyn, Queens	Significant street flooding in Greenpoint, Brooklyn, and on Brooklyn-Queens Expy. Significant widespread street flooding in Woodside, Queens
July 22, 2003	Inland flood	Queens, Staten Island	Significant street flooding in Bayside Hills and Ridgewood Con Ed reports significant flooding that results in street closings near Richmond Avenue and Victory Blvd.
August 4, 2003	Inland flood	Brooklyn, Manhattan, Queens, Staten Island	Rainfall rates of 2 to 3 inches per hour N and R subway tunnels flood Basements in Brooklyn flood Sewers and septics back up onto streets in Annadale, Staten Island
August 17, 2003	Inland flood	Brooklyn	Isolated locations receive as much as 3 to 4 inches of rain in 2 hours OEM reports water levels up to car doors on the Belt Pkwy. near Pennsylvania Avenue
September 23, 2003	Inland flood	Bronx, Brooklyn, Manhattan, Queens	Several lanes close on the FDR and Harlem River Drives in Manhattan, the Van Wyck Expy. in Queens, Ocean Parkway in Brooklyn, and several local streets in Riverdale in the Bronx
June 17, 2004	Inland flood	Bronx, Brooklyn, Manhattan, Queens	Significant flash flooding on roadways results in the need for people to be rescued from cars
June 25, 2004	Inland flood	Queens, Staten Island	Several cars trapped in floodwaters
July 2, 2004	Inland flood	Bronx, Queens	179th Street and Major Deegan Expwy. in the Bronx flood Bell Blvd. and 208 Place intersection in Queens flood with 2 people requiring rescue from cars
September 8, 2004	Inland flood	Bronx, Brooklyn, Manhattan, Queens	Remnants of Hurricane Frances Rainfall of up to 6 inches Extensive flash flooding across the region, resulting in rescues of people from homes and cars

Date	Event	Location(s)	Description
September 18, 2004	Inland flood	Citywide	Remnants of Hurricane Ivan Torrential rains of up to 5 inches in some areas
September 28, 2004	Inland flood	Citywide	Remnants of Hurricane Jeane drop 3 to 6 inches of rain across southeastern New York State Numerous roads and highways are closed
July 6, 2005	Inland flood	Brooklyn	Slow-moving thunderstorms producing rainfall rates of around 2 inches per hour cause flash flooding of streets
October 14, 2005	Inland flood	Brooklyn, Queens	Flooding along Ocean Pkwy. and the Grand Central Pkwy. Several trees and power poles lean from soggy ground
June 1, 2006	Inland flood	Staten Island	Flash flooding on the West Shore Expwy.
June 2, 2006	Inland flood	Manhattan, Queens, Staten Island	Flash flooding on FDR in Manhattan Flash flooding of roads, submerged vehicles, and a few houses on Staten Island surrounded by 5 feet of water
July 12, 2006	Inland flood	Citywide	Flash flooding of the FDR service road at 34th Street in Manhattan, with thunderstorm Wall collapse in Washington Heights in Manhattan
July 21, 2006	Inland flood,	Citywide	Partial flooding from thunderstorm resulted in road closures on the Staten Island Expy., the Belt Pkwy., the Brooklyn-Queens Expwy., the Grand Central Pkwy. and Van Wyck Expwy. Subway service suspended in both directions on the R and W lines between Whitehall Street in Manhattan and Ditmars Blvd. in Queens
August 10, 2006	Inland flood	Manhattan, Queens	Flash flooding forces closure of subway lines 1, 2, 3, and 6.
August 25, 2006	Inland flood	Bronx, Queens	Flash flooding along many major roads results in road closures Most significant flooding along the Major Deegan Expwy. and Cross Bronx Expwy.
October 28, 2006	Inland flood	Bronx	Flash flooding along portions of the Bronx River Pkwy. and Bruckner Expwy.

Date	Event	Location(s)	Description
November 8, 2006	Inland flood	Staten Island	Heavy rain floods many basements and closes numerous streets Staten Island Railroad service is suspended because of flash flooding across tracks
April 15, 2007	Flood	Brooklyn, Manhattan, Queens	Nor'easter brings heavy rain and high winds. 8.41 inches of rain in Central Park Street flooding along the Belt Pkwy. in and FDR Drive in Manhattan
April 27, 2007	Inland flood	Bronx, Manhattan, Queens	Rainfall of 2 to 3 inches Flash flooding of the Jackie Robinson Pkwy. and West Side Hwy. In Manhattan
June 4, 2007	Inland flood	Bronx, Brooklyn, Manhattan, Queens	Heavy rain from the remnants of Tropical Storm Barry causes flash flooding in parts of southeast New York. Rainfall amounts of up to just under 4 inches in Central Park
June 27, 2007	Inland flood	Bronx, Queens	Severe thunderstorms produce flash flooding, hail, and high winds across parts of the region
July 11, 2007	Inland flood	Manhattan	Heavy rain
July 18, 2007	Inland flood	Bronx, Brooklyn, Manhattan, Queens	A cluster of heavy thunderstorms produces torrential rain that results in widespread and significant flash flooding across the region Maximum rainfall rates are estimated at 2 to 3 inches per hour Total rainfall of around 3 to 6 inches
August 8, 2007	Inland flood	Citywide	Storms produce copious amounts of rainfall, causing widespread, significant flash flooding, including of several subway lines Properties in Brooklyn experience damage from heavy rain and fallen trees Large closures due to flooding along several highways
October 11, 2007	Inland flood	Bronx, Brooklyn, Manhattan, Queens	A low-pressure system slowly moving north from the mid-Atlantic coast across New England produces flash flooding across parts of New York City
June 14, 2008	Inland flood	Citywide	Thunderstorm causes flash flooding
July 27, 2008	Inland flood	Staten Island	Caused by thunderstorms with torrential downpours

Date	Event	Location(s)	Description
August 11, 2008	Inland flood	Citywide	Numerous thunderstorms with torrential rainfall lead to flash flooding Reports of sinkholes and stranded cars
August 14, 2008	Inland flood	Queens	Thunderstorms producing torrential rainfall lead to flash flooding. Total rainfall of almost 1.5 inches reported
August 15, 2008	Inland flood	Bronx, Manhattan	Thunderstorms producing torrential rainfall lead to flash flooding Several highways closed
September 6, 2008	Inland flood	Citywide	Tropical Storm Hanna causes torrential rain from heavy showers and thunderstorms, resulting in flash flooding and some riverine flooding Closures due to flooding along several highways and roads
July 29, 2009	Inland flood	Citywide	Thunderstorms produce very heavy rain leading to flash flooding Several highways closed due to flooding
October 24, 2009	Flood	Staten Island	Rainfall over 18 to 24 hours causes isolated flooding
March 13, 2010	Coastal flood	Bronx, Manhattan, Queens	Automated Surface Observing System (ASOS) records 3.84 inches of rainfall in Central Park and 3.16 inches at LaGuardia Airport
March 28, 2010	Heavy rain	Manhattan, Queens	A Nor'easter causes widespread flooding Suspension of some subway lines reported Closure of highways and roads due to flooding
March 30, 2010	Heavy rain, flood	Bronx, Queens	A Nor'easter causes widespread flooding A mudslide on the MetroNorth railroad tracks Total rainfall of 4.38 inches recorded in Central Park
August 22, 2010	Inland flood	Queens	Heavy rain and training thunderstorms Several vehicles became stuck in floodwaters with occupants rescued by local fire department

Date	Event	Location(s)	Description
October 1, 2010	Flood, inland flood	Bronx, Brooklyn, Manhattan, Queens	Remnants of Tropical Storm Nicole result in heavy rain and flooding Suspension of some subway lines reported Closure of highways and roads due to flooding Total rainfall recorded by the ASOS at JFK Airport and LaGuardia Airports of 3.08 inches and 3.06 inches respectively
October 11, 2010	Inland flood	Brooklyn	A wave of low pressure along a cold front moving through the area causes heavy rain and flash flooding
August 14, 2011	Inland flood	Brooklyn, Queens, Staten Island	Heavy rain results in flash flooding
August 28, 2011	Coastal and tidal flooding	Bronx, Brooklyn, Manhattan, Queens	Hurricane Irene makes landfall locally as a tropical storm Copious amounts of moisture within the storm produce extended periods of heavy rainfall, resulting in widespread moderate to major flooding
June 22, 2012	, Inland flood	Staten Island	Showers and thunderstorms ahead of a cold front produce heavy rain, resulting in isolated flash flooding
July 18, 2012	Inland flood	Manhattan, Queens	Thunderstorms produce heavy rainfall and result in flash flooding Closure of highways entrance/exits ramps due to flooding
October 29, 2012	Coastal flood	Citywide	Post-tropical storm Sandy brings record-breaking tides and wave action, combined with high winds, to cause 43 deaths and untold number of injuries and inflict damages estimated at $19 billion 51 square miles of New York City flooded—17 percent of the city's total land mass
May 8, 2013	Inland flood	Brooklyn	Thunderstorms training over area produce heavy rain that coincides with high tide, resulting in flash flooding across parts of southern Brooklyn
May 9, 2013	Inland flood	Queens	Showers and thunderstorms produce heavy rain, leading to flash flooding

Date	Event	Location(s)	Description
May 23, 2013	Inland flood	Staten Island	Storms produce heavy rain, resulting in flash flooding
June 2, 2013	Inland flood	Manhattan	Showers and thunderstorms produce heavy rainfall, resulting in isolated flash flooding
June 6-8, 2013	Flood	Manhattan	The remnants of Tropical Storm Andrea tracking up the Eastern Seaboard result in a prolonged period of heavy rain Total rainfall of 4.77 inches over the course of 3 days recorded by the ASOS in Central Park 4.16 inches fell on June 7.

Table 3: Historical Occurrences of Flooding in New York City

B. Vulnerability Assessment

i. Social Environment

Socio-demographic characteristics can be important factors in determining vulnerability to a flood hazard; they can play a significant role in shaping risk perception and determining a population's capacity to take risk-reduction actions to minimize the impacts of a flood. In New York City, high-risk populations include children, seniors, low-income residents, those who do not speak English very well and thus are "linguistically isolated," those with disabilities or other pre-existing health conditions, and in-patient populations at hospitals and other healthcare facilities. For a detailed discussion of at-risk populations, see "Social Environment" in Risk Assessment Section 4: New York City's Hazard Environment. Here, a close examination of the potential impact of a flood hazard those over the age of 65 and those living below the poverty line to help illustrate the potential impact of a flood on at-risk populations.

	New York City		Bronx		Brooklyn		Manhattan		Queens		Staten Island	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Population	398,102	4.9	16,422	0.5	164,803	6.6	89,277	5.6	99,110	4.4	28,490	6.1%
Housing Units	174,842	5.2	5,826	1.1	71,311	7.1	43,695	5.2	43,043	5.2	10,967	6.2%

Table 4: Population and Households in 100-Year Floodplain (Source: US Census 2010)

Borough	Persons Per Acre
Bronx	5.9
Brooklyn	22.5
Manhattan	43.6
Queens	8.9
Staten Island	3.9
New York City	**13.0**

Table 5: Population Density in 100-Year Floodplain (Source: US Census 2010)

Population over the Age of 65

Age plays a central role in determining an individual's ability to take risk-reduction actions in an emergency. New Yorkers over the age of 65 are among the most vulnerable groups in a flood-related disaster. As a group, seniors are more likely to have health conditions and disabilities that require regular access to health services and medication. During flooding events, these services are often disrupted or severely restricted. Decreased mobility due to a disability or age-related fragility can prevent timely evacuation or movement to safer ground. In the aftermath of a flood, exposure to mold in flood-damaged buildings can have a greater impact on older populations, particularly those with respiratory infections, asthmatic symptoms, or other pre-existing health conditions.

15 percent of those living in the PWM 100-year floodplain—or approximately 60,600 people—are over the age of 65.

Flood risk vulnerability is acute among immigrant seniors. Almost 50 percent of New York City's older residents are foreign-born. As a group, older immigrants often earn lower wages, have less in retirement savings, and receive fewer benefits from traditional entitlement programs like Social Security and Medicare than native-born seniors. According to Center for Urban Futures, nearly two-thirds of immigrant residents age 65 and older have limited English proficiency and therefore may not be aware of critical city services and resources available during an emergency.

Hurricane Sandy tragically highlighted the vulnerability of seniors to flood hazards in New York City. Nearly half of the fatalities during Hurricane Sandy were among adults aged 65 or older, most due to drowning. The Mayor's Special Initiative for Rebuilding and Resiliency (SIRR) found that 27% of the households in the surge area included seniors, three percentage points higher than throughout New York City. Seniors living alone made up 12.1% of all households in the surge area. Since the city's elderly population is growing more rapidly than the overall population, this type of social vulnerability is likely to increase in the future.

	New York City		Bronx		Brooklyn		Manhattan		Queens		Staten Island	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Under 5	22,812	5.7	1,069	6.5	8,934	5.4	4,793	5.4	6,421	6.5	1,595	5.6
Under 18	80,463	20.2	3,629	22.1	32,572	19.8	15,130	16.9	23,157	23.4	5,975	21.0
Over 65	60,583	15.2	1771	10.8	29,157	17.7	11,024	12.3	15,280	15.4	3,351	11.8

Table 6: Population by Age Group within 100-Year Floodplain (Source: US Census 2010)

	Estimate of Population that Speak English less than "very well"	Estimate of Population for English Proficiency is determined	% Speak English less than "very well"
New York City	95,627	376,918	25.4%

Bronx	2,342	15,318	15.3%
Brooklyn	58,011	157,149	36.9%
Manhattan	17,983	85,022	21.2%
Queens	12,753	92,602	13.8%
Staten Island	4,538	26,827	16.9%

Table 7: New Yorkers Who Speak English Less than "Very Well" within the 100-Year Floodplain (Source: ACS 5YR 2007-2011)

Low-Income Population

Low-income communities are disproportionately affected by almost all disasters, including floods. A flood can damage and/or destroy housing, businesses, and inventory. Floods can also damage critical infrastructure and disrupt vital services (see Built Environment, below). Low-income households have fewer resources to prepare for and recover from such disasters and therefore face higher health and safety risks along with economic hardships. In New York City, a one-person household earning $11,500 or less and a four-person household earning $23,000 or less are designated as low-income (see Social Environment in New York City's Hazard Environment). Approximately 18% of those living in the 100-year floodplain according to the PWMs—or 70,000 people—is estimated to be below poverty level.

Moreover, a significant percentage of low-income households are renters and thus have little control over investment in post-flood repairs. With the high-cost of housing in New York City, finding alternative housing options—even temporarily, during an evacuation or immediately following a storm—can pose a serious challenge. As a consequence, many low-income individuals and families continue to occupy their damaged homes to avoid a greater allocation of income towards rent or even homelessness. Yet occupying uninhabitable residences can increase the vulnerability of low-income households in other ways, including increasing exposure to mold and other hazardous materials in flood-damaged buildings. Health problems, in turn, can result in lost wages or even loss of employment, further increasing economic vulnerability.

	Estimate of Population Below Poverty Level	Estimate of Population for whom poverty status is determined	% Below Poverty Level
New York City	70,706	390,756	18.1%
Bronx	3,159	15,617	20.2%
Brooklyn	30,768	163,669	18.8%
Manhattan	19,061	86,546	22.0%
Queens	15,671	96,546	16.2%
Staten Island	2,047	28,378	7.2%

Table 8: Population below Poverty Level within 100-Year Floodplain (Source: ACS 5YR 2007- 2011)

Hurricane Sandy offers data points that help illustrate vulnerability based on income and access to resources. Post-Sandy, low-income households—both renters and owners—were especially hard-pressed to cover losses, despite the availability of FEMA assistance. The median

household income reported by FEMA-registered New Yorkers was $82,000 for owners and $18,000 for renters. Nearly one-third of owners (29.9%) and two-thirds of renters (64.9%) have household incomes of less than $30,000 per year (roughly 60% of the median income in New York City). Given the extremely low incomes of the renters claiming damages, they are particularly at risk of being unable to locate new housing that is affordable to them. In normal times, the overall amount of housing affordable to these households earning less than $30,000 per year is limited to just 22% of rental units in New York City. Replacing lost housing for these families is likely to be a long-term challenge for New York City.

While low-income renters were particularly vulnerable to housing instability after Sandy, many homeowners affected by Sandy were already facing the threat of foreclosure when the storm hit. They may face an even tougher struggle to retain their homes. There were 1,800 owners of one- to four-family homes in the surge area who had had foreclosure proceedings started against them in the two years prior to the storm.

ii. Built Environment

New York City boasts one of the world's densest and most diverse agglomerations of infrastructure and built assets. However, much of this built environment is vulnerable to inundation and structural damage during a flood.

- Buildings
- Wastewater and Waste Management Infrastructure
- Transportation Infrastructure
- Energy Infrastructure
- Telecommunications
- Critical Assets

Buildings

Flood risk varies by building height, construction type, and age. In general, low-rise buildings (one to two stories) are more vulnerable to structural damage than mid-rise (three to six stories) and high-rise (seven stories or higher) buildings. Moreover, low-rise buildings tend to house primary uses on the ground floor and therefore face higher risks of experiencing substantial damage. Low-rise buildings also tend to be constructed of lighter, wood stud-frame materials, which are more prone to structural damage and fire from electrical shorts caused by flooding than steel, masonry, or concrete frames, which are more characteristic of more recent and denser building types. Although wood buildings are less expensive to repair, reconstruct, and elevate than masonry buildings, new wood-frame housing is generally not permitted in New York City.

Older buildings are more likely to sustain significant flood damage than newer buildings primarily due to the increasingly stringent building and zoning standards that have been put into effect over time. Adherence to flood-resistant construction standards greatly reduces

vulnerability to flood damage. While data on the elevation and floodproofing characteristics of buildings is limited, building age serves as a proxy indicator of structural vulnerability.

Not surprisingly, during Hurricane Sandy, older (constructed before 1961) one-story buildings sustained the most severe structural damage. High-rise buildings generally experienced less structural damage, but they did sustain damage to building systems (housed in basements or otherwise insufficiently elevated), which was in many cases costly and disruptive. While severe damage to small buildings clearly has adverse consequences for owners and occupants, damage to larger buildings can also have lasting economic consequences, particularly in coops or condominiums, or where lost or damaged space represents a significant share of the building's cash flow.

Single-story light-frame buildings constructed before 1961—such as bungalows erected for seasonal use in many coastal areas of the city—was the building type most vulnerable to Hurricane Sandy's effects. Buildings matching these characteristics represent 21% of the buildings in the PWM 100-year floodplain (see Table 9).

FEMA's 2013 PWMs define the 100-year floodplain as an area that encompasses 67,700 buildings, or over 534 million square feet of floor area. These buildings contain substantial value and house important functions such as housing, offices, schools, and hospitals. Approximately 196,700 residential units, home to almost 400,000 New Yorkers, are located within the 100-year floodplain.

	1 Floor		2 Floors		3-6 Floors		7 Floors or Higher	
	Combustible	Non-Combustible	Combustible	Non-Combustible	Combustible	Non-Combustible	Combustible	Non-Combustible
Pre-1961	21.0%	2.6%	35.4%	1.0%	7.4%	1.2%	0.1%	0.4%
Post-1961	2.8%	0.9%	18.8%	0.5%	6.7%	0.7%	0.1%	0.6%

Table 9: Building Type and Age within 100-Year Floodplain (Source: MapPluto 13V1; FEMA, Preliminary Working Maps)

Wastewater and Waste Management Infrastructure

Much of the city's critical wastewater and waste management infrastructure is located in the 100-year floodplain. These critical facilities are often sited along the waterfront out of operational necessity or were built there years ago during the development of the infrastructure network.

For example, all of the city's 14 wastewater treatment plants are located along the waterfront at low elevations because waterfront adjacency significantly reduces the cost and environmental impact of treating wastewater in New York City. All 14 of the city's wastewater treatment plants have assets in the PWM 100-year floodplain that are potentially vulnerable to inundation by storm surge. If not properly adapted, the majority of New York City's wastewater treatment infrastructure is at risk of being damaged in severe storms or floods, which can lead to combined sewer overflows and contamination of the waterways—as Hurricane Sandy

powerfully demonstrated. Floodwaters from a surge can cause significant damage not only to wastewater management facilities but to the critical equipment they house. The corrosive impact of seawaters on electrical systems creates disruptions in the power supply at these facilities, resulting in an overflow of partially treated or untreated sewage into waterways.

Additionally, a significant share of both municipal and private solid waste management facilities, as well as other industrial facilities that store and use hazardous materials, are located within the 100-year floodplain. Flooding at facilities that store hazardous materials and solid waste—but don't properly manage such materials—can cause dispersion of contaminants, with adverse effects on employees, nearby populations, and natural resources.

Transportation Infrastructure

Many parts of the New York's transportation system, such as ferry terminals, are located near the waterfront due to operational needs or demands of transportation networks. Some transportation assets are built in low-lying areas or even below sea level. For example, rail and vehicular tunnels and subway stations—which make up a significant portion of the city's transportation network—are all located underground. According to the PWMs, approximately 12% of the city's roadway networks, all of the major tunnel portals other than those for the Lincoln Tunnel, portions of both airports, a variety of commuter rail assets, all three heliports, and numerous subway entrances and vent structures (principally in Lower Manhattan) are located in the 100-year floodplain. These assets are vulnerable to flooding from both coastal surge and heavy downpour.

Hurricane Sandy illustrated the potential impact a storm surge can have on vehicular tunnels, subway stations, roads, and airports. The transportation outages that followed the storm impaired mobility and access to, from, and within the city and the region, affecting 8.5 million public transit riders, 4.2 million drivers, and 1 million travelers.

Locations where tunnel entrances are in low-lying areas or in areas with poor subsurface drainage are particularly vulnerable to flooding. Examples of infrastructure matching this flood profile include the F train on Hillside Avenue in Queens and several subway lines in Lower Manhattan.

Generally, heavy downpours pose only a moderate risk to roads and bridges, which may experience more frequent temporary flooding, but not more lasting damage. New York City's vast street network is also vulnerable to flooding from heavy precipitation, storm surge, or, as in the case of neighborhoods such as Hamilton Beach and Broad Channel in Queens, high tides.

Energy Infrastructure

Much of the city's underground electric and steam distribution systems and generating facilities are located near the coast, and are thus vulnerable to storm surge and floodwaters. Approximately, 88% of the city's steam generating capacity lies within the PWM 100-year floodplain. In the electric system, 53% of in-city electric generation capacity, 37% of

transmission substation capacity, and 12% of large distribution substation capacity are within the 100-year floodplain. Sea-level-rise projections indicate the numbers of at-risk facilities will continue to grow in the coming decades.

For the natural gas system, the biggest risk that storm surge poses is to the distribution infrastructure. Although flooding itself will not stop the flow of gas, service can be compromised if water enters pipes.

Moreover, the generation of much of the city's electricity and steam power is dependent on natural gas and liquid fuel. Any disruption to the fuel supply chains can result in a disruption in power and steam production. Given the location of key terminals, pipelines, and refineries—and the importance of waterfront access for the movement of fuels into New York City—the greatest risk to the liquid fuel supply is storm surge. Of the 39 terminals in the New York metropolitan area, nearly all lie within FEMA's 100-year floodplain as mapped on the 1983 FIRMs.

Telecommunication Infrastructure

New York City's telecommunication services – telephone, wireless, internet, and cable – are vulnerable to flooding, particularly from storm surge. Though telecommunications facilities are generally farther from the floodplain, almost 13% of the city's critical telecommunication facilities lie in the PWM 100-year floodplain. Also, the high dependency of telecommunications on the power network significantly increases risk of service interruption during a flood. Vulnerability is projected to increase with climate change. For example, by the 2020s, the number of critical facilities in the 100-year floodplain will grow to approximately 18%. By the 2050s, that number is expected to climb to 24%. With up to 2.5 feet of sea level rise expected by the 2050s, the risk to critical central offices, including the two largest central offices serving Southern Manhattan, is likely to increase.

Critical Assets in 100-year floodplain

Table 10 displays the vast number of critical assets located within the 100-year floodplain. These assets have a 1% chance of being flooded in any given year.

Critical Asset	#
Subway stations	27
Rail stations	8
Bridges and tunnels	32
Major roads (miles)	154
Airports	2
Ferry landings	33
Emergency services—police stations	18
Emergency services—fire stations	8
Emergency services—EMS stations	4
Educational—colleges	4
Educational—public schools	99
Educational—private schools	30
Healthcare—hospitals	5

Healthcare—nursing homes	16
Healthcare—hospice	1
Healthcare—adult day healthcare centers	6
Infrastructure—power plants	10
Infrastructure—wastewater treatment plants	7
Telecommunications	10

Table 10: Critical Assets in the 100-Year Floodplain

The vulnerability of New York City's critical assets to flooding was reinforced by the city's experience during Hurricane Sandy. Close to 2 million people lost power at some point during the storm, with almost a third of these customers in Manhattan. Six hospitals closed—four in Manhattan, one in Brooklyn, and one on Staten Island—requiring City and State health officials, co-located at the City's Office of Emergency Management, to coordinate the evacuation of nearly 2,000 patients. Many of the city's highways, roads, railroads, and airports flooded. For example, all six East River subway tunnels connecting Brooklyn and Manhattan were knocked out of service by flooding, along with the Steinway Tunnel that carries the 7 train between Queens and Manhattan, the G train tunnel under Newtown Creek, the Long Island Railroad and Amtrak tunnels under the East River and the PATH and Amtrak tunnels under the Hudson River.

However, the PWMs do not reflect the full flooding risk to New York City's building stock and critical infrastructure. That is because these maps are based on historical storm profiles and do not take into account potential changes in coastal storms or projected sea level rise. Based on recent high-end projections for sea level rise, the city's floodplain could expand to include, for example, more than 88,000 buildings by the 2020s and more than 114,000 buildings by the 2050s.

Potential Loss Estimates

HAZUS-MH flood scenarios were completed using HAZUS-MH v2.1 (with ArcGIS 10.0). The HAZUS-MH flood model provides damage estimates based on the depth of flooding for a given location. It is assumed that damages are a result of standing water (the model does not account for damage that may be inflicted by water moving at high speed). This methodology should not be treated as or confused with a storm surge model.

This analysis focused on the impacts of the 1% annual chance flooding event (a.k.a. the 100-year flood). At the time of the analysis, FEMA was in the process of completing updates to the FIRMs for New York City. Although the new maps were not in effect at the time of publication, FEMA had already produced PWMs, published in May 2013, which contained the best available data to date. In the case of the PWMs, the floodplain consists of flood zones AE, AO and VE.

As with the other hazards modeled, the focus was on damage to buildings (as quantified by building damage counts, damage states, and dollar losses). Damages are categorized by percent of total replacement cost. These determinations are based on the depth of flooding in relation to the height of the first finished floor of a building. The results of the analysis help shed light on the expected distribution and level of losses for different areas. Although building damage

counts may not always reflect exact conditions on the ground, especially when analyzing small areas, percentages of buildings damaged and losses over the entire study area should provide a relatively accurate picture of the level of damage that might be expected to occur.

Overall, 13,341 buildings are in the 100-year floodplain. Slightly less than half of these buildings are predicted to have damage based on the HAZUS-MH output; 2.5% of these buildings are predicted to have significant damage to more than 50% of the structure.

Borough	Percentage of Building Damage							
	None	1–10%	11–20%	21–30%	31–40%	41–50%	>50%	Total
Bronx	529	34	295	316	74	90	24	1,362
Brooklyn	2,280	271	450	271	44	46	11	3,373
Manhattan	211	70	70	111	10	1	4	477
Queens	2,512	346	594	655	181	130	89	4,507
Staten Island	1,961	78	478	497	250	148	210	3,622
Total	7,493	799	1,887	1,850	559	415	338	13,341

Table 11: HAZUS-MH Calculations for Building Damage from a 100-Year Flood

Table 12 and Figure 11 through Figure 15 highlight the key findings from the HAZUS-MH run of a 100-year flood in New York City. A 100-year flood affecting all five boroughs could cause more than $12 billion in damage. More than 60% of the total damage would be to contents such as furniture, supplies, and other possessions.

Borough	Building Damage	Contents Damage	Inventory	Total
Bronx	302,256	439,998	21,455	763,709
Brooklyn	903,775	2,025,808	148,686	3,078,269
Manhattan	1,737,769	2,639,381	49,764	4,426,914
Queens	1,053,671	2,323,539	72,530	3,449,740
Staten Island	224,797	268,275	10,232	503,304
Total	4,222,268	7,697,001	302,667	12,221,936

Table 12: HAZUS-MH Calculations for Capital Stock Losses for a 100-Year Flood

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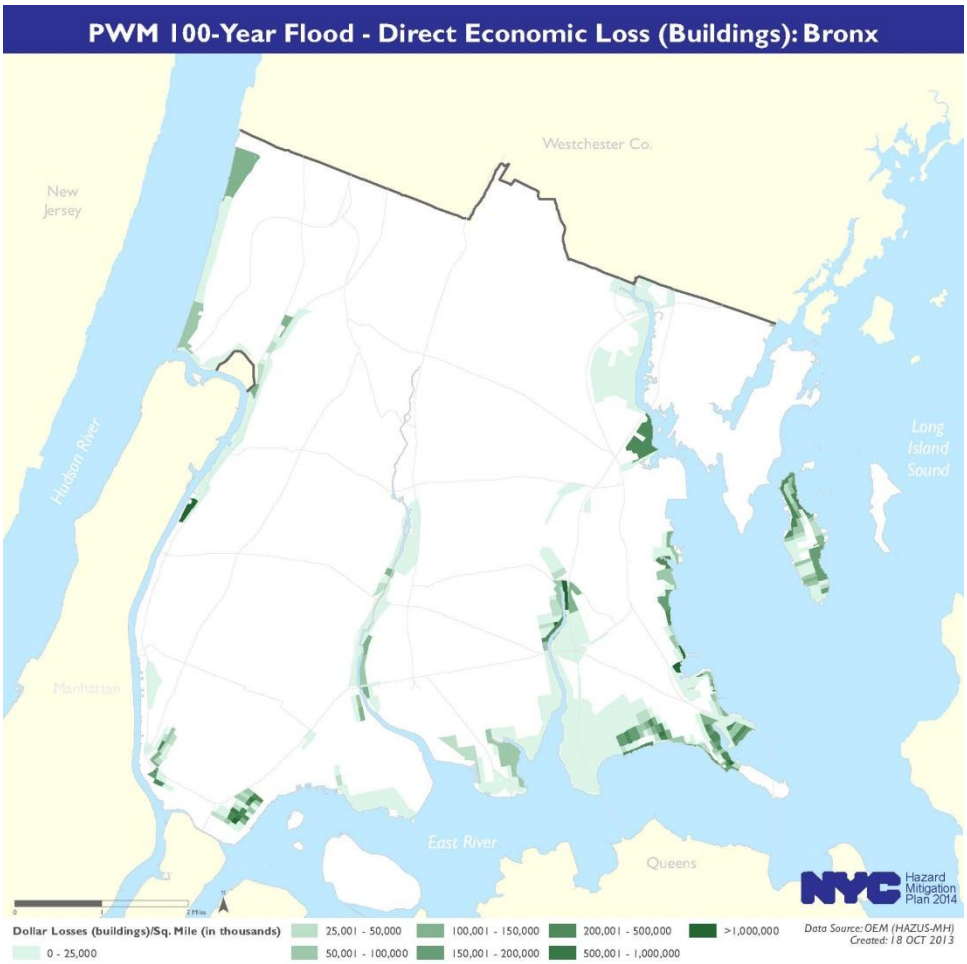

Figure 11: HAZUS-MH Results for Economic Losses from a 100-Year Flood in the Bronx

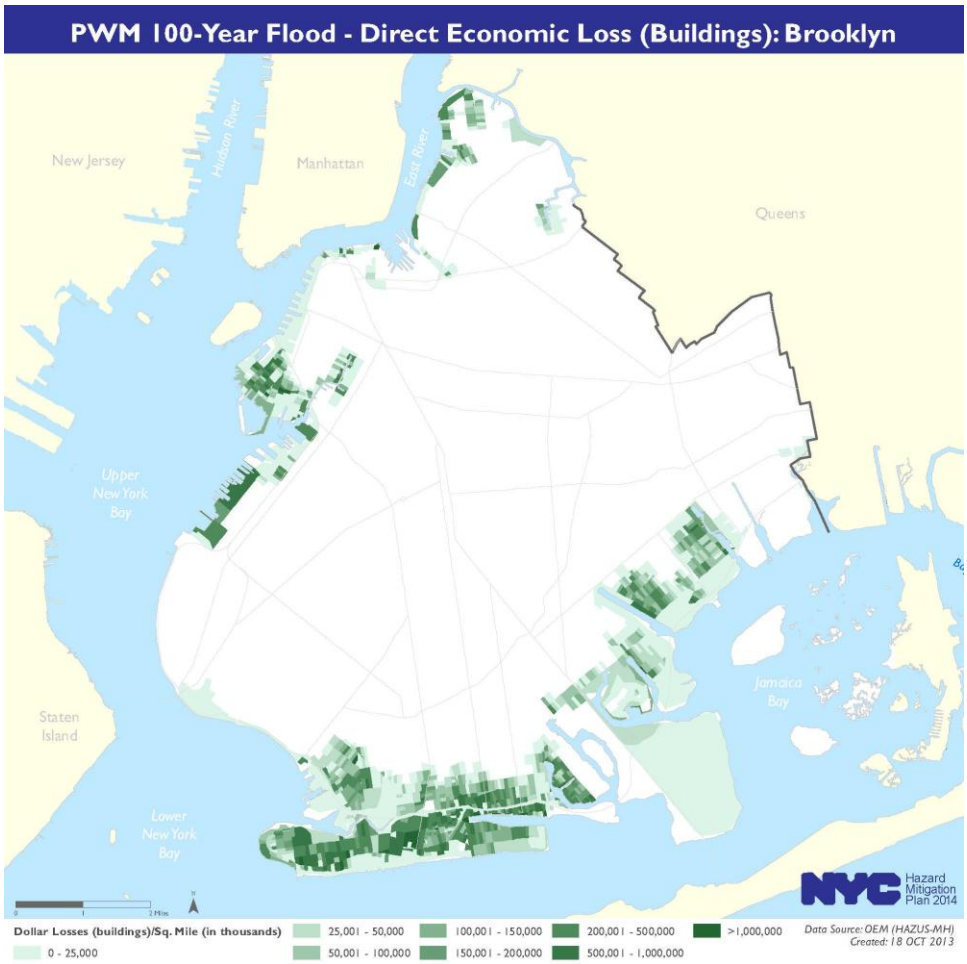

Figure 12: HAZUS-MH Results for Economic Losses from a 100-Year Flood in Brooklyn

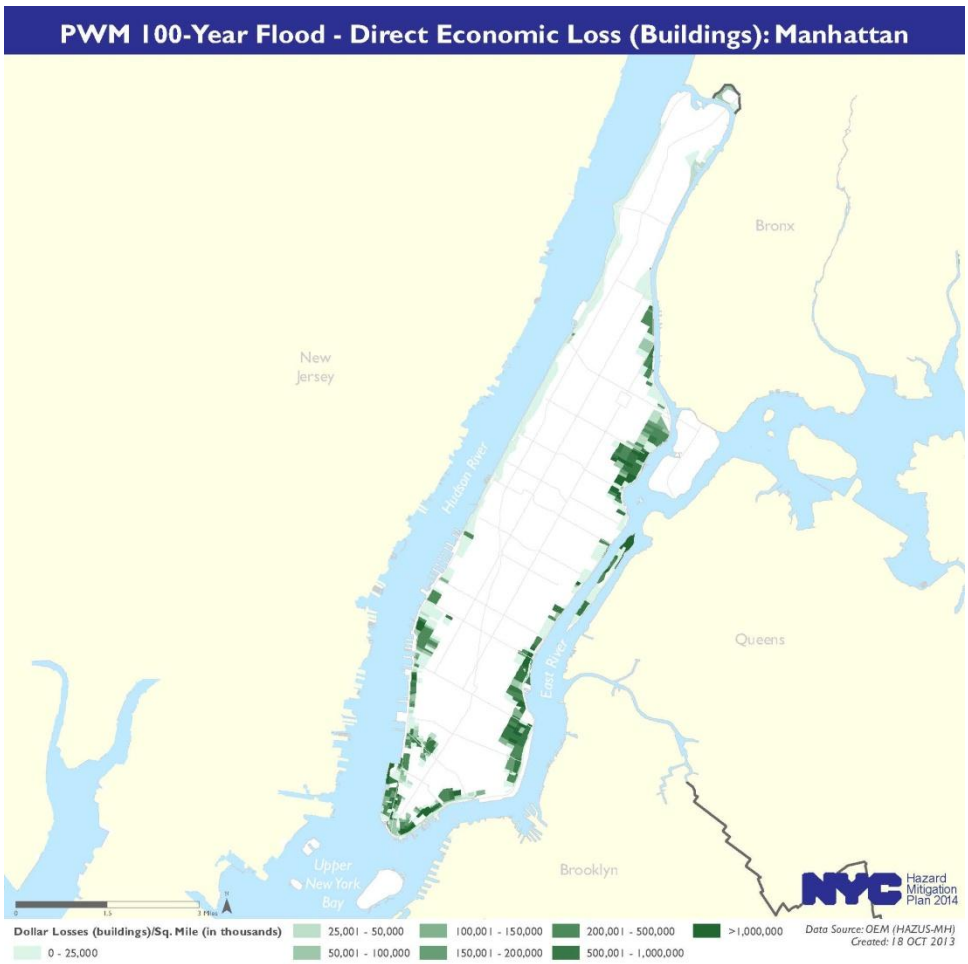

Figure 13: HAZUS-MH Results for Economic Losses from a 100-Year Flood in Manhattan

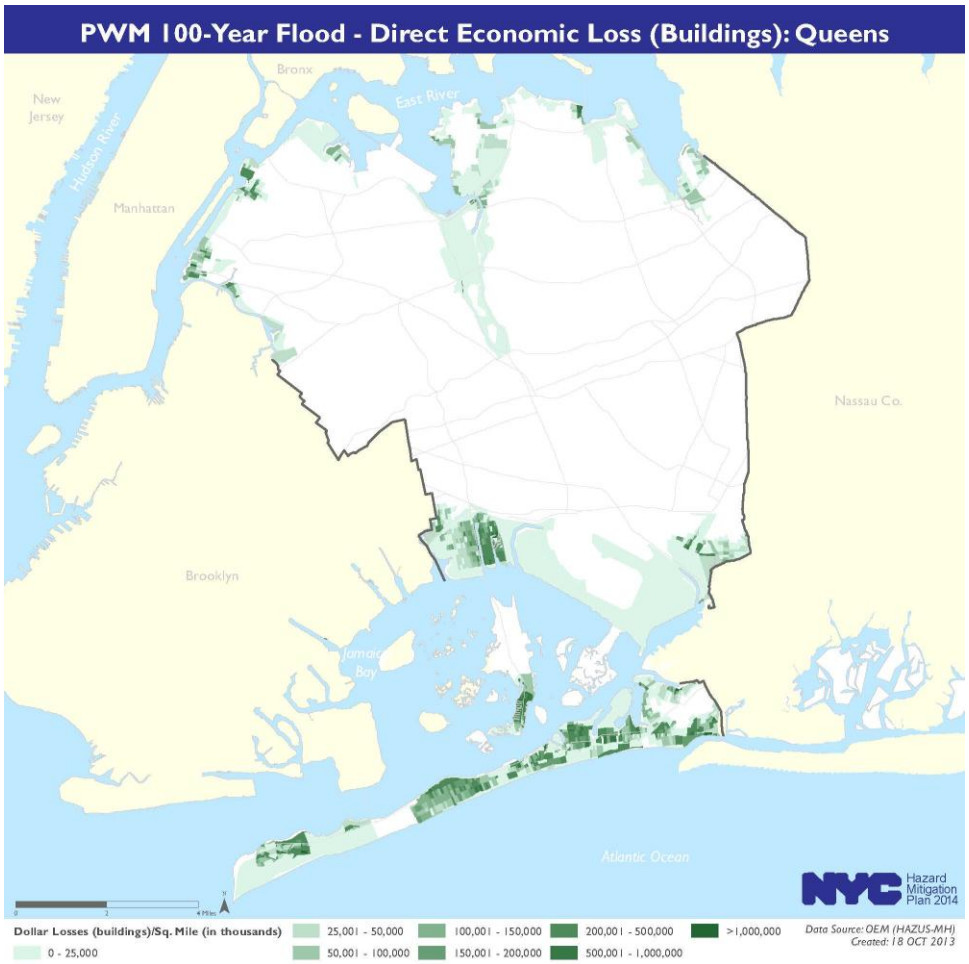

Figure 14: HAZUS-MH Results for Economic Losses from a 100-Year Flood in Queens

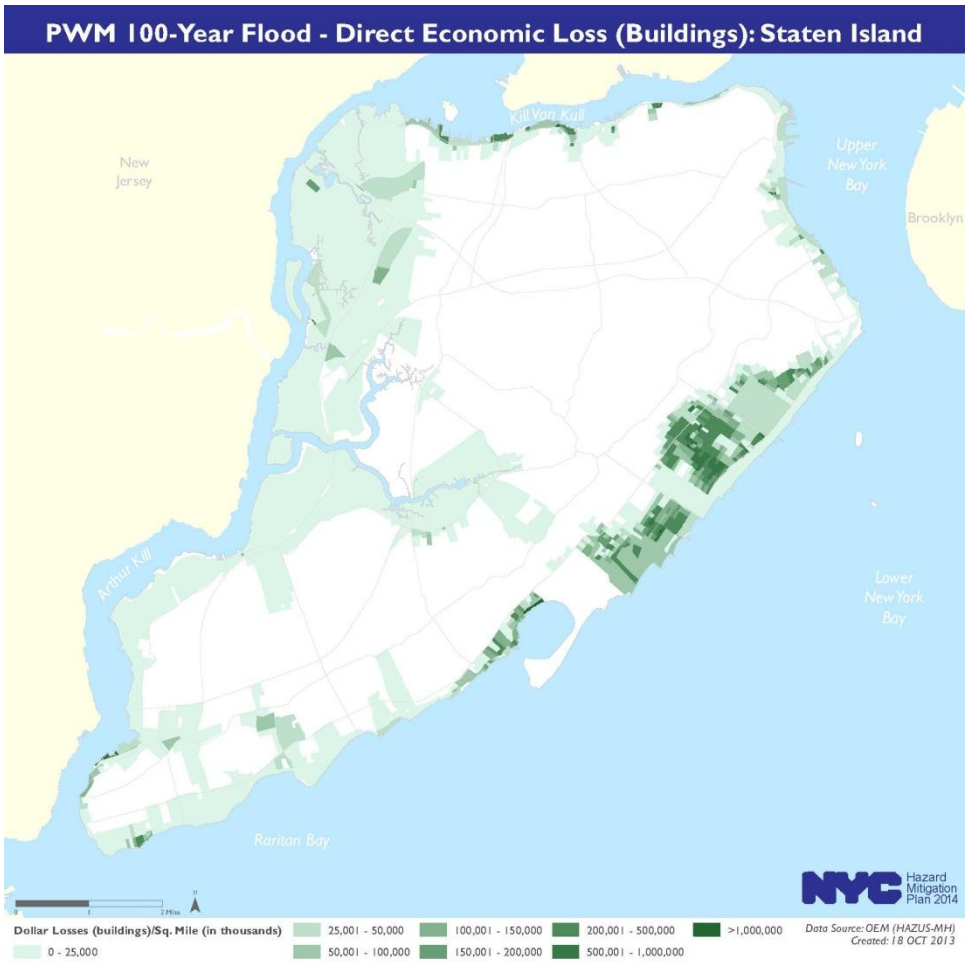

Figure 15: HAZUS-MH Results for Economic Losses from a 100-Year Flood in Staten Island

iii. Natural Environment

New York City's natural areas—its parks, trees, beaches, wetlands, and barrier islands—often act as the first line of defense against flooding. They are also among the city's most vulnerable assets to flooding hazards. According to FEMA's PWMs, more than 5,800 acres of the city's parkland—almost 24% of total parkland—are within the 100-year floodplain.

Some city parkland is composed of natural areas—such as wetlands, meadows, and dunes—that are able to withstand and recover from most storm events without significant repair costs. However, other parkland contains landscaped areas and facilities such as ballfields, recreation centers, pools, plazas, amphitheaters, and paths. Such areas and facilities are, not surprisingly, more vulnerable to structural damage (see Figure 16).

Flooding from coastal storm surge is the most significant risk to the city's parks. This was made evident during Sandy, when 5,700 acres of New York's park system were inundated by floodwaters, causing $800 million in damages.

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

Flooding from storm surge also affected city marinas and piers, including the 79th Street Boat Basin in Manhattan, the World's Fair Marina in Queens, the Sheepshead Bay Piers in Brooklyn, and the Lemon Creek Marina on Staten Island. Docks, pilings, and piers were damaged, and buildings supporting these marinas were inundated, causing damage to equipment and electrical and plumbing systems.

In addition to storm surge, heavy downpours can threaten inland parks, natural areas, and preserves. Flooding resulting from heavy downpours can damage planted areas and surface materials without adequate drainage.

The city's tidal wetlands play a role in protecting against coastal floods, attenuating waves, and detaining some amount of storm surge. In general, wetlands are effective at protecting against smaller levels of storm surge and less significant waves than experienced during Hurricane Sandy. Wetlands also have the added benefit of sheltering a wide variety of plants that protect the quality of waterways by absorbing nutrients and filtering sediment and contaminants. In fact, during Sandy, salt marshes located in Jamaica Bay and its tributary systems remained largely clear of floating debris, with much of their vegetation surviving. Yet they are vulnerable to erosion from both coastal storm surge and intense rainfall events.

According to the New York City Panel on Climate Change (NPCC), sea levels are expected to rise around New York City. By the 2020s, under high-end sea-level-rise projections, 6,600 acres (27%) of the city's parkland could lie in the 100-year floodplain, increasing to over 7,400 acres (or 31%) by the 2050s. Sea level rise could result in a significant loss of tidal wetlands if wetlands do not receive an adequate supply of sediment to keep up with rising tides.

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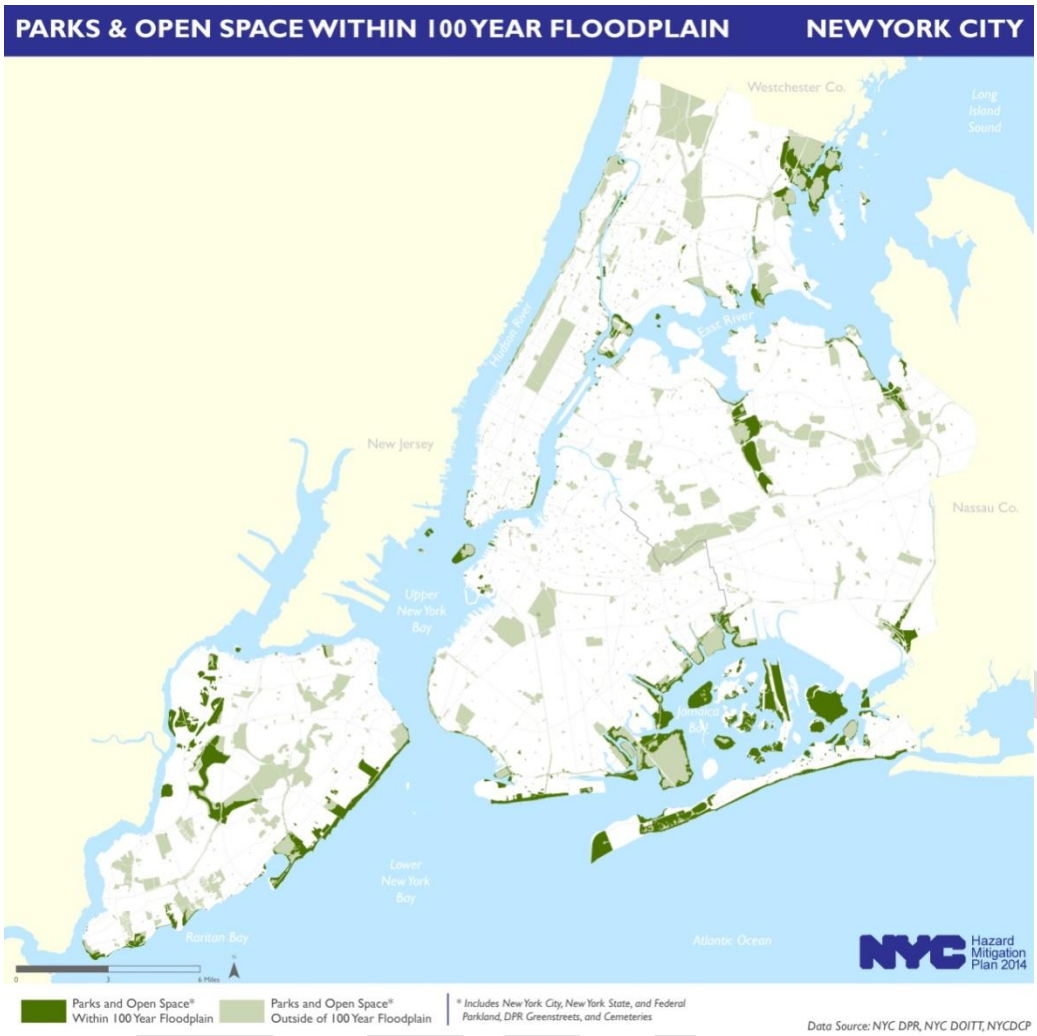

Figure 16: Parks and Open Space in the 100-year Floodplain

	Within Flood Zone	Overall	%
DPR Parks	6,654	28,380	23.4
Greenstreets	26	174	15.1
Schoolyard- playground	3	146	2.3
State Parks	263	752	34.9
Federal	4,225	6,513	64.9
Citywide	11,172	35,966	31.1

Table 13: Parks in the 100-year Floodplain

iv. Future Environment

Climate change is projected to exacerbate flooding hazards in the future. The rise in sea levels will create higher storm surges that will flood larger areas. Some low-lying areas of the city are already subject to coastal flooding at astronomical high tides. These areas will become more vulnerable to regular flooding from daily and monthly high tides. Additionally, changes in storm activity may lead to a greater number of the most intense coastal storms. (For more information on climate projections, see "Future Environment" in Risk Assessment Section 4: New York City's Hazard Environment.)

Sea Level Rise

The NPCC projects that by mid-century, sea levels could rise as much as 2.5 feet especially if the polar ice sheets melt at a more rapid rate than previously anticipated. That magnitude of sea level rise would threaten low-lying communities in New York City with regular and highly disruptive tidal flooding, and make flooding as severe as from today's 100-year storm at the Battery up to five times more likely. The NPCC also predicts that it is more likely than not (more than 50% probable) that there will be an increase in the most intense hurricanes in the North Atlantic Basin.

Sea Level Rise		2020s		2050s	
	Baseline	Middle Range (25th-75th percentile)	High End (90th percentile)	Middle Range (25th-75th percentile)	High End (90th percentile)
	0	+4 to 8 inches	+11 inches	+11 to 24 inches	+31 inches

Table 14: Sea Level Rise in 2020 and 2050

Future Flood Maps

The City worked with the NPCC to develop a series of "future flood maps" for New York that will help guide the city's resiliency and mitigation efforts. These forward-looking maps are created by using a simplified "bathtub model" approach of combining the NPCC's high-end sea level rise projections with FEMA's June 2013 PWMs. The future flood maps illustrate how the 100-year floodplain could increase over the next several decades with high-end projections for sea level rise. Because these maps were not developed using advanced coastal modeling, the accuracy of the flood projections is limited. Although they are not suitable for evaluating risks to individual properties, they are extremely useful for understanding the general extent of future flood risks.

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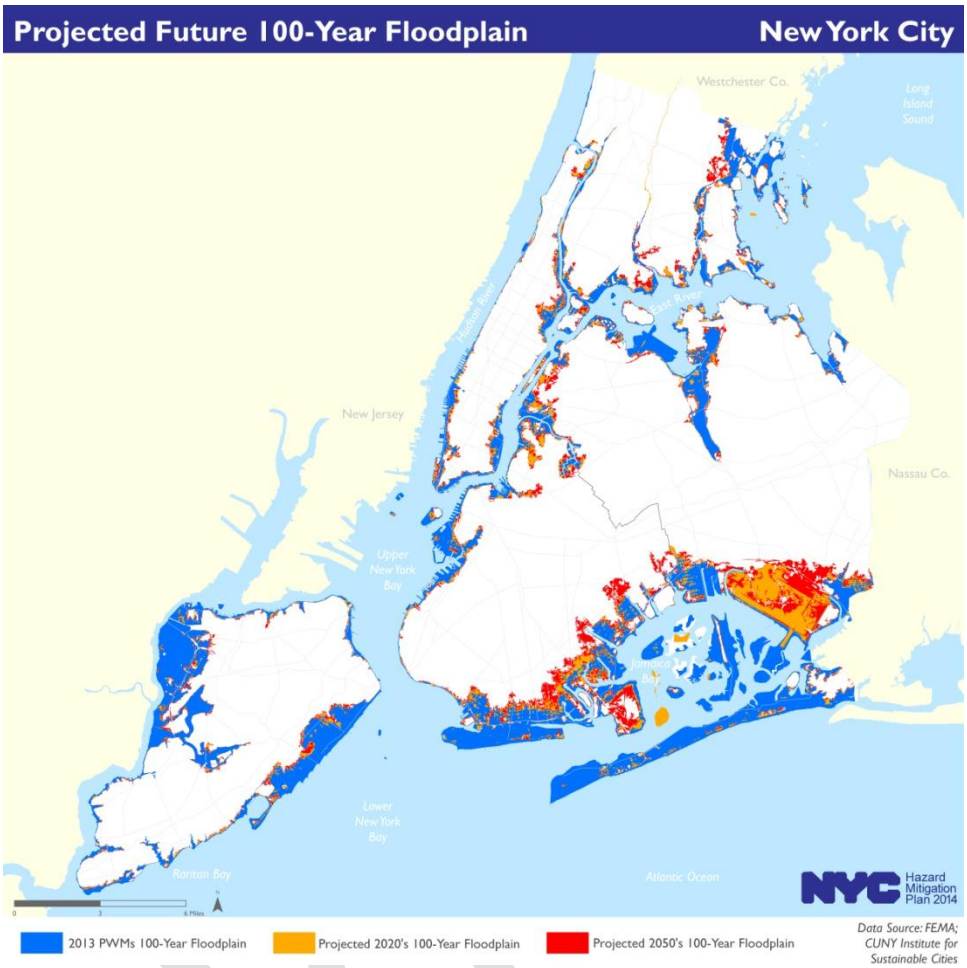

Figure 17: Projected Future 100-Year Floodplain

The future flood maps show that with a rise in sea level by the 2020s the area that could be flooded in a 100-year storm could expand to 59 square miles (up 23% from the PWMs) and encompass approximately 88,000 buildings (up 31%). With more than 2.5 feet of sea level rise by the 2050s, New York City's 100-year floodplain could be 72 square miles—a staggering 24% of the city—an area that today contains approximately 114,000 buildings (almost twice as many as encompassed by the PWMs). This area currently accounts for the infrastructure responsible for 97% of the city's power generation capacity, 20% of its hospital beds, and a large share of its public housing. Over 800,000 New Yorkers, or 10% of the city's current population, now live in the 100-year floodplain projected for the 2050s—a number of flood-vulnerable residents that is greater than the total number of people living in the entire city of Boston.

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A. SUMMARY

Hurricane Sandy, which made landfall on October 29, 2012, was an unprecedented storm in many respects as well as the costliest natural disaster in New York City's history. Much progress has been made to rebuild and restore the City since the storm. However, many of the hardest-hit areas are still in the midst of recovery—a process that will likely continue for years to come. As the recovery continues, the City is also looking to the future and planning ahead to prevent another disaster of this magnitude. Sandy prompted City officials, businesses, academics and residents to think more seriously about and move forward with strategies to protect New York City as it becomes increasingly vulnerable in the face of climate change.

B. STORM CHARACTERISTICS

i. Formation and Evolution

Sandy was first classified as a tropical storm in the central Caribbean on October 22, 2012, strengthening into a hurricane on October 24th before making initial landfalls in Jamaica, eastern Cuba and the Bahamas (see Figure 1). From there, Sandy continued on a northerly path paralleling the Eastern Seaboard of the United States. As Sandy continued to track northward, the weather forecast models came into agreement that the storm would take an unusual westward turn and make landfall in southern New Jersey. To make matters worse, Sandy was interacting with a frontal system which was moving eastward at the time, causing the storm to morph into an incredibly dangerous hurricane/nor'easter hybrid.

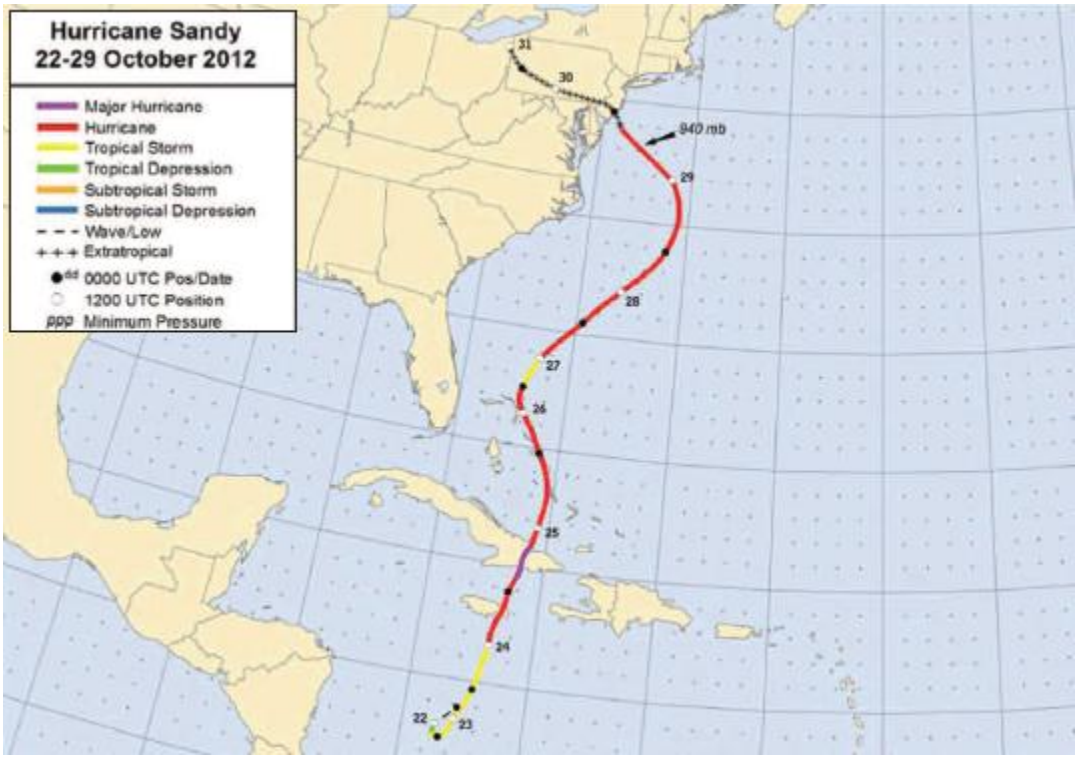

Figure 1: Sandy's Path (source: NOAA).

ii. Unique Characteristics

From a meteorological standpoint, Hurricane Sandy was an anomaly. For one thing, the storm was massive, stretching nearly 1,000 miles across at its peak (see Figure 2). The storm generated waves and storm surge that were significantly larger than would have been expected from a Category 1 storm in select locations; this is because tropical storm-force or higher winds were spread across such a large area. Before Sandy made landfall, its wind field stretched from the Atlantic to as far west as Chicago and produced large waves on the Great Lakes.

Sandy's track was another unusual characteristic. Most storms in the western Atlantic either move east out to sea or move north-northeast, paralleling the east coast of the United States. However, a blocking high pressure system over the northern Atlantic, combined with a pronounced southerly dip in the Jet Stream caused Sandy to make an unprecedented sharp westward turn before it made landfall.

The same weather pattern facilitated the interaction between Hurricane Sandy and the weather system moving eastward, producing a storm with an unusual combination of tropical and non-tropical characteristics. In fact, Sandy marked the first time in recorded history in which snow (experienced in parts of the interior Northeast and Mid-Atlantic) was associated with a tropical cyclone. Just prior to landfall, Sandy's minimum central pressure, another indicator of storm strength, set a record for any east coast storm north of Cape Hatteras, NC at 940 millibars.

Figure 2: Satellite Image Showing Sandy Engulfing Much of the Eastern United States and Southern Canada.

C. PRE-STORM PREPARATIONS IN NEW YORK CITY

When computer forecast models began to suggest a possible landfall in the region, New York City activated its Coastal Storm Plan (for more information, see Mitigation Strategy Section 6: Emergency Planning and Operations). Many pre-storm preparations were related to transportation. Several days before the storm, City agencies fueled vehicles and generators in anticipation of possible fuel shortages. At 7 p.m. on October 28 (the day before the storm), the Metropolitan Transportation Authority (MTA) began a citywide shutdown of buses, subways, and commuter rails (Metro North and Long Island Railroads). At 12 a.m. on October 29, The Port Authority of New York and New Jersey (PANYNJ) suspended all PATH service between New York and New Jersey. The MTA and PANYNJ also closed bridges and tunnels as conditions warranted. Airlines cancelled all scheduled flights into and out of area airports.

At the same time, the City issued mandatory evacuation orders for Zone A (evacuation zones have since been revised; see Risk Assessment Section 6: Coastal Storms), plus the Rockaway Peninsula and Hamilton Beach in Queens and City Island in the Bronx. The Mayor's Office, in coordination the Office of Emergency Management (OEM) and the Department of Homeless Services (DHS), opened emergency shelters throughout the city. The Department of Parks & Recreation (Parks) closed all City parks. All New York City residents who were not evacuated, other than authorized government personnel and essential emergency personnel, were advised to stay home. In anticipation of power outages, utility crews were brought in from other states. Utility providers also erected temporary storm barriers around their facilities.

D. IMPACTS ON NEW YORK CITY

i. Landfall

On October 29, shortly after transitioning from a Category 1 hurricane to an extra-tropical storm, Sandy made landfall near Atlantic City, New Jersey. This was a worst-case scenario storm track for New York City (see “Coastal Storms” Hazard Analysis). Sandy's track, combined with its massive size and coincidence with an astronomical high tide (up to half a foot higher than normal high tide), produced surge that well exceeded what would typically be expected from a Category 1 hurricane. Storm surge reached all-time record levels at various locations throughout New York City, including the Battery in lower Manhattan, which experienced a 9.40 foot storm surge and a 14.06 foot storm tide. Figure 3 shows the extent of the storm surge inundation throughout New York City. In addition to the unprecedented storm surge, massive waves crashed into ocean-facing beaches. One buoy south of New York Harbor measured a wave height of 32.5 feet.

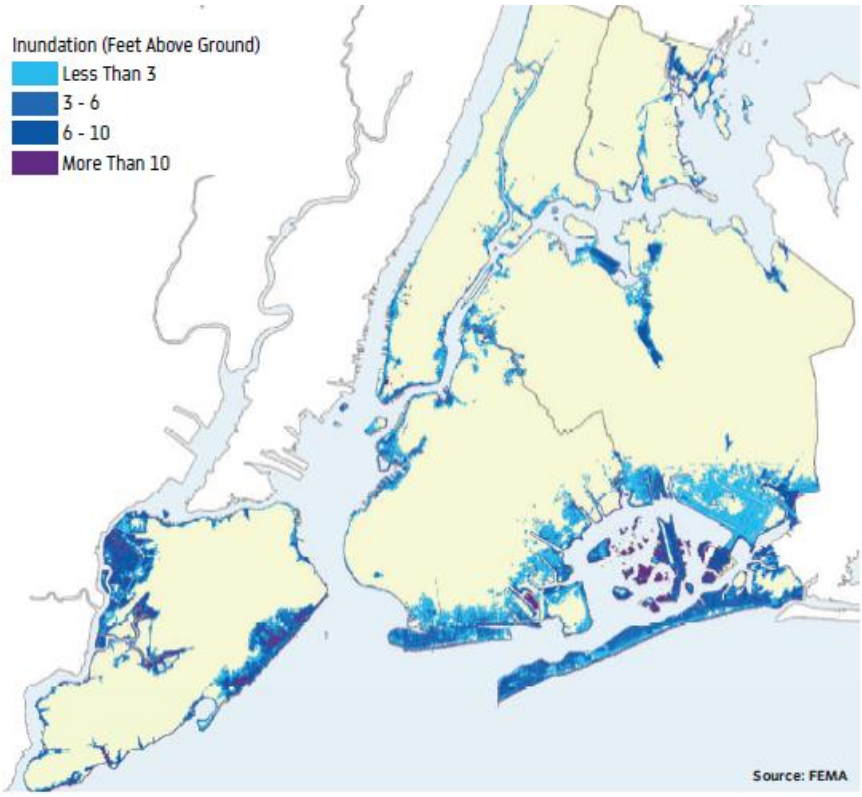

Figure 3: Sandy Storm Surge Inundation in New York City (source: FEMA)

Although Sandy did not produce a significant amount of rain in New York City (less than one inch), the majority of the Tri-State Area experienced repeated wind gusts over 60 mph for at least several hours, including at both LaGuardia and Kennedy Airports. Downed trees and power lines blocked roadways. A number of fires also resulted where saltwater came into contact with electrical wires. One massive fire in the Queens community of Breezy Point destroyed over 100 homes.

ii. Aftermath

When Sandy finally moved out of the area, it left significant damage in its wake. As a result of the storm, there were 44 deaths in New York City (the 44th death was confirmed by the New York City Office of the Chief Medical Examiner – OCME – in June, 2013), 23 of which were in Staten Island and the remainder of which were spread across Queens, Brooklyn and Manhattan. The majority of these deaths were attributed to drowning in areas where storm surge rose rapidly.

In total, Sandy flooded 51 square miles of New York City—17% of the City's total land mass (see Figure 3), and caused approximately $20 billion in damage to the City's building stock and infrastructure. The most affected areas were the eastern and southern shores of Staten Island, the Brooklyn/Queens waterfront, Southern Queens, Southern Brooklyn, and Lower Manhattan.

Various methods have been employed to calculate the amount of building stock and exposed population within the inundation zone, each resulting in slightly different estimates. Depending

on the methodology used for calculation, there are an estimated 70,000 to 90,000 buildings and roughly 450,000 residents within the inundation zone. Approximately 150,000 residents were displaced from their homes and forced to seek temporary housing or immediate home repairs.

Building damage from Sandy was widespread and in many cases severe. As of December 2012, DOB had tagged 800 buildings as being destroyed or structurally unsound, with tens of thousands more suffering at least minor damage. Nearly 70,000 housing units were registered with FEMA as having sustained at least some level of damage. Residents in New York City Housing Authority (NYCHA) developments were hit particularly hard, with roughly 80,000 residents in 423 buildings significantly impacted.

Overall, there were several indicators of how the storm impacted New York City's building stock. Shoreline areas that experienced the force of waves sustained more damage to buildings than areas with still-water flooding only. Other factors related to physical characteristics (such as building height and construction type) as well as age (which defined the regulations in force when the building was constructed) were also important determinants. Overall, older, 1-story, light-frame buildings suffered the most structural damage.

Sandy caused significant damage to the City's critical infrastructure, disrupting services and damaging facilities essential to the well-being of the City's residents. Table 1 displays the number of critical facilities that were inundated during Sandy, categorized by facility type (thus satisfying New York State Hazard Mitigation Planning Requirement No. 2). The City's power distribution systems suffered a particularly heavy blow. Inundation of five Con Edison substations and four LIPA substations, combined with damage to overhead power lines, resulted in the loss of power to nearly two million residents.

ASSET TYPE	IN SANDY INUNDATION AREA	NOT IN SANDY INUNDATION AREA	TOTAL
Airports (perimeter)*	2	0	2
Nursing Homes (FP)	15	158	173
Hospitals (FP)	6	55	61
Police Stations (FP)	2	75	77
Fire Stations (FP)	18	210	228
EMS Stations (FP)	8	71	79
WWTP (FP)	10	4	14
Power Plants (est. FP)	9	17	26
DOE School Sites	77	1213	1290
Private Schools	30	818	848
Colleges	7	116	123
Ferry Landings**	N/A	N/A	47
Subway Station (point)	31	459	490
Rail Station	9	33	42

ASSET TYPE	IN SANDY INUNDATION AREA	NOT IN SANDY INUNDATION AREA	TOTAL
Cultural Facilities (DCP)***	1	36	37
Bus Depots	6	24	30
Bridges****	29	41	70
Tunnels****	3	1	4
Major Roads (mi)****	235	652	887
Total	**497**	**3984**	**4528**
Percentage	**11%**	**88%**	**100%**

DISCLAIMERS:
Note that asset counts are NOT based on facility field reports from the event. Hindcast data may contain inaccuracies. Unless otherwise noted, a facility point was used to do a spatial calculation. This may result in some inaccuracies in Category designation. FEMA MOTF Hindcast data was produced using the SLOSH model. It is the best available data but note that it may not reflect actual ground conditions in all areas. Assets that fall within the Hindcast extent but appear to be the result of DEM (terrain data) anomalies were excluded from the inundation area. Where possible, facility footprints were used for the analysis. When this data was not available, point locations were used. May not always reflect actual conditions on the ground. Asset types with "FP" indicate that the actual facility footprint was used in the calculation (for power plants FPs were estimated).
*Hindcast data shows inundation for both LGA & JFK but field reports indicated only LGA was definitively impacted by surge
**Active NYC commuter/commercial/recreational ferry landings only (includes Ellis & Liberty Island). Hindcast data clipped to shoreline - cannot accurately determine impact to ferry landings.
***Determination made by OEM/DCP on which assets to include
****Estimated only. Based on visual review of bridge/tunnel segments with ortho photo. Considered not in a zone if all New York City approaches are fully clear of inundation.

Table 1: Critical Assets in Sandy Inundation Zone (Source: OEM; Analysis based on FEMA MOTF Hindcast data).

The City's transportation infrastructure was severely impacted by Sandy (see Figure 4). The Metropolitan Transportation Authority (MTA) suffered an estimated $5 billion in damage, half of which was attributed to the inundation of subway and commuter rail tunnels, including seven subway tunnels and two LIRR tunnels beneath the East River which needed to be pumped. Significant flooding also occurred in the PATH train and Amtrak tunnels beneath the Hudson River connecting Manhattan and New Jersey. Corrosion from saltwater flooding caused severe damage to the electrical equipment at the South Ferry subway station (Subway service has since been restored to the old South Ferry station, but the new station remains closed indefinitely due to damage sustained during the storm). Additionally, one subway bridge, three subway yards, and six city bus facilities were flooded.

More than 500 miles of roads suffered significant damage. Roads were littered with trees and debris, and the Brooklyn-Battery and Queens-Midtown passenger car tunnels were inundated by storm surge. While subway service was out—it took days to restore—there was gridlock on city roads and bridges.

Both LaGuardia and Kennedy Airports remained closed for days after the storm (although field reports indicated that only LaGuardia was definitively inundated by storm surge). Over 12,000 flights scheduled into and out of the three New York City area airports were cancelled.

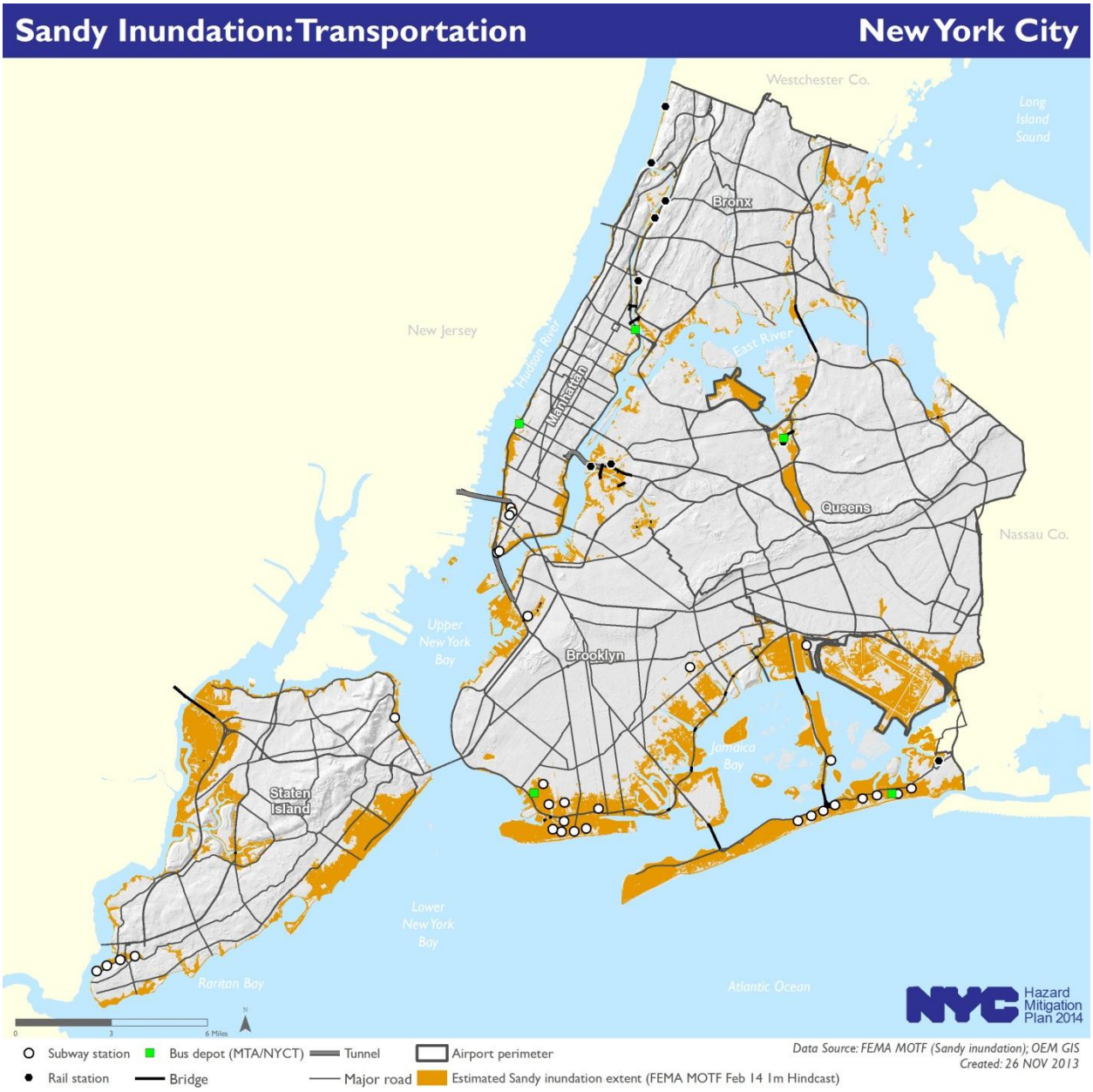

Figure 4: Transportation Infrastructure Inundated During Sandy.

Sandy also severely impacted the City's supply of liquid fuels. The storm shut down refineries for several weeks, stopped marine and pipeline deliveries for three to four days, and damaged storage terminals. For four days after the storm, the system received no new supply, and for almost a month after that, supply was limited. As a result, many gas stations closed, and many of the ones that remained open had significant fuel shortages.

Sandy placed a significant strain on the City's healthcare system (see Figure 5). In total, six hospitals were forced to close, which required City and State health officials to coordinate the evacuation of nearly 2,000 patients. Sandy also forced the closure or partial closure of 31 nursing homes and adult care facilities, from which 4,500 additional patients required evacuation. Many of these facilities were forced to close due to flood damage to the backup power generators.

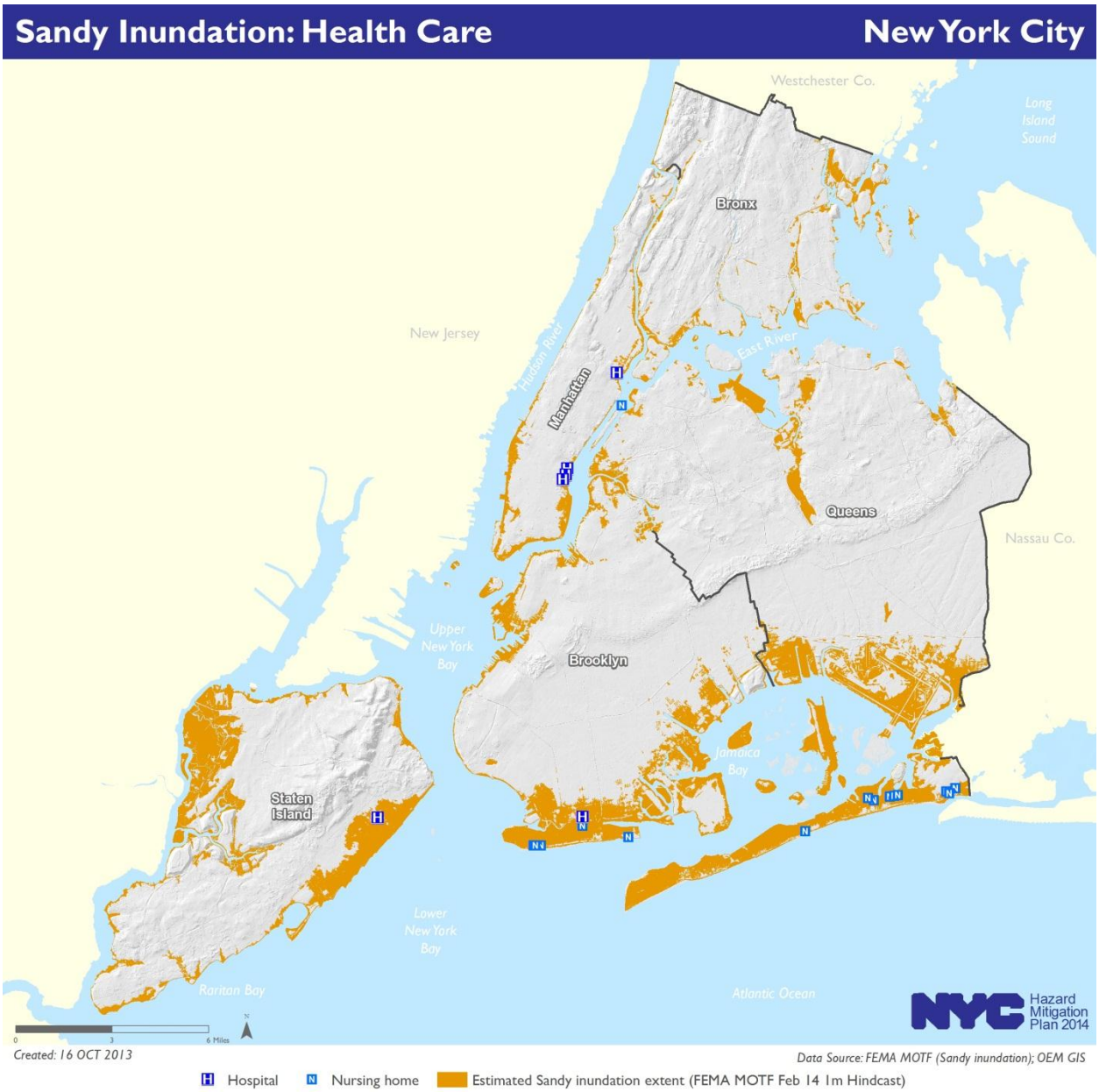

Figure 5: Healthcare Facilities Inundated During Sandy.

The City's telecommunications system also experienced significant outages during Sandy. Short-term outages to wireless and cell service generally occurred as a direct result of power loss, while flood damage at critical facilities—in Lower Manhattan, Red Hook in Brooklyn, and the

Rockaway Peninsula in Queens—disrupted landline and Internet service for up to 11 days. Flood damage to building telecommunications equipment caused even longer outages in some coastal areas.

Damage to City schools resulted in over one million children being unable to attend school for at least a week. Some schools which suffered severe damage were forced to close for the remainder of the year (see Figure 6).

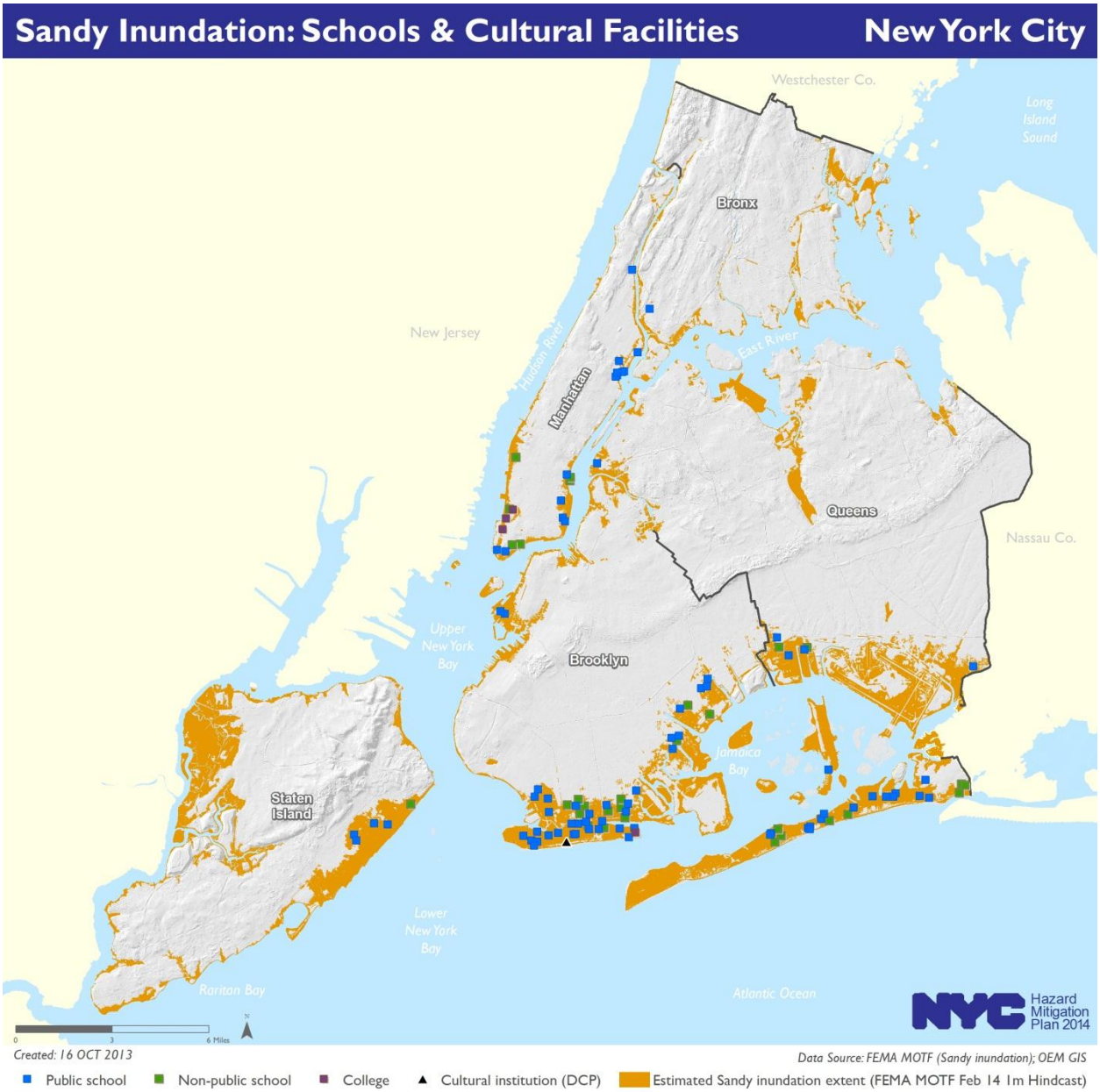

Figure 6: Schools and Cultural Facilities Inundated during Sandy.

Sandy also had a significant impact on the environment and on recreational areas. When storm surge inundated wastewater treatment plants it caused 10 of the 14 plants operated by the

Department of Environmental Protection (DEP) to release untreated or partially treated sewage into local waterways. Due to loss of power, 42 of the 96 pumping stations, which facilitate the movement of combined sewage through the system, were temporarily out of service. The city's stormwater and combined sewer systems were simply unable to handle the unprecedented volume of storm surge.

City parks and natural areas remained closed or inaccessible for several days after the storm as crews worked to remove downed trees and debris. City beaches suffered severe damage and erosion from storm surge and battering waves, including nearly three miles of boardwalk on the Rockaway Peninsula. Storm surge also inundated and damaged coastal wetland ecosystems.

Loss Estimates

Loss estimates from Sandy were calculated using the same HAZUS-MH methodology as was used for flooding (see Built Environment section of Flooding Hazard Analysis) over the Sandy storm surge inundation zone, provided by FEMA MOTF. This hazard boundary was used to produce a depth grid to perform a HAZUS-MH coastal flood analysis. Note that this is not a true storm surge model as it does not account for the impacts of fast-moving surge. Over 50% of all buildings within the Sandy storm surge inundation zone were flooded (Table 2), amounting to roughly $20 billion in total damages (Table 3).

Borough	% of Buildings Damaged
Bronx	41
Kings	42
New York	39
Queens	54
Richmond	73
City Total	**53**

Table 2: Percentage of buildings in Sandy inundation zone damaged due to flooding, by borough.

Borough	Capital Stock Loss ($)	Income Loss ($)	Total Loss ($)
Bronx	405,881,000	2,533,000	408,414,000
Kings	5,123,469,000	62,542,000	5,186,011,000
New York	7,006,110,000	70,448,000	7,076,558,000
Queens	5,238,726,000	87,869,000	5,326,595,000
Richmond	1,998,276,000	10,594,000	2,008,870,000
City Total	**19,772,462,000**	**233,986,000**	**20,006,448,000**

Table 3: Direct economic losses due to flooding from Sandy, by borough.

E. POST-STORM RECOVERY

Although it will likely take years for New York City to fully recover from Sandy, much progress has already been made. In the days and weeks following the storm, roads were reopened, flooded tunnels were de-watered, public transportation resumed, power was restored, and the

airports gradually returned to normal flight schedules. One week after Sandy struck, many subway lines were fully or partially restored, but some elements of the system remained closed for a longer period, with repairs projected to take months or even years. However, the opening of A train service to Broad Channel and the Rockaway Peninsula in May 2013 shows the strong commitment of the City's transportation agencies to the restoration of service as quickly as possible.

In the months following Sandy, thousands of City employees and service volunteers worked tirelessly to clear 700,000 tons of debris and rebuild neighborhoods. Relief money, food, and supplies were brought in to help the hardest-hit communities. The Mayor's Office of Housing and Recovery Operations (HRO) was established to rebuild and repair homes and return displaced residents to safe and sustainable housing. The City worked with FEMA to create and implement the federal Sheltering and Temporary Essential Power (STEP) program as NYC Rapid Repairs, a free program to restore power, heat, and hot water to private homes. When the program concluded in April 2013, it had repaired approximately 11,500 homes representing more than 20,000 units. Many of the residents displaced by Sandy have since returned to their homes.

HRO also developed loan and grant programs to help businesses clean up and reopen. By mid-March 2013, 82% of the 11,295 businesses that were inundated had reopened. Additionally, the City has been working with the United States Army Corps of Engineers (USACE) to restore miles of damaged or eroded beach, boardwalk, and waterfront. This work has been occurring in areas including the Rockaway Peninsula, Coney Island, and the southern shore of Staten Island. Many beaches in these areas were open for business again during the summer of 2013.

In January 2013, President Obama signed the Disaster Relief Appropriations Act of 2013, which provides $15.1 billion in Community Development Block Grant Disaster Recovery (CDBG-DR) funds to repair and restore areas affected by Sandy. New York City has received two allocations of funding of CDBG-DR funding: $1.77 billion from the first round of CDBG-DR grants and $1.447 billion from the second round of CDBG-DR grants. HUD has approved the City's action plan for the first round of funding and the City is moving forward with using these funds for rebuilding and recovery-based housing programs, business programs, infrastructure, resiliency programs, and citywide administration and planning. The City is in the process of updating this action plan to reflect the additional funding received from the second round of CDBG-DR funding.

After Sandy, FEMA issued interim mapping and elevation products to provide New Yorkers a better understanding of flood risks since the current Flood Insurance Rate Maps (FIRMs) were out of date. This included the Advisory Base Flood Elevations (ABFEs) and Preliminary Work Maps (PWMs). The City has also since revised its hurricane evacuation zones to take into account different characteristics of storms (see Coastal Storms Hazard Analysis).

A number of citywide and community-level resiliency initiatives have come about in the wake of Sandy. The most comprehensive of these is the Special Initiative for Rebuilding and Resiliency (SIRR), initiated by Mayor Bloomberg in December 2012 to explore what happened during

Sandy and how to prepare for and protect New York City from the impacts of climate change. The most significant accomplishment of this initiative was a report released in June 2013 entitled "A Stronger, More Resilient New York", a comprehensive plan with actionable recommendations for rebuilding the communities impacted by Sandy and increasing the resiliency of buildings and infrastructure citywide. The report includes community rebuilding and resiliency plans for the areas most affected by Sandy: the Brooklyn-Queens waterfront, the East and South Shores of Staten Island, southern Queens, southern Brooklyn, and southern Manhattan. Many of the actions incorporated in the Hazard Mitigation Plan are from this report.

Additional city resiliency actions are included in the Hurricane Sandy After Action Report to Mayor Bloomberg, with recommendations on how the City's response capacity and performance can be strengthened in the future. In collaboration with SIRR, the City also reconvened the New York City Panel on Climate Change (NPCC), a team of climate science experts who make climate projections for New York City and offer recommendations for how the city can adapt to a changing climate. The NPCC released its second report in June 2013, coinciding with the release of the A Stronger, More Resilient New York report.

F. LESSONS LEARNED

Prior to Sandy, New York City's vulnerability to hurricanes and climate change had been well established, but few people anticipated the devastation that such a coastal storm could bring. Moreover, although New York City had already been factoring climate change into its planning, and undertaking resiliency initiatives, Sandy revealed that these efforts should be expanded and accelerated. Although a direct link between Sandy and climate change cannot be proven, sea level rise will continue to exacerbate the impacts of storm surge in the future.

A number of city needs that Sandy brought to light are outlined in the Hurricane Sandy After Action report, which groups its recommendations according to seven themes:

I. Improved evacuation, including updated evacuation zones and better, clearer communication to help New Yorkers understand how to protect themselves from the risk of severe weather.
II. Improved accessibility of all coastal storm-related information and services to make them available to all New Yorkers, including persons with disabilities or special medical needs, homebound populations, non-English speakers, and undocumented immigrants.
III. Better integration of the City's data across platforms and agencies to increase situational awareness and allow more targeted, efficient response and recovery operations.
IV. Additional capacity to respond to large-scale building inundation and loss of power, including pre-storm identification of the equipment and skilled resources likely to be needed for building restoration and better coordination with private building owners.

V. Better coordination of relief to affected areas and to vulnerable or homebound populations, including more efficient deployment of volunteers and donations to residents and business owners.
VI. The development of a mid- to long-term housing plan for New Yorkers displaced by damage from coastal storms.
VII. Partnership with the federal and state authorities that regulate and enforce standards for private companies and utilities that provide essential services to New York City residents.

The Analysis of Sandy's impacts emphasized the need for updated FEMA flood zones and new hurricane evacuation zones. Sandy also underlined the need to rethink how to build or rebuild in vulnerable coastal areas by promoting more flood -resistant building designs and encouraging land uses that can accommodate periodic flooding. The importance of accurate weather and climate forecasting and warnings was another lesson to come out of the City's experience with Sandy. Along with this comes the need to improve coordination amongst weather experts, emergency management officials, and the general public.

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A. HAZARD PROFILE

i. Hazard Description

Severe thunderstorms, tornadoes, and windstorms are what are known as severe weather, and these weather events can pose serious risks in New York City.

Severe Thunderstorms

Thunderstorms are caused by a combination of moisture, unstable air, and lift caused by cold or warm fronts moving into the area. Non-severe thunderstorms produce lightning, rain, small hail, and winds less than 58 mph. According to the National Weather Service (NWS), the national average size of a thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Thunderstorms are normally localized events.

About 10% of thunderstorms are classified as severe. Severe thunderstorms consist of winds measuring 58 mph or higher, flash flooding, lightning, and, sometimes, hail measuring at least 0.75 inches in diameter. Lightning always occurs during thunderstorms, and thus is not a criterion for determining the severity of the storm.

Hailstones are falling particles of ice. Hail develops as warm, moist air rises in the upper atmosphere and then cools. As the air cools below the freezing point, water vapor condenses into ice crystals. These ice crystals remain suspended by high-velocity updraft winds, grow larger, and eventually fall to the ground as hail. The size of hail is usually determined by the severity of the storm but typically ranges from 0.20 inches to 4.5 inches in diameter.

The NWS issues a Severe Thunderstorm Watch when severe thunderstorms are possible over a large area, in some cases several states. A Severe Thunderstorm Warning is issued when a severe thunderstorm is occurring or expected to occur within a matter of minutes.

Severe thunderstorms and hail pose serious threats to human life and property in New York City. Between 1959 and 2002, 132 people died in New York State after being struck by lightning. Severe storms can also leave broken tree limbs, downed power lines, and other debris, which may lead to power outages, transportation disruptions, and damage to buildings and vehicles.

Tornadoes

Thunderstorms can also create a favorable environment for tornadoes, which are violent rotating columns of air with winds up to 300 miles per hour. These short-lived storms generally appear as funnel-shaped clouds, gray to black in color, extending toward the ground from the base of a thundercloud. Tornadoes actually begin as transparent—and it is at this time that they are especially dangerous because they cannot easily be seen; as they pick up debris and dust, they acquire their grayish coloration. Most tornadoes move southwest to northeast at an average forward speed of 30 mph, but tornadoes can move in any direction and may vary from stationary to 70 mph. Tornadoes are most frequent east of the Rocky Mountains during spring and summer between 3 PM and 9 PM. They may also accompany hurricanes (see Coastal Storms Hazard Analysis). Tornadoes are the most violent of all atmospheric phenomena and,

over a small area, the most destructive—they can uproot trees and buildings and turn harmless objects into deadly missiles in a matter of seconds. Their damage paths can exceed one mile in width and 50 miles in length. Each year there are an average of 1,200 tornadoes nationwide, causing 60 to 65 fatalities and 1,500 injuries.

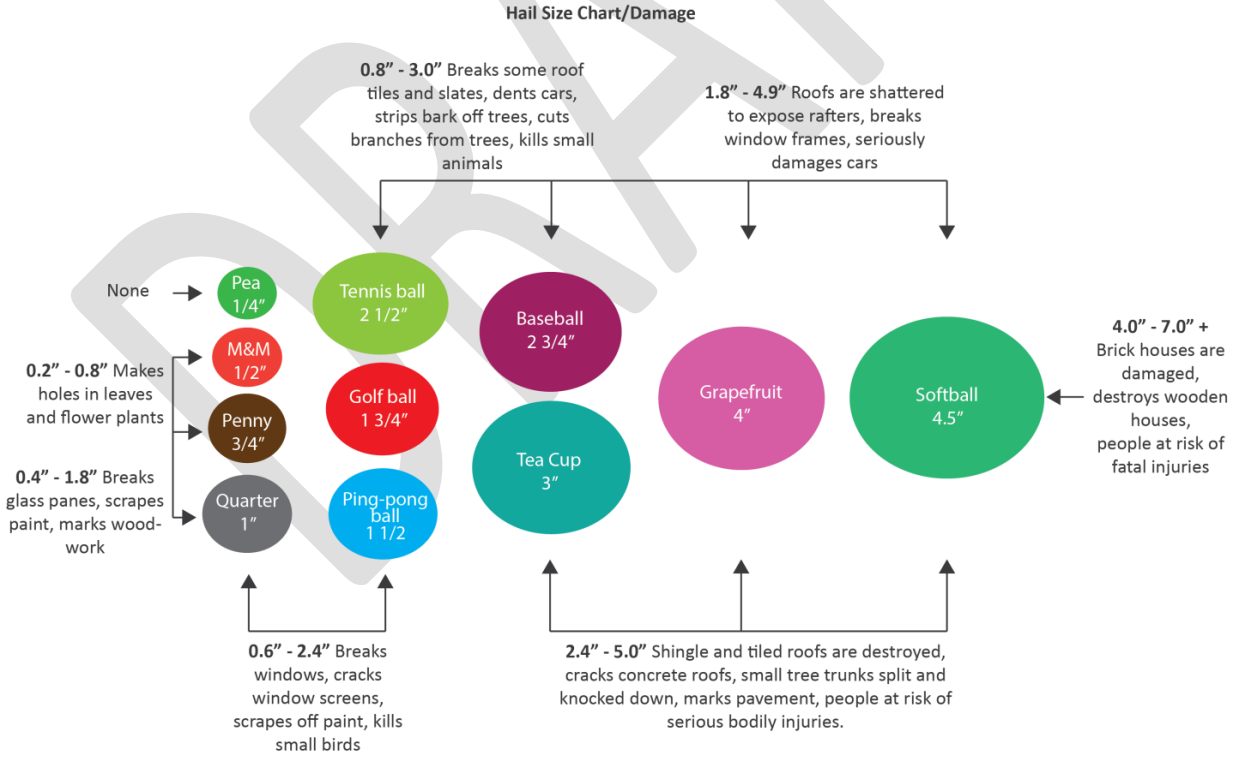
Windstorms

High-wind events are often associated with other storms, such as hurricanes or nor'easters (see Coastal Storms Hazard Analysis), but may occur independently. High winds can cause downed trees and power lines, flying debris, and building collapses—all of which may lead to power outages, transportation disruptions, damage to buildings and vehicles, injury and death. Flying debris is the primary cause of damage during a windstorm. While a building may remain generally structurally sound, broken glass from windows can cause injuries inside and outside the building and extensive damage to building contents.

ii. Severity

Severe Thunderstorms

A thunderstorm is considered severe if it produces wind gusts of at least 58 mph and/or large hail of at least 1 inch in diameter. Severe thunderstorms can also produce tornadoes. Generally the size of hailstones is correlated with the severity of the thunderstorm. As shown below in Figure 1, hailstones vary widely in scale.



Source: Burt, Christopher C. *Extreme Weather: A Guide and Record Book Climate Change Edition.* W.W.Norton & Company Inc. New York (2007).

Figure 1: Hail Size and Related Damages

Tornadoes

The Fujita Scale (F-Scale) is the standard measurement for rating the strength of a tornado. The NWS has used this scale and an analysis of damage after a tornado to infer wind speeds. On February 1, 2007, the NWS transitioned from the F-Scale to the Enhanced Fujita Scale (EF-Scale). The EF-Scale is considerably more complex and enables surveyors to assess tornado severity with greater precision. Table 1 compares the F-Scale and EF-Scale.

F - Scale	3 -sec. gust speed (mph)	EF - Scale	3 -sec. gust speed (mph)	TYPICAL DAMAGE
F0	45 -78	EF0	65-85	Light damage. Some damage to chimneys. Branches broken off trees. Shallow-rooted trees pushed over, signboards damaged.
F1	79-117	EF1	86-109	Moderate damage. Peels surface off roofs. Mobile homes pushed off foundations or overturned. Moving autos blown off roads.
F2	118-161	EF2	110-137	Considerable damage. Roofs torn off frame houses. Mobile homes demolished. Boxcars overturned. Large trees snapped or uprooted. Light-object missiles generated. Cars lifted off ground.
F3	162-209	EF3	138-167	Severe damage. Roofs and some walls from off well-constructed houses. Trains overturned. Most trees in forest uprooted. Heavy cars lifted off the ground and thrown.
F4	210-261	EF4	168-199	Devastating damage. Well-constructed houses leveled. Structures with weak foundations blown away some distance. Cars thrown and large missiles generated.
F5	262-317	EF5	200-234	Incredible damage. Strong frame houses leveled off foundations and swept away. Automobile-sized missiles fly through the air in excess of 100 meters (109 yards). Trees debarked. Incredible phenomena will occur.

Table 1: Comparison of Fujita and Enhanced Fujita Scales

Windstorms

The Beaufort Wind Scale, shown below, aids in the estimation of wind speed and corresponding typical effects.

Wind Speed (mph)	Name	Damage
25–31	Strong breeze	Large branches in motion; whistling in telephone wires; umbrellas used with difficulty
32–38	Near gale	Whole trees in motion; resistance felt while walking against the wind
39–46	Gale	Twigs break off trees; wind impedes walking
47–54	Strong gale	Slight structural damage to chimneys and slate roofs

Wind Speed (mph)	Name	Damage
55–63	Storm	Seldom felt inland; trees uprooted; considerable structural damage
64–72	Violent storm	Very rarely experienced; widespread structural damage; roofing peels off buildings; windows broken; mobile homes overturned
73+	Hurricane	Widespread structural damage; roofs torn off homes; weak buildings and mobile homes destroyed; large trees uprooted

Table 2: Beaufort Wind Scale

iii. Probability

Severe weather is a common occurrence in New York City, making it a highly probable hazard. Based on the frequency of past occurrences of severe weather, it is very likely that New York City will continue to experience these types of events.

Severe Thunderstorms

Non-severe thunderstorms occur on 25-30 days annually across New York City, whereas severe thunderstorms occur much less frequently, but at least a few times each year across the city. Based on the annual frequency of past severe thunderstorms in New York City, the probability of at least one of the criteria for severe storms being met (usually winds) is high and happens multiple times on a local scale each year, whereas the recurrence interval for tornadoes and large hail is much lower.

From 1974 to 2013, there have been 16 major occurrences of severe thunderstorms and hail, and eight of these storms have been citywide events. Although hail doesn't always occur during thunderstorms, all eight of the citywide events produced hailstones, which ranged from 0.75 inches to 1.75 inches in diameter. From 1974 to 2013, there were 14 occurrences of severe hail (equal or greater than 3/4 inch) in New York City.

Tornadoes

Although not as common as severe thunderstorms, tornadoes are still probable for the future. Over the past 28 years, 13 tornadoes have hit New York City, 11 of which were scaled F0 or F1. In the past six years, tornado activity has increased in New York City. There have been seven tornadoes (counting all tornados for events with multiple tornadoes) since 2007, compared to five tornadoes over the 18-year period beginning in 1985 (the first recorded occurrence of a tornado in New York City).

Windstorms

From 1974 to 2013, there have been 31 documented windstorms with gusts above 40 mph in New York City. During this same period, there have been 14 major windstorms with wind gusts ranging from 50 to 90 mph. Based on the historic occurrences, New York City experiences a high-wind event at least once a year.

iv. Location

Based on historic occurrences, severe weather has an equal probability of occurrence city-wide.

Thunderstorms and Hail

Although thunderstorms occur throughout New York City, they don't necessarily affect all five boroughs at the same time or with the same severity. The Bronx has experienced the most severe thunderstorms, with five occurrences and hailstones ranging from 0.75 inches to 1.0 inches. Four major severe thunderstorms have occurred in Queens, producing hailstones of 0.75 inch to 2.75 inches in diameter. Brooklyn experienced two major storms that produced hailstones ranging from 0.75 inch to 1 inch, while Staten Island experienced one major thunderstorm with 0.75-inch hailstones.

Tornadoes

A common misconception is that tornadoes do not occur in dense urban areas such as New York City; however, tornadoes have occurred in all five boroughs. Scientists caution that though rare, a tornado is possible anywhere in the City. Figure 2 shows the locations of previous tornadoes in New York City.

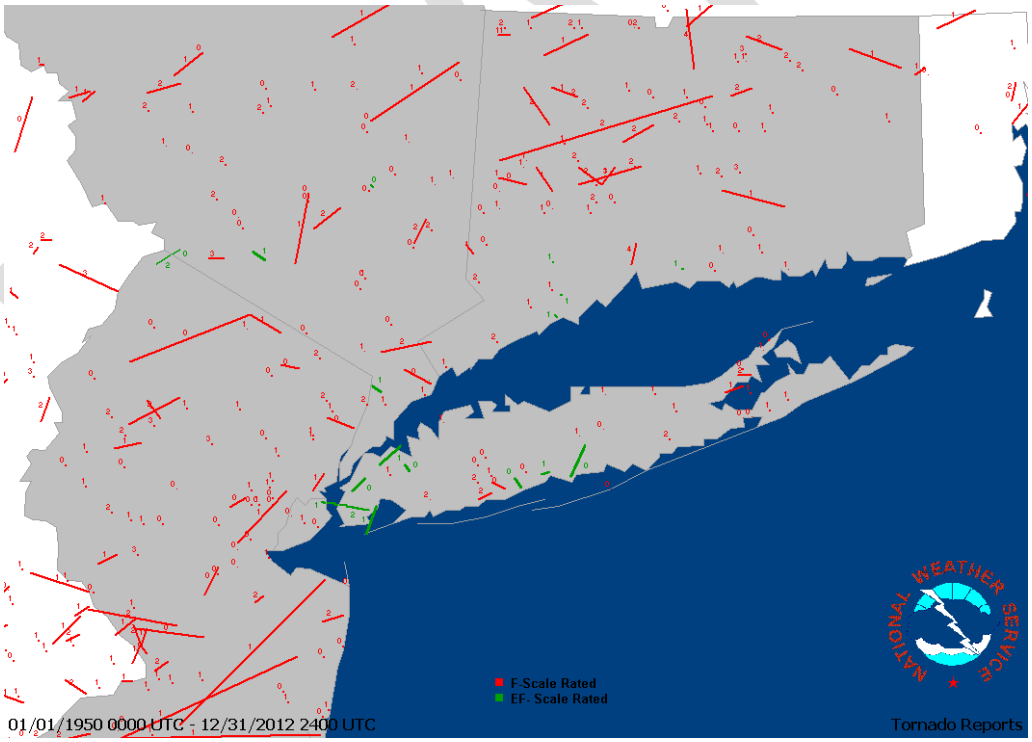


Figure 2: Tri-State Tornado Climatology 1950 – 2012

Windstorms

Windstorms occur in all five boroughs of New York City. Figure 3 and Figure 4 below show wind zones throughout the United States and New York State. These wind zones portray the frequency and strength of extreme windstorms.

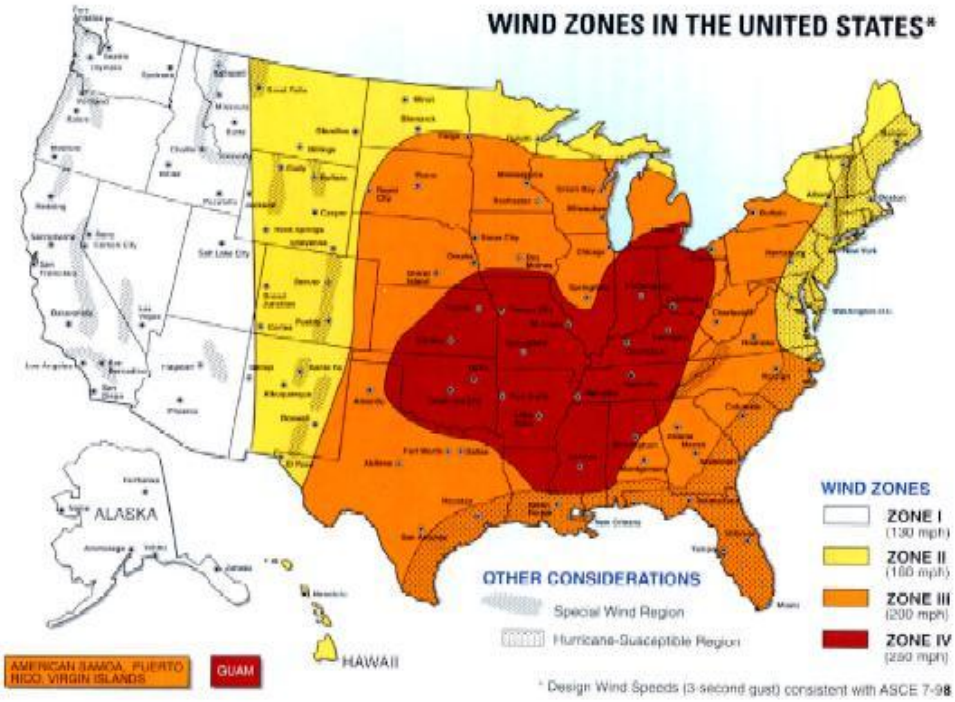


Figure 3: Wind Zones in the United States (Source: FEMA, 2008)

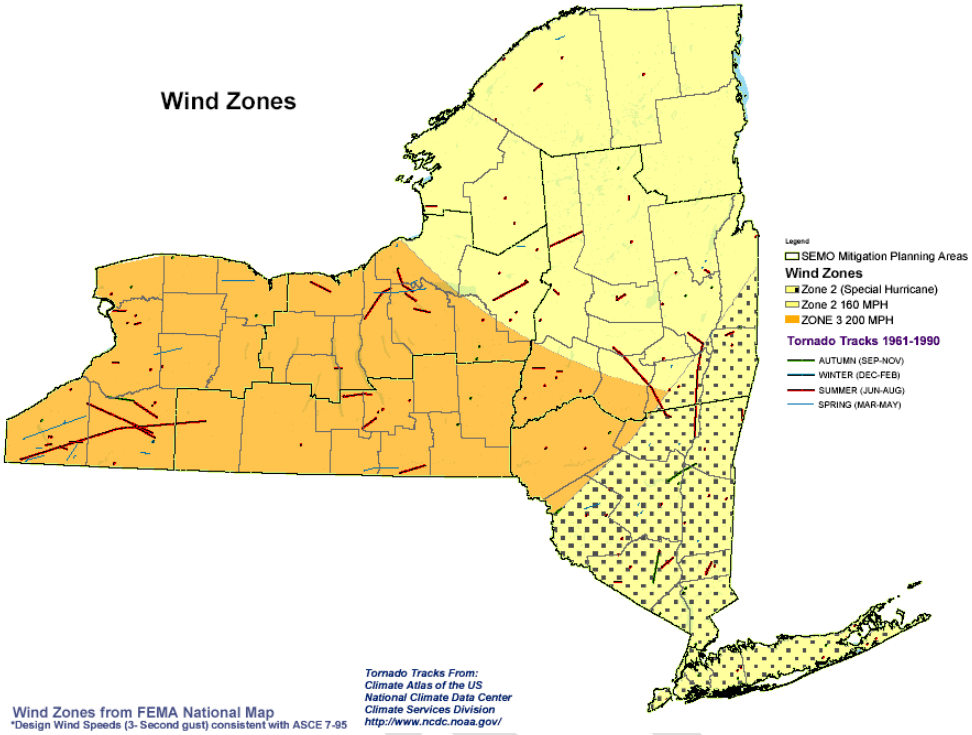


Figure 4: Wind Zones in New York State (Source: FEMA, 2008)

v. Historic Occurrences

Table 3, below, describes selected severe thunderstorms, tornadoes, and high-wind events from 1974 to 2013. Due to the high frequency of annualized severe thunderstorms, the historic occurrences table only features major severe thunderstorms. **Error! Reference source not found.** displays the number of occurrences of different types of severe events (hail, high wind, tornadoes) between 1974 and 2013.

Date	Event	Location(s)	Description
September 2, 1974	Tornado	Bronx	• F1 tornado • No injuries or fatalities
October 5, 1985	Tornado	Queens	• F1 tornado • Runs for 2 miles; width of 50 yards • No fatalities; 6 injuries
August 10, 1990	Tornado	Staten Island	• F0 tornado • Runs for 2 miles; width of 17 yards • No fatalities; 3 injuries
March 2, 1994	Windstorm	Citywide	• High winds of 61 mph

13. SEVERE WEATHER: THUNDERSTORMS, TORNADOES, and WINDSTORMS

Date	Event	Location(s)	Description
August 31, 1995	Tornado	Manhattan	• F1 tornado • Runs for less than a mile with a width of 10 yards • No fatalities; 1 injury • Property damages total $30,000
October 28, 1995	Tornado	Staten Island	• F1 tornado • No fatalities or injuries • Estimated damage $500,000
February 25, 1996	Windstorm	Citywide	• Intensity unknown • 1 fatality in Brooklyn due to a fallen tree • 1 reported injury
March 19, 1996	Windstorm	Citywide	• High winds of 79 mph • No fatalities or injuries
October 19, 1996	Windstorm	Citywide	• High winds of 92 mph • Fallen trees cause 3 fatalities; no additional injuries • Downed power lines and trees close Bayonne Bridge • Roof reported to be ripped off a Bronx building
March 6, 1997	Windstorm	Citywide	• Winds of more than 60 mph • Knocks down trees and power lines on houses and streets • 75-foot maple tree falls on school bus carrying 10 children • Two injuries caused by flying debris
November 2, 1997	Windstorm	Citywide	• Reported wind gusts of 40 to 46 mph • 1 fatality; 1 injury
November 4, 1997	Thunderstorms and hail	Bronx	• 1-inch hailstones from a line of scattered thunderstorms • Gusty winds and heavy rain
November 27, 1997	Windstorm	Manhattan	• Winds average 25 to 35 mph; gusts around 50 mph • Winds caused loss of control of parade balloon which struck a light pole causing it to fall inuring 4 spectators
February 4, 1998	Windstorm	Manhattan	• Winds of 57 mph • No fatalities; 1 injury reported

Date	Event	Location(s)	Description
June 30, 1998	Tornado/hail	Bronx/Queens	• 0.75-inch hail and damaging winds from a wave of severe storms in the Bronx • High winds in Queens down trees that strike and injure three girls • F1 tornado in Long Island
September 7, 1998	Severe thunderstorms/hail	Citywide	• Intense line of severe thunderstorms • Wind gusts of 60-80 mph • Downed trees and power lines • Hailstones of 1.50 inches • Staten Island high winds down trees, causing a building to collapse • Tree falls on three people in the Bronx, resulting in 1 fatality and two injuries • Two injuries in Brooklyn: one caused by downed tree and one by hailstones
March 18, 1999	Windstorm	Manhattan	• Winds 40 to 47 mph • 15-foot metal rod tumbles 22 stories from top of 1 Times Square; injuring 3 women
May 18, 2000	Severe thunderstorms/hail	Bronx/Queens/Brooklyn	• Line of severe thunderstorms produce damaging wind gusts • Large hailstones (0.75 to 1.0 inch) • Heavy rain and lighting • Downed trees in the Bronx • Large awning blown off building in Brooklyn • 1-inch hailstones in Woodside, Queens
December 12, 2000	Windstorm	Citywide	• Winds of 64 mph • Nor'easter • 1 fatality; 6 injuries
May 29, 2001	Severe thunderstorms/hail	Brooklyn/Queens	• Scattered severe thunderstorms with high winds • People in 19 houses in Queens report downed trees and power lines • 0.75-inch hailstones reported in Brooklyn
August 2, 2002	Severe thunderstorms/hail	Manhattan/Staten Island/Bronx	• 0.75-inch hailstones in Staten Island • Man struck and killed by lightening in Manhattan • Thunderstorms in Bronx • High wind downs power lines near Fordham University

Date	Event	Location(s)	Description
September 11, 2002	Windstorm	Citywide	• Strongest winds measure 66 mph in Queens • Winds last at least 6 hours • 1 fatality; 4 injuries • Widespread power outages • Construction debris causes injuries
September 19, 2003	Windstorm	Bronx	• Winds up to 46 mph • Hurricane Isabel • No fatalities; 1 injury • Downed trees and power lines
October 15, 2003	Windstorm	Queens	• Winds of 45 mph • No fatalities or injuries reported • Downed trees and power lines reported • Property damage estimated at a least $100,000
October 27, 2003	Tornado	Staten Island	• F0 tornado • No fatalities or injuries
November 13, 2003	Windstorm	Citywide	• Winds of 64 mph • 1 fatality; no injuries reported
August 11, 2004	Severe thunderstorms/hail	Bronx	• Severe thunderstorms produce flash flooding • Wind damage and 1-inch hailstones
December 1, 2004	Windstorm	Brooklyn	• Winds of 70 mph • No fatalities or injuries reported
December 23, 2004	Windstorm	Queens	• Winds of 47 mph • 1 fatality caused by tree crushing traveling car; no injuries
March 8, 2005	Windstorm	Queens	• Winds of 58 mph • No fatalities or injuries reported
April 2, 2005	Windstorm	Queens	• Winds of 58 mph • No fatalities or injuries reported
October 16, 2005	Windstorm	Citywide	• Winds of 36 mph • No fatalities or injuries reported • Trees downed • Windows in a high-rise office building in Manhattan blow out • $17,000 in property damage
October 25, 2005	Windstorm	Citywide	• Winds of 48 mph • No fatalities or injuries reported • Downed trees reported • Property damaged reported $35,000

Date	Event	Location(s)	Description
November 24, 2005	Windstorm	Citywide	• Winds of 40 mph • Parade balloon struck a lamppost causing a 30lb light to fall into the crowd • Two injuries reported • No cost in damages reported
January 15, 2006	Windstorm	Queens	• High winds of 63 mph • No fatalities and 1 injury reported
January 18, 2006	Windstorm	Bronx, Manhattan, Staten Island, Queens	• Winds of 68 mph • No fatalities or injuries reported
February 17, 2006	Windstorm	Brooklyn, Queens, Staten Island	• Winds of 61 mph • No fatalities or injuries reported
October 20, 2006	Windstorm	Staten Island	• Winds of 58 mph • No fatalities or injuries reported
January 20, 2007	Windstorm	Citywide	• Winds of 47 mph • Flying construction debris results in 1 injury
August 8, 2007	Tornado	Brooklyn	• EF2 tornado • Discontinuous path • 16 homes have moderate to severe roof damage • Tornado tears roof off a car dealership • Downed trees reported • Event accompanied by severe flooding • Federally declared disaster with more than $7.2 million given in Individual and Household Program (IHP) funding from the Federal Emergency Management Agency (FEMA) • More than 3,700 residents file claims at Disaster Assistance Service Centers
March 8, 2008	Windstorm	Manhattan/Bronx/Brooklyn	• Damaging winds cross over Lower Hudson Valley and New York City • Scaffold collapse in Manhattan • Downed power lines in the Bronx • Downed tree in Brooklyn
June 10, 2008	Windstorm	Citywide	• Wind gusts of 80 mph • Causes widespread downed trees

Date	Event	Location(s)	Description
June 22, 2008	Severe thunderstorms/hail	Bronx	• Severe thunderstorms cross over Lower Hudson Valley • 0.75-inch hailstones reported along Pelham Parkway • Flash flooding
August 11, 2008	Severe thunderstorms/hail	Citywide	• 1.75-inch hailstones in the Bronx accumulating up to one inch • Hailstones damage cars, flower and vegetable gardens • Downed tree limb in Cross Island Parkway in Queens
August 15, 2008	Windstorm	Bronx	• Wind gusts of 70 mph
February 12, 2009	Windstorm	Citywide	• Wind gusts of 50 to 60 mph • One fatality in Staten Island • One injury caused by fallen tree in Brooklyn
July 29,2009	Severe thunderstorms/hail	Citywide	• 0.75-inch hailstones in Staten Island • 70-mph wind gusts in Queens • Flash flooding forces some road closures in the Bronx
August 18, 2009	Severe thunderstorms/hail	Citywide	• 0.75-inch hailstones in Bronx • 80-mph wind gusts in Manhattan/Bronx • OEM reports a few hundred trees down in Central Park • Downed trees hit cars in Manhattan • Fewer than 100 trees down in Queens, but some damage cars
June 24, 2010	Severe thunderstorms/hail	Citywide	• 1.75-inch hailstones fall on Throgs Neck Bridge • One car damaged in Queens • Downed trees, utility poles, street lamps, and one chimney collapse in northeastern Queens • Wind gusts of 54 mph at La Guardia Airport • Downed trees in Bronx

Date	Event	Location(s)	Description
July 25, 2010	Tornado	Bronx	• EF1 tornado touches down in the Bronx • Large tree damages car • Seven injuries • $150,000 in damage
September 16, 2010	2 Tornadoes	Brooklyn/Queens	• EF0 tornado in Park Slope, Brooklyn, and EF1 tornado in Flushing, Queens • Park Slope tornado causes significant tree damage and estimated $8.5 million in damage • Queens tornado causes severe damage to residential buildings; one fatality; estimated $17.2 million in damage
October 1, 2010	Windstorm	Brooklyn/Queens	• 60-mph wind gusts
August 1, 2011	Severe thunderstorms/hail	Queens	• Severe thunderstorms produce lime-size hailstones in Glen Oaks • 2.75-inch hailstones reported in Bayside, causing damage to cars
August 28, 2011	Tornado	Queens	• Hurricane Irene produces two confirmed tornadoes: one EFO in Cunningham Park and one on Long Island
July 26, 2012	Severe weather	Citywide	• Warm front triggers multiple severe thunderstorms • One fatality: lighting strikes the steeple of a Brooklyn church that collapses, striking and killing a pedestrian
August 15, 2012	Severe weather	Citywide	• Multiple rounds of severe thunderstorms • Downed trees in Brooklyn damage cars • 1-inch hailstones in Queens • Downed power lines and power outages in Queens
September 8, 2012	2 Tornadoes	Brooklyn/Queens	• EFO tornado in Queens and EF1 tornado in Brooklyn • Tornado in Queens causes estimated damages of $20,000 • Tornado in Brooklyn causes structural damage to several homes and estimated damages of $250,000

Table 3: Selected Severe Weather Events 1974 to 2013

Severe weather can also prompt Presidential Disaster Declarations. This is an action made by the President that makes U.S. federal funding available for emergency relief and reconstruction assistance to affected jurisdictions. Since 1953, there have been two presidential disaster declarations for severe weather in New York City (Table 4**Error! Reference source not found.**).

Disaster Declaration No.	Date of Storm	Date of Declaration	Description	Public Assistance (PA)	PA (Emergency Work)	Individual and Household Program (IHP)
DR-1724	Aug. 8, 2007	Aug. 31, 2007	EF2 tornado in Brooklyn	$0	$0	$5.1 million
DR-1943	Sept. 16, 2010	October 14, 2010	EFO tornado in Brooklyn and EF1 in Queens	$17.9 million	$11.4 million	$0

Table 4: Presidential Disaster Declarations for Severe Weather 1953-2013

B. Vulnerability Assessment

i. Social Environment

The City closely monitors severe weather, but thunderstorms, tornados, and windstorms can occur with little or no warning, increasing risk to the social environment by compromising public safety. People who are caught outdoors during severe weather are vulnerable to injury and death. Hailstones can fall at speeds faster than 100 mph and can strike and injure people.

Data on death and injuries from severe weather confirm the risks of these events. Between 1959 and 2002, 132 people died in New York State after being struck by lightning. During a thunderstorm in August 2004, two individuals were killed after stepping out of their car into a flooded intersection electrified by a downed power line in New York City.

Construction sites, scaffolding, and crane equipment increase public safety risks from severe weather. Strong winds can free up loose construction materials and debris that can injure individuals who are caught outdoors. At least eight confirmed injuries that occurred during windstorm events were due to flying construction debris.

Large, older trees can fall on people and property, causing injury or death. At least 11 people have been killed by downed trees in New York City during a severe weather event:

- February 25, 1996 – 1 fatality during high-wind event
- October 19, 1996 – 3 fatalities during high-wind event
- March 6, 1997 – 4 fatalities during high-wind event
- September 7, 1998 – 1 fatality during severe thunderstorm/hail event
- December 23, 2004 – 1 fatality during high-wind event

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- September 16, 2010 – 1 fatality during tornado

People who live in high-rise buildings are at greater risk from high winds. This is because wind pressure on upper floors is stronger and can result in broken windows.

ii. Built Environment

Hail can cause severe damage to buildings, cars, and trains. According to the NWS, hail causes more than $1 billion in crop and property damage each year. In addition, NWS also estimates that lightning costs more than $1 billion in insured losses each year.

High winds pose a serious threat to buildings and infrastructure. Due to New York City's dense urban environment, flying debris can severely damage structures. Areas with tall buildings—such as Midtown Manhattan, the Financial District, and Downtown Brooklyn—are at a greater risk because of increased wind pressures at greater heights. While these structures can withstand strong winds, glass windows pose a potentially fatal threat if broken.

Construction sites are also especially vulnerable to high winds. Loose tools and construction materials, cranes, scaffolding, and other building appurtenances may loosen in high winds.

Structural vulnerability to wind is related to the building's construction type. Wood structures and manufactured homes are more susceptible to wind damage, while steel and concrete buildings are more resistant to it. Less than 0.1% of the city's buildings are manufactured housing, and 54% are wooden structures. Ninety-three percent of Staten Island's structures are made of wood, increasing that borough's vulnerability to windstorms and tornadoes.

The 2008 New York City Construction Code addresses high winds in a dense, high-rise environment. The Construction Code establishes wind-exposure categories to set design requirements for new buildings. These requirements account for location, surroundings, and occupancy to ensure buildings can withstand extreme winds. For example, buildings along the coastline are subject to higher wind loads, as are buildings that are more than 300 feet tall.

It is not possible to estimate potential losses to specific structures from severe weather. However, based on historic occurrences, tornadoes have caused up to $7.2 million in IHP funding from FEMA. (For more information on the city's physical and structural vulnerability, see New York City's Hazard Environment.)

iii. Natural Environment

Severe weather can negatively affect the natural environment. For example, tornadoes and windstorms can destroy historic trees and damage the aesthetic value of parks and open space. The secondary impacts from severe weather on the natural environment include lightning-induced fires and hazardous material leaks and spills.

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iv. Future Environment

The impact of severe weather on the future environment is complex and varies by the type of storm. Some of the impacts of climate change are warmer weather and moister air, which could create an environment favorable for severe storms. However, these same conditions have been shown to reduce the wind shear necessary for tornadoes to get a full lift. At this point it is unclear how the long-term effects of climate change will impact the strength and occurrence of tornadoes.

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A. Hazard Profile

i. Hazard Description

Wildfires, also called wildland fires or brushfires, are uncontrolled fires that are ignited in woodland, brush, or grassland areas with minimal development. When wildfires burn out of control and begin to threaten buildings or other manmade structures, they are referred to as wildland-urban interface (WUI) fires. This is because WUI is the area, or zone, where structures and other human developments come into contact with undeveloped areas or vegetative fuels.

For wildfires to ignite, grow, and sustain themselves, they require optimal weather conditions, a fuel source, and an ignition source. Optimal weather conditions include lack of precipitation, high temperatures, and low relative humidity (which allow vegetation and brush to burn more easily) and high winds (which cause the fire to spread). During periods of unusually dry weather or sustained drought, dry leaves, brush, and grass accumulate, forming a hazardous source of fuel. Tall perennial grasses called phragmites, typically found in temperate wetland areas, significantly contribute to the risk of wildfires. The combination of high fuel loads and WUI development create a dangerous scenario when weather conditions are favorable. Once the right combination of fuel and weather is in place, all that is required is an ignition source. Ignition sources can be natural, such as lightning, but are more commonly the result of human activities (such as dropped cigarette butts, campfires, or intentional "prescribed" fires that burn out of control).

A recent New York City Fire Department (FDNY) analysis of wildfires within the Gateway National Recreation Area (which includes parts of the Rockaway Peninsula, southeastern Brooklyn, and Jamaica Bay) indicates that the New York City area has a bimodal fire season; that is, during a given year there is an increase in brushfires during two separate periods: one during spring and one during fall. Although wildfires may occur during any time of year, conditions are most conducive for the start of brushfires during these periods due to low relative humidity and strong winds. Most wildfires (65.1%) occur during the first six months of a year, with 14.6% occurring in winter and 50.5% in spring. The occurrence of fires drops to 12.6% in summer but rises again to 22.3% in fall. FDNY has defined the spring fire season as March 17 through April 30 and the fall fire season as October 15 until November 30; during these periods, the FDNY's brushfire units are staffed daily.

ii. Severity

The severity of wildfires is dependent on weather conditions (temperature, precipitation, relative humidity, and wind) and the type and amount of fuel available. If favorable weather conditions persist for a significant period, more fuel will accumulate and any fires that are sparked will be more severe.

The flammability of fuel is determined by moisture content, chemical makeup, and density of fuel particles. Typically, fuel sources containing oils or resins that promote combustion and have low moisture content (partially determined by the weather) are most likely to burn easily,

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quickly, and intensely. Fuel particles also need to be close enough together so that they will ignite each other, but not so close as to prevent air circulation.

There are three recognized levels of intensity and patterns of wildfire spread. At the lowest level are ground fires, which are sustained by glowing combustion and primarily burn organic matter and leaves in the soil. At the next level are surface fires, which burn leaf litter, fallen branches, and other fuels at ground level. The hottest and most dangerous fires are crown fires, which can reach significant heights and burn the top layer of foliage on trees, known as the canopy or crown. Crown fires are also the most difficult type of fire to contain.

When fires begin to threaten the built environment, they are classified according to the alarm assignment system. Alarm assignments start at one and increase with fire severity; the more significant the fire, the higher the alarm assignment number. There is technically no maximum alarm assignment, although fires are rarely classified above five alarm.

iii. Probability

Wildfires occur many times a year throughout New York City, although the frequency and recurrence interval vary depending on the exact location.

iv. Location

While New York City does not experience the devastating wildfires that often rage through the western United States, certain areas of the city face a significant risk. Staten Island is the most vulnerable of the five boroughs (particularly along the eastern shore), although parts of southern Queens and Brooklyn around the wetlands of Jamaica Bay are also prone to wildfires. These areas contain the highest concentration of phragmites in the city, and the grasses become highly flammable during optimal weather conditions. In addition, Staten Island has the highest percentage of wooded area in the city as well as the largest WUI zone.

Although wildfires occur many times a year throughout the city, most of them are small fires and do not affect built structures. Wildfires that are considered 2-alarm or higher, i.e. "all-hands", are more serious. Between 1996 and 2013, New York City experienced 887 such fires (an average of almost 50 per year). Of these, 354 were in Staten Island (an average of almost 20 per year), 240 were in Queens (an average of about 13 per year), 156 in Brooklyn (an average of about 9 per year), 104 in the Bronx (an average of about 6 per year), 10 in Manhattan (an average of one fire every 1.8 years), and 23 in unknown locations. Figure 1 shows the percentage of serious wildfires by borough between 1996 and 2013.

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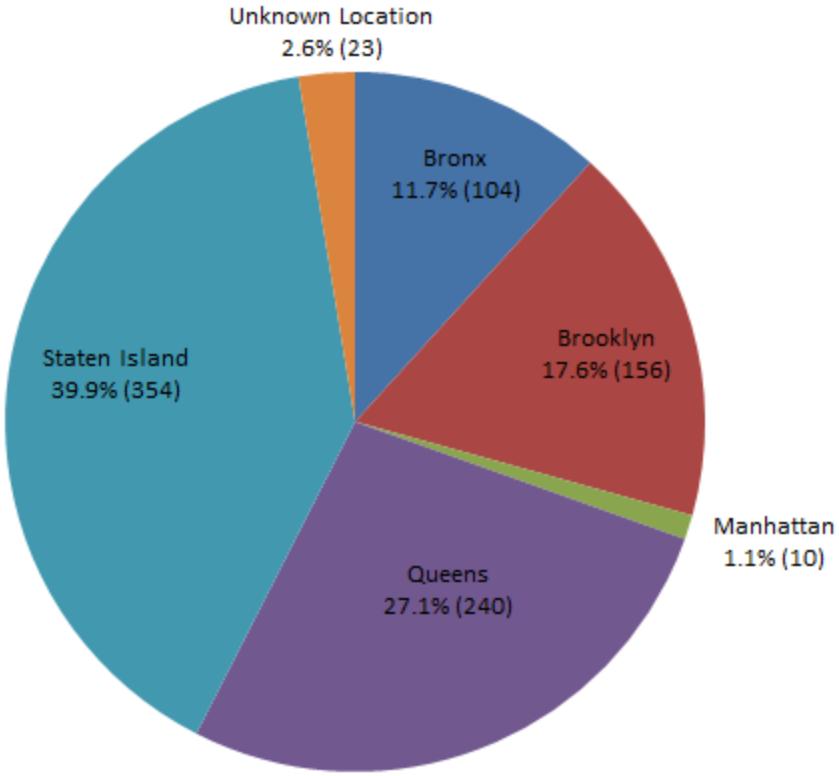

Figure 1: Serious wildfires in New York City by borough 1996 to 2013 (Source: FDNY)

In 2012, the New York City Department of Parks & Recreation (DPR), in collaboration with the New York City Department of Environmental Protection (DEP), FDNY, the New York State Department of Environmental Conservation (NYS DEC) and the United States National Park Service (NPS), developed a Community Wildfire Protection Plan (CWPP) for the borough of Staten Island. The goal was to establish recommendations and priorities to help vulnerable communities protect residents, homes, infrastructure, and the natural environment from the impacts of wildfires. The Staten Island CWPP encompasses the area of Staten Island bounded to the north and east by Lower New York Bay, to the south by the southern boundary of Great Kills Park, and to the west by Maryland Avenue and Hylan Boulevard (see Figure 2). This area includes the communities of Oakwood Beach, Midland Beach, South Beach, Old Town, Grasmere, Arrochar, and Shore Acres. The population of this area is 51,200 residents.

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Figure 2: Area covered by Staten Island Community Wildfire Protection Plan (Source: Staten Island CWPP, 2012)

v. Historic Occurrences

Table 1 lists and describes some significant wildfires in New York City between 2008 and 2011.

Date	Category	Location	Description
July 8, 2008	Wildfire	Staten Island	• Brushfire near Hopkins Avenue and Hylan Blvd. in Staten Island
September 15, 2008	Wildfire	Staten Island	• Two large brushfires burn over 40 acres in Staten Island
March 23, 2009	Wildfire	Staten Island	• Brushfire near Richard Avenue and Hylan Blvd.
March 24, 2009	Wildfire	Staten Island	• 2-alarm brushfire near 2900 Veterans Rd.
March 25, 2009	Wildfire	Bronx	• Brushfire breaks out just north of NYPD shooting range at Rodman's Neck • No injuries reported • Operations not interrupted
April 4, 2009	Wildfire	Brooklyn	• 2-alarm brushfire near 77-75 Flatbush Ave.
April 12, 2009	Wildfire	Staten Island	• Large brushfire near Kissam Avenue on Staten Island spreads to three adjacent structures
April 16, 2009	Wildfire	Queens	• Brushfire in Howard Beach area of Queens
January 12, 2010	Wildfire	Queens/Brooklyn	• 2-alarm brushfire in Gateway National Park

Date	Category	Location	Description
June 30, 2010	Wildfire	Queens	• Brushfire in Howard Beach area of Queens
July 18, 2010	Wildfire	Queens	• Brushfire near 165th Avenue and 83rd Street, in Howard Beach area of Queens
September 8, 2010	Wildfire	Staten Island	• Brushfire near Woodrow Road and Alexander Avenue
September 9, 2010	Wildfire	Staten Island	• Brushfire in Great Kills Park
October 16, 2010	Wildfire	Staten Island	• Brushfire near Great Kills Park
October 23, 2010	Wildfire	Staten Island	• Large brushfire near Forest Hill Road and Richmond Avenue
November 12, 2010	Wildfire	Staten Island	• 5-alarm, 100-acre brushfire near Kissam Avenue and Mill Road on Staten Island spreads to nearby garage and delays traffic
December 9, 2010	Wildfire	Staten Island	• Large brushfire near Richmond Hill Road and Old Mill Road on Staten Island
March 28, 2011	Wildfire	Staten Island	• Brushfire in Siedenburg Park, Staten Island

Table 1: Wildfires in New York City 2008 to 2011

B. Vulnerability Assessment

i. Social Environment

In developed parts of New York City, wildfires tend to present a greater risk to firefighters and first responders than to residents or their property. When wildfires do threaten populated areas, residents may be at risk, especially those who choose not to evacuate. The situation may be particularly dangerous in the case of fires that spread quickly or unpredictably, which can result in little or no advanced warning or evacuations. Secondary health effects may result from smoke inhalation and poor air quality in the vicinity of these fires. Populations that may be particularly vulnerable include the elderly, residents with pre-existing respiratory conditions, and, in the event of an evacuation, people with mobility impairments (for more information on vulnerable populations, see Risk Assessment Section 4: New York City's Hazard Environment).

ii. Built Environment

When wildfires reach the WUI, they have the potential to cause significant damage to the built environment. In New York City, particularly on Staten Island, there are many areas where the built environment is directly adjacent to open areas with minimal or no natural buffers. This can potentially put many homes and critical facilities at risk. In addition, these fires are often more difficult to contain than normal building fires due to their size, abundant natural fuel sources, and weather conditions. Buildings constructed of wood and other combustible materials are particularly at risk, especially if they have wooden exteriors. Utilities, transportation, and telecommunications infrastructure are also vulnerable to the effects of wildfires, which may in turn lead to service disruptions.

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The CWPP area on Staten Island is primarily comprised of residential homes, light commercial zones, open space, and manufacturing areas. The area contains 13 schools, 11 daycare facilities, 12 historical sites, one hospital, and one psychiatric facility.

The Consolidated Edison Company has substantial utility distribution infrastructure in the CWPP area, but only some of it is vulnerable to wildfire damage. There are four electric substations in the CWPP, but only one is near enough to a fire prone area to be at any risk. Con Edison's distribution of electricity, however, is almost exclusively via wooden street poles and overhead power lines, making that system vulnerable, especially in areas where phragmites grow.

One of DEP's wastewater treatment plants, located in the southwest portion of the Oakwood Beach watershed, is also at risk of periodic fire.

iii. Natural Environment

Depending on the type and severity of the wildfire, the impacts of fire on the natural environment can be either positive or negative. For certain ecosystems, fires are a necessary part of the ecological cycle and promote the overall health and longevity of these environments. Benefits of fires include insect pest control, removal of invasive species, addition of nutrients for trees and other types of vegetation, and removal of undergrowth that may prevent the growth of native species. Certain types of vegetation are also dependent on periodic fires for survival. Additionally, burned trees may provide homes for certain species of birds and mammals and a base from which new plants can grow.

Although low-intensity fires may be beneficial to the environment, high-intensity fires can be devastating. In addition to burning large stands of trees, these fires cause soil destruction and the removal of debris needed to protect seedlings. In extreme cases, wildfires can destroy entire habitats and threaten numerous species.

Although certain ecosystems require periodic fires to sustain themselves, a dangerous situation can arise if too frequent. In these cases, fuel can accumulate to dangerous levels and result in devastating fires. Periodic intentional burning (also known as "prescribed" or "controlled" fires) is a tactic often used to reduce the amount of fuel available for large fires and to promote healthy ecosystem function.

iv. Future Environment

Wildfires are a frequent occurrence in certain areas of the city and will likely continue into the future. Since wildfires are largely dependent on weather conditions, climate change may affect the frequency of wildfires in the future. However, there is still much uncertainty as to what effect climate change will have and how significant it would be. Other factors that may play a role in determining future vulnerability are the rate of future development within fire hazard areas and the presence of buffers between urban infrastructure and wooded areas.

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A. Hazard Profile

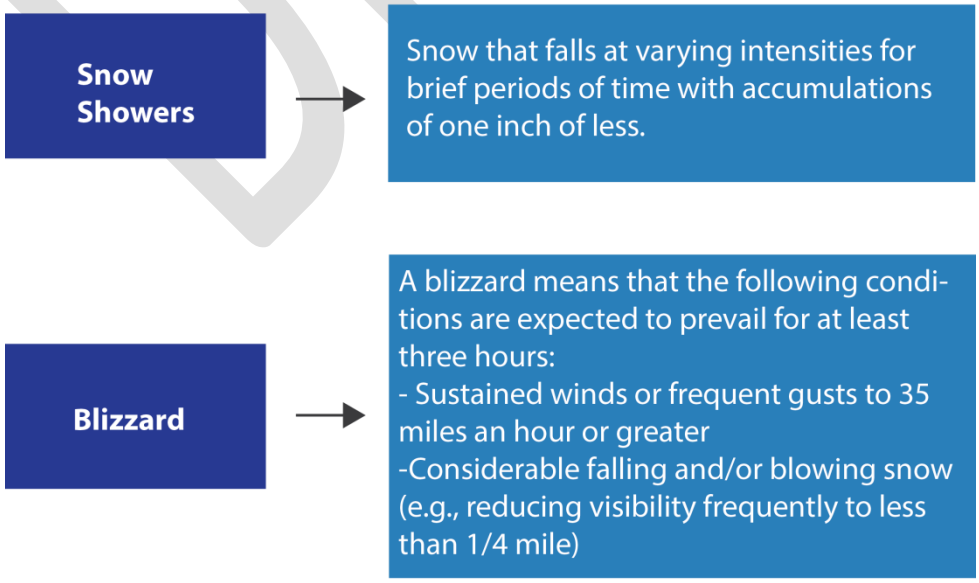
i. Hazard Description

New York City winters often usher in heavy snow and ice. Winter storms can include snow showers, blizzards, snow squalls, thundersnow, and ice storms (see Figure 1). Heavy snow generally means snowfall accumulating to four inches or more in depth in 12 hours or less, or snowfall accumulating to six inches or more in depth in 24 hours or less. According to the National Climatic Data Center, the city averages 28 inches of snowfall annually. A blizzard is a severe snowstorm characterized by strong winds of 35 miles per hour or more with snow and blowing snow, reducing visibility to less than 1/4 mile for a period of three hours or longer.

A snowsquall is characterized by moderate to heavy snowfall accompanied by strong gusty winds and sometimes lightning. Thundersnow events are less common in the winter months, but when these storms occur they are accompanied by thunder and lightning. There have only been two reported thundersnow events in New York City.

Ice storms occur when damaging accumulations of ice accompany freezing rain. Significant ice accumulations are usually 1/4 inch or greater. These accumulations of ice are capable of downing trees and utility lines, resulting in loss of power and communication. Furthermore, these accumulations of ice make walking and driving extremely dangerous. In addition, ice accumulations on roads can make them impassable and affect rail beds and the mass transit switch system.

The winter months can also bring frigid temperatures that pose a hazard to public health and safety, especially for people who work outdoors, people who are homeless, those without adequate home heat, and at-risk populations such as seniors and children (see Risk Assessment Section 10: Extreme Temperatures).



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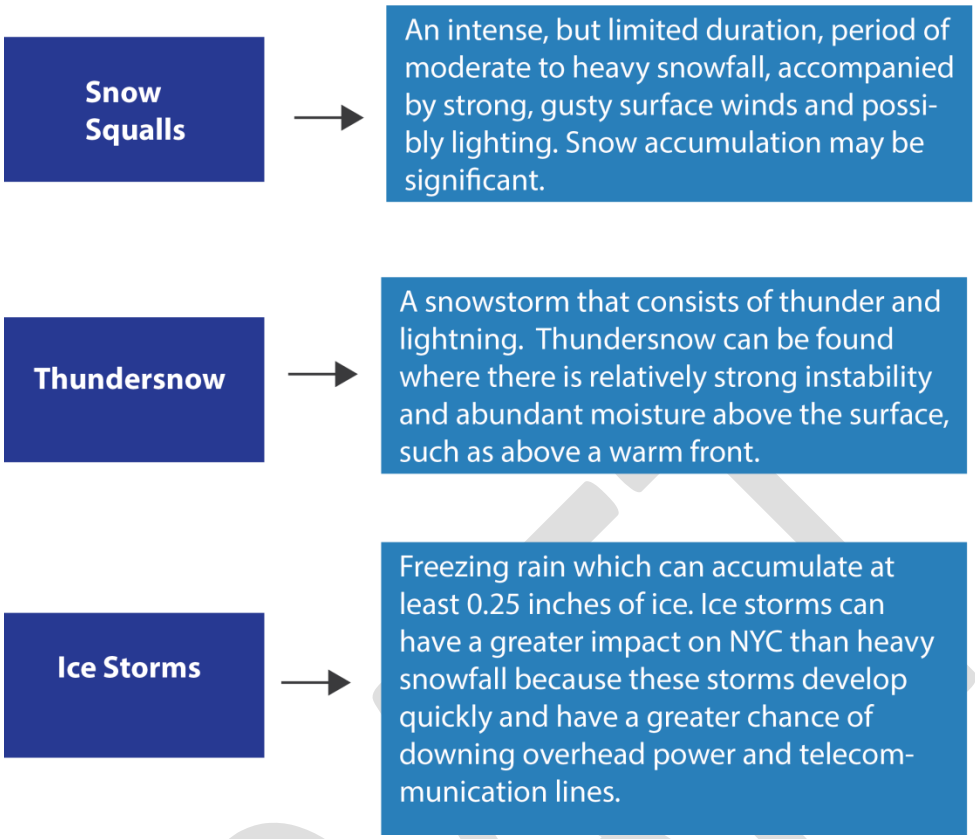

Figure 1: Winter Storm Types

ii. Severity

The severity of a winter storm depends on several factors including temperature, wind speed, type of precipitation, and rate of deposition. The time of year the storm hits also affects the severity. For example, a storm that occurs during the early winter months, when trees still have leaves, may result in more downed trees and power lines because the leaves hold the accumulation of snow and ice.

The severity of a winter storm can be classified by meteorological measurements and by evaluating societal impacts. The Northeast Snowfall Impact Scale (NESIS, see Figure 2) characterizes and ranks high-impact northeast snowstorms and was developed because of the transportation and economic impacts Northeast snowstorms can have on the rest of the country. These storms have large areas of snowfall accumulations of 10 inches and greater. NESIS has five categories: Notable, Significant, Major, Crippling, and Extreme (see Figure 1).

CATEGORY	DESCRIPTION
1	Notable
2	Significant
3	Major
4	Crippling
5	Extreme

Figure 2: Northeast Snowfall Impact Scale (NEIS)

The NESIS index differs from other meteorological indices in that it uses population information in addition to meteorological measurements, and

thus gives an indication of a storm's societal impact. NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The distribution of snowfall and population information are combined in an equation that calculates a NESIS score, which varies from around one for smaller storms to over 10 for extreme storms. The raw score is then converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers.

Since 1798, New York City has experienced 19 snowstorms with snowfall totaling 16 inches or greater. According to NESIS, of these 19 storms, one was Extreme, five were Crippling, five were Major, three were Significant, and one was Notable. The remaining 12 historical snowstorms did not qualify for a NESIS rank.

ii. Probability

Snowstorms and severe winter weather are frequent occurrences in New York City. Based on historical frequency, New York City can expect a snowstorm of 16 inches or more approximately once every nine years.

iii. Location

All areas of New York City are susceptible to winter storms. However, during winter storm events, snowfall totals can vary widely across the city. For example, during the winter storm on December 26 and 27, 2010, snowfall ranged from 13 inches in Queens to 29 inches in Staten Island (see Table 1: **Inches of Measured Snowfall December 26 and 27, 2010 (Source: National Weather Service)**.

Great Kills	Central Park	LaGuardia Airport	Kennedy Airport
29.0	20.0	13.0	15.6

Table 1: Inches of Measured Snowfall December 26 and 27, 2010 (Source: National Weather Service)

iv. Historic Occurrences

Table 2, below lists major snowstorms in New York City from 1798 to 2013 (measured at Central Park)**.**

Date	Name	Total (inches)	NESIS	Comments
November 19–21, 1798	The Long Storm	~18	N/A	• Snow from Maryland to Maine
January 26–28, 1805	N/A	~24	N/A	• 48 hours of continuous snow
January 14–16, 1831	The Great Snowstorm	~15	N/A	• Rivals the Storm of the Century of 1993 for expansiveness of coverage
January 26–28, 1836	The Big Snow	~15	N/A	• Interior sections see widespread 30- to 40-inch tallies
March 12–14, 1888	The Blizzard of '88	21	4	• Extreme blizzard conditions leave behind more than 50 inches of snow in some areas of Connecticut and the Hudson Valley

Date	Name	Total (inches)	NESIS	Comments
March 16–18, 1892	St. Patrick's Day Snowstorm	15.4	N/A	• Largest snowstorm on record for many areas of the South
February 17–18, 1893	N/A	17.8	N/A	• Follows a warm spell when temperatures reached as high as 54°F
February 25–27, 1894	N/A	15.2	N/A	• Before the storm, temperatures start out around 0°F before rising to just above freezing
February 12–13, 1899	The Blizzard of 1899	16	4	• Temperatures in the single digits for most of the storm
February 4–7, 1920	N/A	17.5	N/A	• Parts of Westchester receive more than 20 inches of snow
January 22–24, 1935	N/A	17.5	N/A	• Snow from Gulf Coast to Maine
March 7–8, 1941	N/A	18.1	N/A	• Quick drop-off of snow toward the coast as parts of New Jersey and Eastern Suffolk report less than 10 inches of snow
December 26–27, 1947	Big Snow	26.4	2	• Worst blizzard since 1888 and record holder until 2006
December 19–20, 1948	N/A	16	N/A	• 20-hour duration • Widespread totals of 12-18 inches across the metropolitan area
December 11–12, 1960	N/A	15.2	3	• 20.4 inches recorded at Newark • 17 inches at The Battery
February 3–4, 1961	N/A	17.4	4	• Storm follows prolonged cold period (16 days of temperatures in the teens and 20s) • JFK Airport records 24 inches
February 6–7, 1967	N/A	15.2	2	• Blizzard conditions produce totals of more than 20 inches in parts of New Jersey
February 9–10, 1969	Lindsay Storm	15.3	2	• Mayor John Lindsay receives criticism after sections of New York City remained unplowed for a week
February 5–7, 1978	Blizzard of '78	17.7	3	• Long Island and New England hardest hit • Near hurricane-strength winds • Rare thundersnow reported • 36-hour storm duration
February 19, 1979	President's Day Snowstorm I	12.2	N/A	• Fast-moving snowstorm ushered 12.2 inches of snow in the city • Heaviest snowfall ranged from 18.7 to 20 inches in Washington, D.C. and Baltimore, MD
February 11–12, 1983	Megalopolitan Snowstorm	17.6	4	• Occurs during one of the strongest El Niños of the 20th century

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Date	Name	Total (inches)	NESIS	Comments
March 12 -14, 1993	Storm of the Century	12.2	N/A	• Tremendous snowfall left 13 inches of snow in Birmingham, Al and 36 inches in Syracuse, NY • Dozens of tornadoes reported in the South • Storm ranks as one of the most deadly and costly weather events in the 20th Century
January 7–8, 1996	Blizzard of 1996	20.2	5	• Snow accumulation of more than 30 inches across portions of New Jersey • New York City schools closed, first time since Blizzard of '78
February 16–17, 2003	Presidents' Day Snowstorm II	19.8	4	• 25.6 inches of snow recorded at JFK Airport • "Presidents' Day Snowstorm I" brought 12.2 inches on February 19, 1979
February 11–12, 2006	Blizzard of 2006	26.9	3	• Largest snowstorm in New York City history • Rare thundersnow reported
December 26-27, 2010	Blizzard of 2010	20	3	• New York Airports close • Public transportation severely hampered • Delayed snow removal • 8,000 customers lose power in New York City
February 25-26, 2010	N/A	20.9	3	• Dry snow south and heavy rains East • Extensive damages and power outages from wet snow North • 3rd major Eastern snowstorm in February
January 26-27, 2011	N/A	19	1	• Snowfall rates of over 3 inches per hour • New York City public schools close

Table 2: Major Winter Storms 1798 to 2013

According to the National Weather Service (NWS), the five snowstorms with the greatest snowfall in New York City were:

(1) 26.9 inches on February 11–12, 2006
(2) 26.4 inches on December 26–27, 1947
(3) 21 inches on March 12–14, 1888
(4) 20.9 inches on February 25-26, 2010
(5) 20 inches on December 26-27, 2010

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Severe winter weather can also prompt Presidential Disaster Declarations. This is an action made by the President that makes U.S. federal funding available for emergency relief and reconstruction assistance to affected jurisdictions. Since 1953, there have been three presidential disaster declarations for winter snowstorms and blizzards in New York City (Table 3).

Disaster Declaration No.	Date of Storm	Date of Declaration	Description	Public Assistance (PA)	PA (Emergency Work)	PA (Permanent Work)	IA
DR-1083	January 7, 1996	1/12/1996	There were $21.3 million in eligible damages for all counties affected by the blizzard in Jan 1996	N/A	N/A	N/A	N/A
EM-3184	February 17-18, 2003	3/3/2003	Federal disaster funds were authorized for New York City and 17 counties to pay part of the cost for emergency protective measures undertaken as a result of the snowstorm in February 2003	$33.7 Million	$33.7 Million	$0	$0
DR-1957	December 26-27, 2010	2/18/2011	Federal disaster funds were made available to New York to supplement state and local recovery efforts in the area struck by a severe winter snowstorm in December 2010	$37.7 Million	$30.6 Million	$7.4 Million	$0

Table 3: Presidential Disaster Declarations for Winter Storms from 1953-2013

B. Vulnerability Assessment

i. Social Environment

A major winter storm impacts the safety and daily routine of New Yorkers and causes significant economic losses for businesses and City government.

The public's risk from winter storms varies across different groups. People most at risk are laborers or individuals who spend time outdoors, seniors, children, persons in poor physical health, those without adequate heat in their homes, or the homeless. The ability to tolerate

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colder weather is contingent on age. Older individuals have decreased thermoregulatory ability and also have difficulty compensating for sudden temperature change. At the other end of the age scale, children lose body heat much faster than adults. In addition, underweight individuals lose body heat at a faster rate than those with average body weights. Public health concerns during winter storms may include frostbite, hypothermia, carbon monoxide poisoning (due to poorly ventilated gas ranges and kerosene space heaters, or, in the case of power outages, generators or grills used indoors), and exacerbation of pre-existing respiratory and cardiovascular conditions (see Social Environment in Infrastructure Failures).

Heavy snow and ice can paralyze the city's infrastructure and services, stranding commuters, closing airports, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow and ice can cause roofs to collapse and knock down trees and power lines.

The greatest danger during winter storms in New York City is the risk of automobile accidents. Even small accumulations of ice on roadways can be extremely dangerous to motorists and pedestrians.

During and after winter storms, the loss of business and the cost of snow removal and repairs can have a severe economic impact on New York City. Commercial and financial business may see revenue and productivity losses, although this is usually short-term. Government services may also be affected. A large snowstorm will significantly increase costs to City agencies. The Department of Sanitation (DSNY), NYC Department of Transportation (NYC DOT), and Department of Parks & Recreation (DPR) will incur additional costs related to snow and ice removal and pothole repair.

There are no standard loss estimation models or methodologies for winter storms. Potential losses from winter storms are, in most cases, indirect and therefore difficult to quantify. In May 1994, the New York City Office of the Comptroller conducted a study of the fiscal and economic impact of the winter of 1993-94. The study revealed that the unseasonably cold and snowy weather that winter cost the City about $50 million more than a normal winter ($76 million when adjusted for inflation to 2008 dollars). Of this, $35.7 million was from additional costs to City agencies (DSNY, NYC DOT, and DPR) and snow-related claims against the City. The other $14.7 million was from lost City revenues, such as parking meters and towing fees, and lost savings from the City's energy plan.

More recently, the blizzard on December 26 and 27 of 2010 is estimated to have cost the City of New York over $68 million. The Metropolitan Transportation Authority lost $30 million due to overtime expenses and lost ridership revenue. Furthermore, holiday and weekend pay for workers called in to operate buses, subways, railroads, and crossings totaled $14 million. Total costs to City government were reported to exceed $38.8 million, which was the entire City's snow budget for the year. A majority of the costs were due to overtime pay for DSNY workers.

ii. Built Environment

Structural damage or building collapses because of snow are very rare in New York City. However, buildings with flat rooftops may be at greater risk than other buildings. This is because snow can more easily accumulate on flat roofs and cause damage, even to the point of jeopardizing the building's structural soundness. As the snow melts, it can collect in depressed or recessed areas of a flat roof—a condition commonly called "ponding"—because the water cannot easily travel off the surface. This additional weight, or load, can lead to leaks, roof damage, or even building collapse. Roads and bridges are especially vulnerable to the effects of winter storms because of the possibility of transportation accidents and disruptions.

Chapter 16 of the New York City Building Code governs the structural design of buildings and provides minimum design loads, load combinations, and procedures for determining snow loads. The Department of Buildings (DOB) bases snow loads on New York City regional climate value for ground snow load and incorporates thermal factors for heated and unheated buildings. There are also provisions for snowdrifts caused by parapets and adjacent buildings.

Ice storms can also have a significant impact on the built environment. Ice can disrupt communication and power for days while utility companies repair damage. In addition, ice accumulations can affect rail beds and the public transit switch system. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

iii. Natural Environment

Heavy accumulations of ice can bring down trees. In addition, when snow and ice melts, it creates runoff that flows into the city's sewer system. The increased volume of runoff combined with sanitary waste may exceed the capacity of the City's wastewater treatment plants. When the plants cannot handle the excess water, untreated wastewater is discharged into local waterways (For more information, see Risk Assessment Section 4: New York City's Hazard Environment and Risk Assessment Section 18: Infrastructure Failures).

iv. Future Environment

According to the New York City Panel on Climate Change (NPCC), climate change projections indicate that snowfall will not be as frequent and the length of snow seasons will likely decrease in the future. Nevertheless, the intensity of snowfall per storm is highly uncertain, and it is unknown whether the frequency and intensity of ice storms and freezing rain will change.

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A. Hazard Profile

i. Hazard Description

A hazardous materials (HAZMAT) incident is a situation in which harmful substances are released into the environment. These types of releases are often classified as chemical, biological, radiological, and nuclear (hence the abbreviation CBRN). The cause of a release can be either accidental or intentional. Accidental incidents may result from human error, tainted food products, technological failure, or a natural disaster and may include spills, leaks, airborne releases, or seepage into uncontained areas. Asbestos released during building demolition or collapse is one example of this kind of incident; oil spills or raw sewage releases are others. Intentional releases of hazardous materials include criminal acts such as purposeful dumping by industries to avoid regulatory requirements or terrorist acts that target a specific location and may involve the use of a dispersal device or explosive. Whether accidental or intentional, the impacts of a CBRN event can be significant.

Chemical

A chemical is generally considered hazardous if it exhibits toxicity, reactivity, corrosivity, or flammability. The chemical properties of these substances are such that they can react with and cause damage to living cells and tissue. Exposure pathways include inhalation, skin contact, ingestion or injection. Commercially or industrially used hazardous chemicals (also known as Toxic Industrial Chemicals–TICs) that may be released accidentally include petroleum substances (such as oil, gasoline, and liquid natural gas) and those with industrial applications (such as chlorine and pesticides).

Chemical weapons (released intentionally) are often classified according to their effect on the body, based on the primary organ system affected by exposure. Nerve agents (e.g., sarin, VX, and VR) enter the body through the skin or lungs and affect the nervous system. Blood gases or systemic agents (e.g., hydrogen cyanide) enter the bloodstream either directly or indirectly and are transported throughout the body. Respiratory agents (e.g., chlorine, phosgene) are inhaled and can cause damage to the lungs. Blister agents (e.g., mustard gas, lewisite) damage the skin, and if they get absorbed they can also affect other parts of the body. Depending on the severity of exposure, impacts may include temporary illness or injury, permanent medical conditions, or death.

Biological

Biological hazards include disease-causing microorganisms and pathogens, such as bacteria and viruses. The distinguishing characteristic of these substances is their ability to multiply within a host and cause an infection. Some bacteria and viruses can be spread, or transmitted, from one individual to another. Infections typically occur as a result of airborne exposure, skin contact, or ingestion. In general, exposure to bacteria and viruses can occur through inhalation (as is the case with airborne B. anthracis spores, which cause anthrax), ingestion of contaminated food or water (the case with E. coli, which causes gastrointestinal infection), contact with infected individuals, or contact with contaminated surfaces (which may be harboring, for example,

viruses that cause influenza). Ricin, a toxin found in castor beans, is also classified as a biological agent with the potential for use in an intentional attack.

Radiological

Radiological hazards involve exposure to harmful doses of radiation. According to the Centers for Disease Control (CDC), external radiation occurs when radioactive material in the form of dust, powder, or liquid comes into contact with a person's skin, hair, or clothing. Internal contamination occurs when people swallow or inhale radioactive materials. Sources of accidental radiation exposure include underground seepage of naturally occurring radioactive materials (such as radon gas) into homes and leakage from facilities storing radioactive waste (such as spent fuel rods from nuclear power plants). Intentional releases can come from Radiological Dispersal Devices (RDDs), such as dirty bombs, which trigger small-scale explosions that release and disperse radiation, or Radiological Exposure Devices (REDs), which are not explosive and typically involve the use of a hidden radioactive source designed to unknowingly expose people to radiation.

The health effects of radiation depend on many factors, including the type of radiation, exposure pathway, concentration and amount of exposure, and duration of exposure. Large exposures delivered over a short period of time can cause acute radiation sickness, and, in some cases, death. Lower exposures to radiation over time (e.g., over a working lifetime) increase the probability of developing chronic health problems, birth defects, and cancer, especially if the cumulative dose is significant.

Nuclear

Nuclear incidents are those that result directly from the detonation of a nuclear device or at a nuclear reactor site when accompanied by the release of large amounts of energy in the form of intense light, heat, pressure, and radiation. Radiation exposure typically occurs on a larger scale than with radiological incidents. Nuclear incidents have the potential to cause catastrophic loss of life and injuries. In addition to nuclear fallout associated with mortality and damage to structures, such an incident could significantly disrupt civil services and infrastructure. While the nuclear devices that terrorist organizations may be able to fabricate under special circumstances are relatively small, in extreme circumstances they may still have the potential to cause mass casualties.

ii. Severity

A CBRN incident becomes a citywide emergency when it poses a threat to human safety and welfare or to the environment. Acute exposures to hazardous materials are often difficult to evaluate because people may experience a wide range of adverse health effects, the severity of which varies with intensity and duration of exposure. In a typical population, there is also significant variation in response among individuals. Furthermore, for many substances there is not enough data available on toxic responses in humans to allow for an accurate assessment of health impacts. Thus, the severity of the hazard will depend on the type and amount of material

released, the location of the release relative to human populations, and the characteristics of the exposed population.

Chemical

For chemical hazards, severity is commonly measured using the National Fire Protection Association (NFPA) 704M. This standardized system uses numbers and primary colors on a label to define the basic hazards of a specific material (see Figure 1). The system represents the risk posed by a particular substance, using a four-color diamond: blue (health), red (flammability), yellow (reactivity), and white (special hazards). These are ranked on a scale from 0 (no hazard) to 4 (extreme hazard).

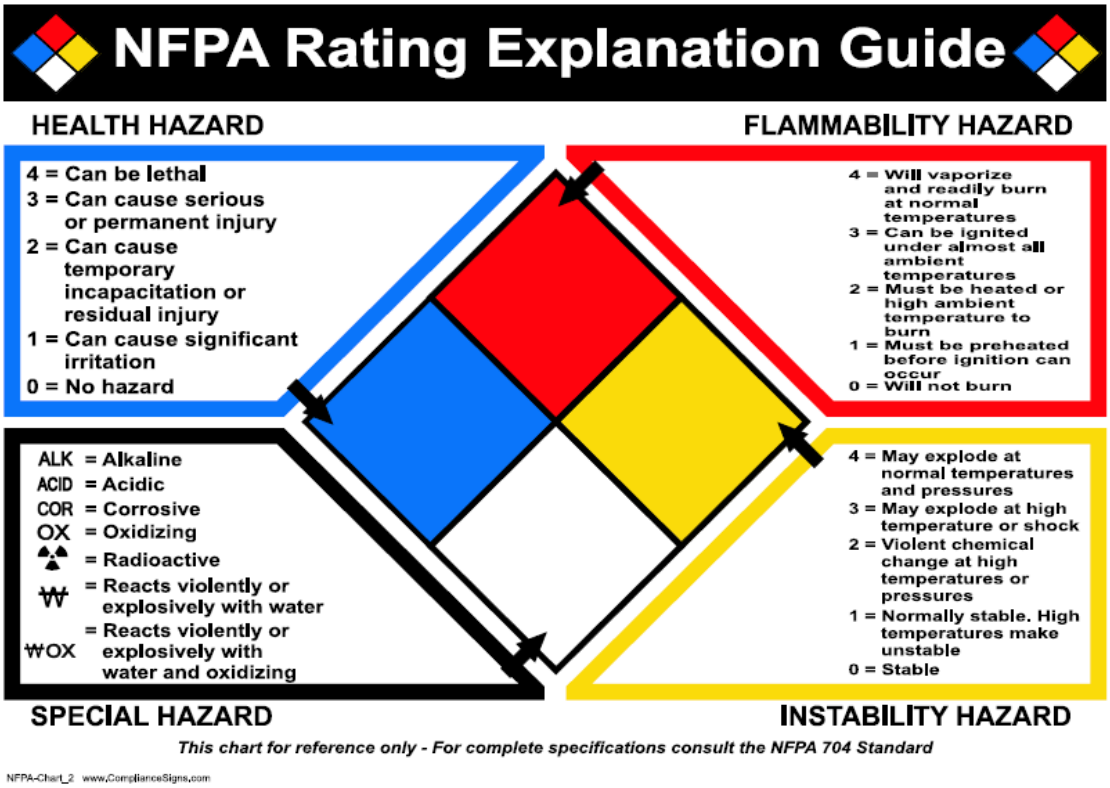

Figure 1: NFPA 704M Rating System for Chemical Hazards (Source: Compliance Signs).

Biological

The severity of a biological hazard will depend on the type, location, and amount of the release, as well as the size, density, and characteristics of the population affected. Virulence is the relative severity of the disease caused by a microorganism (the ratio of clinical cases to the number of infected hosts). Different strains of the same microorganism may cause different diseases with varying levels of severity.

Radiological

Acute health effects of radiological substances typically result from exposure to single, short-duration, high doses (a dose is the amount of energy absorbed by the body). Chronic health impacts result from exposure to relatively low doses for an extended period, causing

accumulation in the body over time. For radiological hazards, severity is dependent on a number of factors, including the size of the dose, the type of radiation emitted, duration of exposure, the ability of the radiation to harm human tissue, and the organs affected. The unit of measurement for absorbed dose is the rad (radiation absorbed dose). Since certain types of radiation are more dangerous than others, the absorbed dose must be multiplied by a "quality factor" to produce a "dose equivalent" that considers the type of radiation to which an individual is exposed. The units of measurement for dose equivalent are the rem (roentgen equivalent man), Sv (Sievert), and mSv (milliSievert), with one Sv equivalent to 100 rem and 1,000 mSv. Doses greater than 100 rem/1 Sv/1,000 mSv received over a short period are likely to cause acute radiation syndrome, leading to possible death within weeks. Table 1 describes some symptoms of radiation exposure from different levels of dose equivalent.

Chest X-ray	0.1 mSv
Average background exposure in one year	3 mSv
Abdominal X-ray	4 mSv
Living on the Colorado Plateau for one year	4.5 mSv
Typical yearly dose for a uranium miner	5-10 mSv
Full-body CT scan	10 mSv
Lowest dose for any statistical risk of cancer	50 mSv
Mild radiation sickness (headache, risk of infection)	0.5-1 Sv
Light radiation poisoning (mild to moderate nausea, fatigue, 10% risk of death after 30 days)	1-2 Sv
Severe radiation poisoning (vomiting, hair loss, permanent sterility, 35% risk of death after 30 days)	2-3 Sv
Severe radiation poisoning (bleeding in mouth and under skin, 50% risk of death after 30 days)	3-4 Sv
Acute radiation poisoning (60% fatality risk after 30 days)	4-6 Sv
Acute radiation poisoning (bone marrow destroyed, nearly 100% fatality after 14 days)	6-10 Sv
Acute radiation poisoning (symptoms appear within 30 minutes, massive diarrhea, internal bleeding, delirium, coma)	10-50 Sv
Coma in seconds or minutes, death within hours	50-80 Sv
Instant death*	>80 Sv

Table 1: Severity, Health Impacts, and Symptoms of Various Levels of Radiation Exposure (Source: Next Big Future)

Nuclear

The severity of a nuclear hazard will depend on the type, location, and amount of the release, as well as the size, density, and characteristics of the population affected.

iii. Probability

Since CBRN releases are generally not predictable, it is not possible to consider single events in terms of probability or recurrence intervals. However, the probability of an event will be higher near facilities that are not routinely maintained or inspected, at potential targets for an intentional attack, and at ports or other facilities where high volumes of hazardous materials are moved on a frequent basis. In addition, an estimated 27 billion gallons of combined sewer overflows (CSOs), containing a variety of hazardous chemical and biological materials, is released into New York Harbor every year from nonpoint sources. Triggers for such releases are heavy precipitation or flooding events (see Probability section of Flooding Hazard Analysis).

Figure 2, provided by the New York City Office of Emergency Management (OEM) and Leonard W. Connell of Sandia National Lab, is an unclassified and commonly used reference chart for the probability of CBRN events.

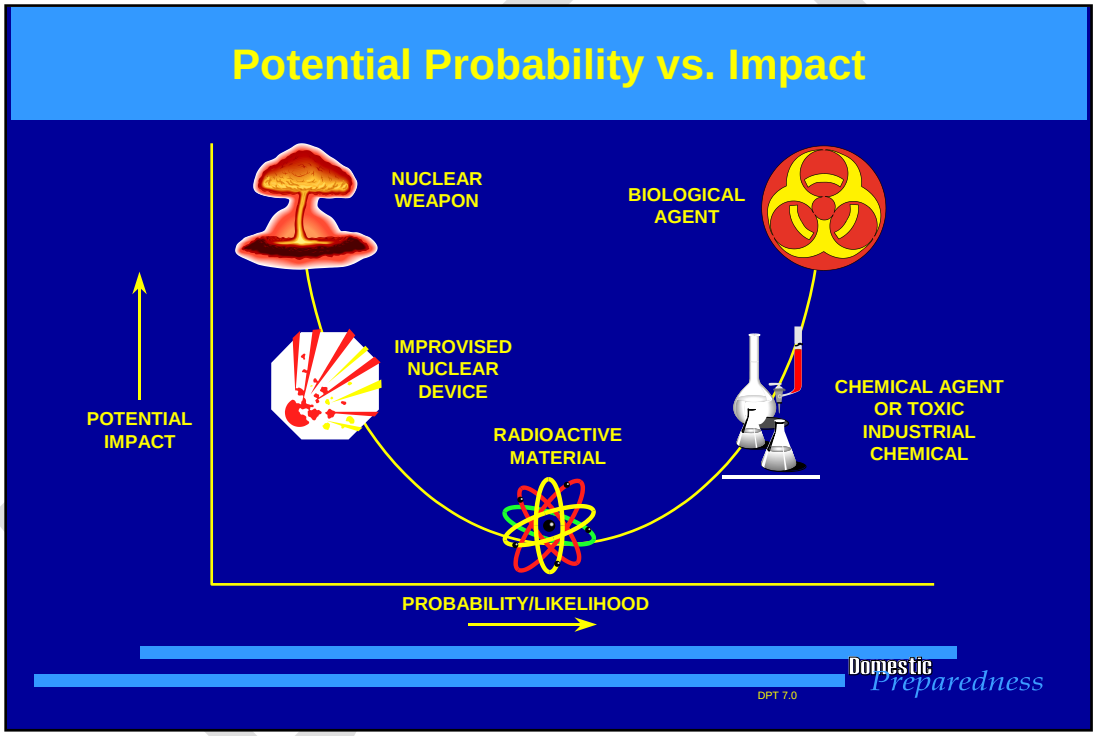

Figure 2: Probability vs. Impact of Different Categories of CBRN Releases.

iv. Location

Locations vulnerable to CBRN releases vary according to the type of release and whether the incident is accidental or intentional.

Chemical

The most at-risk locations for accidental chemical releases include neighborhoods and recreational or natural areas near chemical plants, industrial facilities/storage sites, warehouses, fuel stations, and brownfields/Superfund sites (such as Newtown Creek in Brooklyn/Queens and Gowanus Canal in Brooklyn). Common household chemicals (such as

cleaning solutions) or materials present in most buildings (such as heating oil) may also pose a risk to human health. The most likely targets for intentional releases are densely populated and crowded areas (such as tourist attractions, public transportation facilities, and entertainment venues) and critical facilities (such as financial centers, government offices, power plants, ports, and hospitals). Water supply reservoirs and distribution systems are also targets for a potential release.

Biological
Accidental biological incidents may occur anywhere in the city, although the risk of spread will be highest in the most densely populated areas. These outbreaks could potentially start from, for example, restaurants or food markets selling tainted food products, or from exposure to raw sewage. The most vulnerable locations for intentional biological attacks are the same as for chemical attacks.

Radiological
Accidental radiological incidents are most likely to occur near facilities storing radioactive materials or waste, and in buildings built above or near natural sources, such as radon gas. The most likely targets for an intentional radiological attack are the same as for chemical and biological attacks.

Nuclear
While there are no nuclear power facilities within New York City, a leak at a nearby facility (whether accidental or intentional) could potentially expose New York City residents to harmful radiation. Likely targets for an intentional nuclear detonation are the same as for chemical, biological, and radiological attacks.

v. Historic Occurrences

Although data on CBRN releases is limited, certain types of events (such as CSOs/raw sewage releases and oil spills) are relatively common occurrences, especially during heavy precipitation and flooding. Table 2 includes several examples of significant known CBRN releases in recent decades (details vary based on amount of information available).

Date	Event/Substance	Location	Description
February 10, 1973	Liquefied natural gas explosion	Staten Island	• 40 workers killed in an explosion while cleaning an empty LNG tank in Bloomsfield, Staten Island

16. Chemical, Biological, Radiological, and Nuclear (CBRN)

Date	Event/Substance	Location	Description
November 15, 1979	Oil spill	Brooklyn	• Oil refinery tank explosion in Greenpoint, Brooklyn, releases 17 to 30 million gallons of oil into Newtown Creek • Spill area covers up to 100 acres • Newtown Creek designated a Superfund site in 2010 • No direct fatalities or health effects linked to spill
August 7, 1980	Liquefied petroleum gas	Manhattan	• A Ritter truck carrying 9,000 gallons of liquefied petroleum gas leaks on the George Washington Bridge traveling from New Jersey to New York City • Bridge cleared for 8 hours out of fear of an explosion, creating massive traffic jam
September 2, 1986	Cyanide (intentional)	Manhattan	• 21 injured when cyanide is released in Metropolitan Opera
August 24, 1989	Asbestos	Manhattan	• Steam pipe explosion results in evacuation of Gramercy Park area in Manhattan after discovery of "extremely high" levels of asbestos
September 18, 2001	Anthrax (intentional)	Manhattan	• Letters sent to various media offices in New York City contain anthrax spores • Part of larger coordinated attack that also infects people in other cities and states • 5 people killed, 17 others infected (not all in New York City)
December 3, 2004	Chlorine	Bronx	• An SUV collides with a tractor-trailer carrying barrels of chlorine on the Cross Bronx Expressway, causing chlorine to leak onto the roadway • 3 firefighters and 2 police officers are exposed to high levels of chlorine and treated at the hospital
July 18, 2007	Asbestos	Manhattan	• Steam pipe explosion with asbestos found in the debris
August 15, 2010	Hydrogen peroxide	Manhattan	• Spill in a high-rise building due to machine malfunctioning releases about 30 gallons hydrogen peroxide

Date	Event/Substance	Location	Description
July 20, 2011	Raw sewage	Citywide	• Four-alarm fire at North River Wastewater Treatment Plant on the Hudson River and 135th Street in Manhattan • 15 to 20 million gallons of raw sewage released into Hudson River • Forced closure of 3 beaches in Staten Island and 1 beach in Brooklyn due to high levels of harmful bacteria in the water • DEP treats water with chlorine to reduce concentration of bacteria
October 29, 2012	Release of various hazardous substances during Hurricane Sandy	Citywide	• 10 of 14 DEP wastewater treatment plants are damaged or lose power, releasing approximately 560 million gallons of untreated sewage mixed with stormwater into local waterways • Floodwaters contain numerous other toxic substances such as oil, household chemicals, pesticides, and industrial pollutants
October 22, 2013	Oil spill	Manhattan	• Approximately 50 gallons of home heating oil spill into the street at West 36th Street and 7th Avenue in Manhattan • 3 people are contaminated and treated on-scene

Table 2: CBRN Releases in New York City (1973 to 2013).

B. Vulnerability Assessment

Human safety and welfare can become compromised from negative health effects of poisoning or exposure to toxic substances, fires, or explosions. Additional impacts may stem from long-term isolation of affected areas. Human fear or panic may also cause mental health impacts or disruptions to society, even if the real danger is not particularly severe.

i. Social Environment

CBRN incidents could potentially affect any person who resides in, works in, or visits New York City. Specific impacts will vary according to the type of material released, the geographic area, and the demographics of the population within that geographic area.

To evaluate the existence and/or magnitude of health problems resulting from exposure to a hazardous substance, health risk assessments are utilized. There are generally four steps in the health risk assessment process: health problem identification, toxicology (dose response),

exposure assessment, and health risk characterization. Health problem identification is the process of determining whether human exposure to a hazardous substance could cause adverse health impacts. Toxicology is the process of characterizing the relationship between the dose received and the adverse health effect in exposed populations; it also involves estimating the incidence of effects as a function of exposure and considers factors such as intensity of exposure, age, sex, and lifestyle. Exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of exposure to a substance currently in the environment, or to a hypothetical release of a substance into the environment. The main purpose of exposure assessment is to determine the concentration of hazardous materials over time and space in each environmental media where people may be exposed. The final stage of a health risk assessment is risk characterization, which involves estimating the incidence of health effects under various conditions of exposure described in the exposure assessment. The risk characterization combines the exposure and dose-response assessments.

Chemical
Populations who live or work near sites that contain hazardous materials or potential terrorist targets are at elevated risk of exposure to chemical hazards.

Biological
Densely populated residential areas, crowded business districts, and tourist attractions are at an increased risk from biological hazards due to closer human contact and the potential for increased rates of transmission. The elderly, young children, persons with mobility impairments, and individuals with pre-existing medical conditions or weakened immune systems are also at a heightened risk of succumbing if exposed (for more information on vulnerable populations, see "Social Environment" in Risk Assessment Section 4: New York City's Hazard Environment).

Radiological
The entire population is potentially at risk from radiological hazards, but the elderly, young children, the immobile, and those with pre-existing medical conditions are especially vulnerable. These populations are more likely to have a lower threshold dose of radiation to experience health issues.

Nuclear
Nuclear incidents could potentially impact any person who resides in, works in, or visits New York City.

ii. Built Environment

Although the most significant impacts of CBRN releases are on the human population and the natural environment, some materials can cause damage to the built environment. Impacts will depend on the type of material released and the nature of the exposed buildings, equipment, or infrastructure.

Chemical
Corrosive chemicals can damage building materials and infrastructure. Sensitive equipment and electronics may also be vulnerable to damage or explosions if they come in contact with reactive chemicals. Water distribution and filtration systems and air ventilation systems may be damaged or destroyed if contaminated with certain substances.

Biological
Biological hazards are an inherent danger to living organisms but generally do not pose a significant threat to the built environment.

Radiological
The most significant impacts of a radiological release to the built environment would come from the detonation of an RDD, and not from the radiation itself. However, radioactive contamination of certain structures may necessitate demolition to prevent exposure of occupants.

Nuclear
The entire built environment could suffer severe damage from a nuclear blast or detonation. The extent of damage would depend on the magnitude and location of the blast.

iii. Natural Environment

The impacts of CBRN releases on the natural environment will depend on the type of material released, the magnitude of the release, the location of the release relative to critical natural resources or habitats, and the existence of pathways that would allow substances to spread throughout the environment. Exposure to contaminants can occur via contact with contaminants in the water supply or ambient air. The remediation of the natural environment after a release poses unique challenges and can be lengthy and costly.

Chemical
Hazardous chemicals can be toxic to many species of plants and animals. Even if the only exposure is to species that are low on the food chain, these chemicals can indirectly impact other species as the concentration increases due to bioaccumulation. This may ultimately result in the loss of critical natural resources and ecosystems and negatively impact the human food supply. Depending on the type and size of the release, permanent damage or destruction of critical ecosystems may result.

Biological
Biological releases can also be devastating to plants and animals. Since different microorganisms and pathogens affect different hosts, the severity of impacts will depend on the type of material released. A significant release has the potential to cause wide-ranging impacts on a similar scale as a significant chemical release.

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Radiological
Exposure to significant doses of radiation damages cells and living tissues in plants and animals. Overall risks may be similar to those on human populations, and include genetic defects or mutations, cancer, and death. If the absorbed dose of radiation is relatively low, it may not have significant impacts on the plants and animals directly exposed, but could accumulate in the food chain and ultimately contaminate the food supply.

The disposal of hazardous waste and products from environmental cleanup is also a particular concern, especially regarding radiological waste. There are few radiological waste depositories in the United States, and radiological waste can persist in the environment for hundreds or thousands of years.

Nuclear
Nuclear releases pose the same threats to the environment as radiological releases do, with the additional risk of damage resulting from the nuclear blast itself.

iv. Future Environment

The threat of CBRN releases in the future will depend on a number of factors that are currently uncertain.

Chemical
Increased or decreased reliance on products containing certain types of chemicals can change the risk of exposure. Shifts in the market or industrial trends may also change the number or distribution of facilities where hazardous chemicals are stored. New or emerging chemicals present challenges in understanding and anticipating toxicological effects and conceiving methods to prevent or control exposures. New technologies, such as safer storage, could also decrease the likelihood of a release.

Biological
Potential shifts in population density and distribution may change the number of people impacted and affect the transmission rate for biological hazards. Medical advances and vaccines could also decrease the risk of exposure to certain types of diseases. However, these changes also have the potential to promote genetic mutations in microorganisms and pathogens, which could cause deadly new resistant strains of certain types of diseases.

Radiological
The future risk of radiological releases will depend on changes in the need for these types of materials for usage in industrial processes or power generation. New technologies, such as increased or improved radiation screening, and the development of new alternatives for the storage of radioactive waste will also play a role in determining future vulnerability.

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Nuclear

The future risk of accidental nuclear releases will depend on changes in the need for such materials for power generation and new technologies that could potentially make nuclear facilities either safer or obsolete. Technological advances could also result in the development of more sophisticated nuclear explosive devices. The threat from such devices would depend on the availability of this technology and the pursuit of political aims through intentional harmful acts. However, advances in security may also go a long way in ensuring that such intentional attacks would not happen.

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A. Hazard Profile

i. Hazard Description

While the broad reach of cyberspace has done much to improve communication, innovation, and information, its largely open and unregulated nature also leaves New York City vulnerable to cyber threats. A cyber incident, or the threat of such an event is an adverse event in an information system and/or network.

A cyber attack is an incident that is intentional and malicious in nature. An attack occurs when the digital infrastructure of a person or organization is compromised, often for financial or terror-related reasons. Such attacks vary in nature and are perpetrated using digital medium or, sometimes, social engineering, which targets human operators—as opposed to computers—as a primary vulnerability of a digital system. The growing dependence on digital infrastructure means that even a small incident at a targeted location may have widespread, damaging consequences.

Cyber attacks can take the form of data breaches, crippling viruses, or even physically damaging incidents. Generally, the hazard duration for such attacks last minutes to days, but large-scale events can last even longer.

Cyber attacks differ by motive, attack type, and perpetrator profile. Motivating factors for cyber attacks can vary tremendously; however most attacks fall into one of the following three categories: cyber crimes, hacktivisim and cyber espionage. Hacktivisim is the most common motivation for incidents affecting New York City, based on historical occurrences.

Six forms of cyber attacks are presented in Table 1 below:

Cyber Attacks	Attack Vectors	Description of Attack
Spoofing	Phishing	A person or program successfully masquerades as another by falsifying data and thereby gaining an illegitimate advantage
Tampering	Defacement	Modification of data. Example: modification of website content or appearance can lead to propagation of misinformation
Repudiation	Insider	Challenging authenticity. Example: account compromise or unauthorized access to information technology—data, emails, or network access—leading to altering data integrity
Information Disclosure	Data Leak	The unintentional or intentional release of secure information—possibly private or confidential data—to an untrusted environment

Cyber Attacks	Attack Vectors	Description of Attack
Denial of service	Distributed Denial of Service (DDoS)	An overwhelming number of false requests intended to prevent any legitimate service from functioning properly
Elevation of Privilege	Malicious code	Exploitation of a bug or design flaw, sometimes in an operating system, software application, database or website, which allows a user to gain higher levels of access to resources

Table 1: Major Types of Cyber Attacks (Source: New York City Draft Cyber Incidents Response Protocol)

Cyber attacks may be carried out by so-called external actors, internal actors, and partner actors (see Table 2). According to the Verizon 2013 Data Breach Investigation Report (DBIR), 92% of cyber attacks were perpetrated by external actors (see Figure 1).

Category	Category Description	Description of Attack
External	Outside of the victim organization	This category can be broken into subgroups: organized crime, state-affiliated, unaffiliated, unknown, activist, and former employees
Internal	Inside of the victim organization	In the past, these attacks have usually been malicious, for the purposes of financial gain, though some were the result of breaches due to careless or accidental data exposure
Partner	Third party sharing a business relationship with the victim	The least common of the three categories of attacks, this type of attack might be the result of, for example, a courier losing a device containing sensitive data

Table 2: Perpetrator Categories for Cyber Attacks (Source: Verizon Wireless DBIR, 2013)

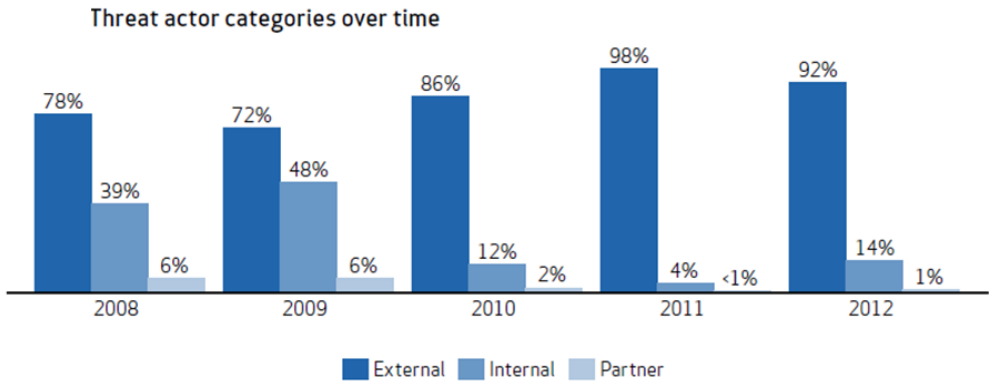

Figure 1: Threat Actor Categories 2008-2012 (Source: Verizon Wireless DBIR, 2013)

ii. Severity

There is currently no official index for measuring the severity of a cyber attack. However, the Gibson Index was created in February 2013 to serve as an open-source

ranking system for the relative severity of cyber attacks. The Gibson Index ranges from 0 to 7, with 7 being the most severe class of attack.

0 – Little or no disruption
1 – Some small real-world consequences
2 – Clear malicious intent, resulting in longer outages
3 – Minor financial damages and moderate privacy implications
4 – Major financial damages and privacy implications
5 – Systematic, coordinated, broad penetration of a multitude of networks
6 – Attacks that manifest themselves in real-world, targeted, intentional damage
7 – Mass casualties from intentional, targeted efforts

iii. Probability

The probability of a cyber attack is difficult to calculate due to the unpredictability of human behavior.

iv. Location

Unlike other hazards associated with specific geographic locations, the Internet is accessible remotely from any location. Attacks that affect New York City can originate from anywhere—even outside the city—adding an additional layer of complexity to protecting the city. The targets of these attacks can be very large corporations, governments, or even individuals—in fact, anything that is digitally connected is technically vulnerable. Specific target sectors that might result in citywide effects include:

- Financial centers
- Government buildings
- Media outlets
- Transportation authorities
- Power/Utilities companies
- Telecommunications networks

Figure 2, below, shows the breakdown of victim industries for cyber attacks in 2012, taken from the Verizon DBIR.

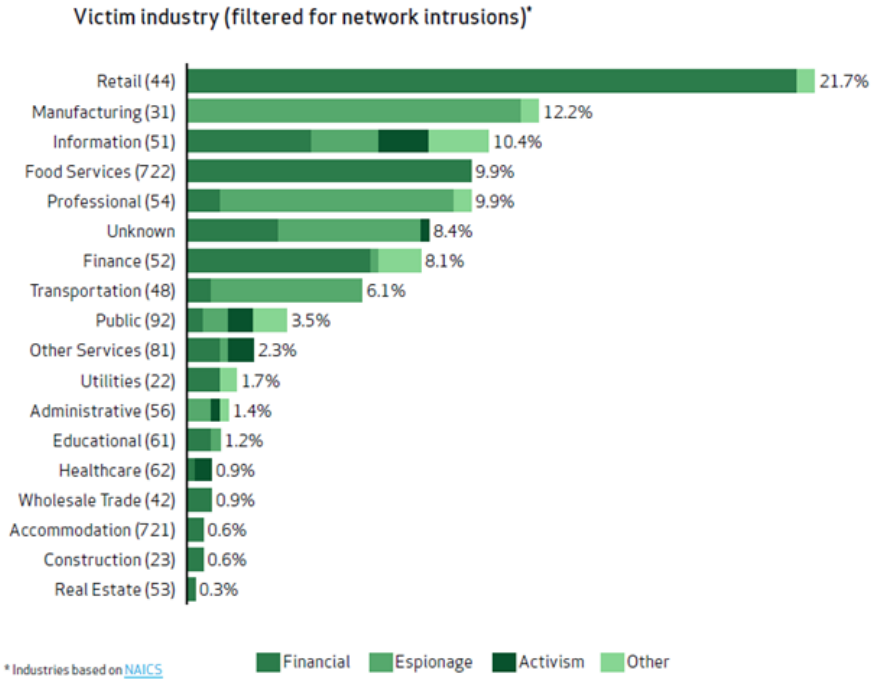

Figure 2: Victims of Cyber Attacks by Industry in 2012 (Source: Verizon DBIR, 2013)

v. Historic Occurrences

There have been significant cyber attacks in New York City over the last few years, as indicated in Table 3, below.

Date	Category	Description
December 8, 2010	Denial of service	• Denial of service for Visa, MasterCard, and Paypal
May 10, 2011	Information disclosure	• Data breach for 360,000 Citibank customers • Cost of the breach was around $22 million, with the hackers making $2.7 million
September 13, 2012	Denial of service	• New York Times hacked
April 23, 2013	Tampering	• AP Twitter feed hacked • A false message about explosions in the White House injuring President Obama is tweeted • Attack causes Dow Jones industrial average to fall 128 points • The White House is forced to reassure reporters that the president was all right and the report was false

Date	Category	Description
August 15, 2013	Denial of service	• CNN.com hacked by Syrian Electronic Army • Deemed malicious external attack
August 15, 2013	Denial of service	• Syrian Electronic Army attack on the Washington Post website through a third-party service provided by a company called Outbrain
August 27, 2013	Denial of service	• Attack on New York Times and Twitter • New York Times website was unavailable to readers due to an attack on the company's domain name registrar, considered more sophisticated than previous incidents • New York Times website was inaccessible for over 10 hours • Attack credited to Syrian Electronic Army • Deemed malicious external attack

Table 3: Significant Historic Cyber Incidents Affecting New York City 2010 to 2013

B. Vulnerability Assessment

i. Social Environment

The social environment is vulnerable to cyber attacks in a number of ways. Stolen personal information can destroy the financial standing of individuals. Additionally, cyber incidents can have a damaging effect on public trust in systems that are traditionally considered stable and secure—such as the nation's industrial, financial, and utility infrastructures. Cyber attacks can create fear and erode the public trust needed for private and public services to run successfully.

ii. Built Environment

A catastrophic cyber incident can have far-ranging effects on public and private infrastructure systems. Cyber attacks can cause physical damage if real assets or the end consumers are affected by service disruption. This might occur if cyber attacks target industries related to utilities, life support, transportation, human services, and telecommunications. In many cases, attacks on these systems initially will not be detected, and any malfunction will be thought to be system failure.

Cyber attacks can have extensive fiscal impacts. Companies and government services can lose large sums of unrecoverable revenue from site downtime and possible compromise of sensitive confidential data. Cyber incidents could result in the theft or modification of important data—including personal, agency, or corporate information—

and the sabotage of critical processes, including the provision of basic services by government or private-sector entities.

iii. Natural Environment

While effects of cyber threats on the natural environment would be unlikely, they are conceivable. Like the effects on the built environment, the effects on the natural environment may come from a system failure that, for example, allows a release of hazardous materials or improper disposal of waste (see CBRN Hazard Analysis).

iv. Future Environment

Vulnerability to cyber attacks may change significantly in the future. As technology improves, security measures will improve, but cyber threat capabilities may also become equally sophisticated. The attack vectors, however, may stay the same. Since the threat of cyber attacks is increasing at a rapid rate, emphasis should be placed on preventative security measures.

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A. Hazard Profile

i. Hazard Description

Aging public infrastructure and utilities are a problem across the United States, especially in older cities like New York. In addition to age-related deterioration, infrastructure and utilities may also face increasing strain from population growth, with more people, there are more cars on the roads, riders on public transit, more demand for water and wastewater treatment, and energy. Endogenous hazards (such as construction or maintenance flaws) and exogenous hazards (natural hazards) may also increase the risk of failure. Effective maintenance and security are critical to reducing potential risks.

Four critical infrastructure sectors established under the authority of Homeland Security Presidential Directive 7 (HSPD-7)—transportation, water systems, energy, and telecommunications—are examined here for their potential for failure in New York City.

Transportation

New York City's transportation system is sprawling and complex, comprised of large, interconnected rails, roadways, bridges, tunnels, and water transportation networks.

Rail Transportation

Freight, commuter, and subway lines are subject to infrastructure failures due to weakening joints, erosion, and unstable rails that can cause train car collisions and derailment. The functioning of rail lines is also vulnerable to disruption due to power failures. Subway breakdowns, while not frequent, can occur as a result of aging machinery.

Rail transportation's underground and above-ground rails are vulnerable to weather-related events. Underground rails are vulnerable to flooding and coastal storm events, whereas above-ground rails are subject to high winds that can cause subway or rail cars to tip or derail. The MTA prepares for these weather events by moving cars to secure locations. Extreme temperatures can also affect railroad tracks, causing the steel to shrink during extreme cold weather and buckle during extreme heat events, which could cause train derailments.

Since rail transportation systems depend on electricity for power, consuming 1.8 billion kilowatt hours of power each year, utility disruptions are also a concern. For example, in October 2013, a power failure caused by the loss of a feeder cable on the New Haven line of the Metro-North Railroad affected commuter service from Grand Central Station in Manhattan to Stamford, Connecticut, for 12 days.

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Roadway Transportation

Bridge components are subject to cracking, rusting, ground subsidence, and corrosion caused by exposure to water, wind, vibration, ozone, dust, dirt, acidity of bird droppings, chemicals in salt products, and gasoline. Many of New York City's bridges are over 100 years old and are vulnerable to age related deterioration. For these reason, New York State law mandates that vehicular bridges be inspected every two years. Bridge maintenance is extremely important to prevent failures. For example, in 1988, NYC DOT inspectors identified areas of rust on the Williamsburg Bridge, which was subsequently closed for two months so repairs could be made.

According to the *PlaNYC Progress Report 2013*, New York City has continued to make major investments in maintaining its bridges. For example, the Brooklyn Bridge rehabilitation project provides for rehabilitation and repair of ramps and approaches, and the Manhattan Bridge's suspenders, which connect the bridge deck to the main cables, have recently been replaced and upgrades have been made to the necklace lighting and maintenance platforms. The smaller Third Avenue and Willis Avenue bridges spanning the Harlem River were completely replaced in 2005 and 2011, respectively. In addition to needing substantial repairs, these bridges had not met current structural or seismic requirements, making them particularly vulnerable. The Goethals Bridge, a PANYNJ facility that connects New York with New Jersey and is part of the I-278 corridor that runs through all five boroughs, will also be completely replaced. In 2013, the raising of the Bayonne Bridge roadway began as part of a harbor-wide effort to accommodate larger container ships; the project is expected to take four years to complete.

Tunnels are also vulnerable to infrastructure failures. Water can seep into tunnels as a result of groundwater penetration or broken water mains. Open vents and active ventilation systems are vulnerable to rain and coastal flooding. NYC DOT, MTA, and PANYNJ regularly inspect tunnels to identify any structural vulnerability.

While at-grade roadways are generally less vulnerable to failure than bridges and tunnels, subsurface conditions (such as a sinkhole or collapsed sewer) can undermine streets and lead to failure.

Retaining walls, many of which were built in the early 1900s, are also vulnerable to failure. In many cases, these retaining walls are critical to the structural integrity and function of major transportation links. In 2005, the failure of a retaining wall in Washington Heights buried a portion of the Henry Hudson Parkway in rubble, causing major disruptions to traffic.

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Water Transportation

Water transportation systems are also vulnerable to infrastructure failures. The New York Harbor allows for water-borne transportation for commuters, residents, and tourists and allows New York City to remain competitive as one of the largest shipping ports worldwide. Accessibility to the waterfront also provides alternative options for evacuating residents during major emergencies in New York City and for moving people safely when other modes of transportation experience shutdowns, such as during power outages. After the 9/11 attacks, ferries safely evacuated hundreds of thousands of people from Lower Manhattan and were used in the following days for transportation of emergency personnel, vehicles, and equipment to and from Ground Zero.

In addition to regular maintenance of the vessels themselves, there are over 50 piers, slips, docks, and ferry terminals in New York City that must be regularly maintained to ensure the safe docking of ferry boats and unloading of passengers. Major coastal storms and ferry accidents are two types of incidents that can cause damage to these structures and result in large debris in the waterways, posing a navigational hazard. Additionally, many of the piers have mechanically operated ramps that rely on electricity to operate, and shipping container terminals cannot operate without power. Any incident resulting in power outages would have a major impact on passenger ferry and shipping operations.

(For more information on the transportation system, see New York City's Hazard Environment)

Water Systems

Water Supply

New York City receives its water from a complex system of tunnels, dams, reservoirs, and aqueducts. As identified in the New York City's Hazard Environment, three upstate reservoir systems impound water from this system. Water is distributed from these reservoirs to the city through three aqueducts and then delivered to Water Tunnels 1 and 2 that are responsible for bringing water to city residents. Water Tunnel 1, completed in 1917, is 18 miles long, and Tunnel 2, completed in 1936, is 20 miles long. Both tunnels have been in continuous service since they were activated. For Tunnels 1 and 2 to be inspected and rehabilitated if needed, the City has been constructing Tunnel 3. Tunnel 3 has been constructed in stages due to its immensity and is projected to be completed by 2020.

Around 30% of the distribution system was built before 1930. Water main breaks are due to a combination of factors including temperature (being more likely to occur in the colder months) and the material from which the water main is made. In 2012, there were almost 350 breaks in the City's network of approximately 6,800 miles of water mains, down from a high of 632 breaks in 2003. This year, there were fewer than six breaks per 100 miles of pipe, well below the accepted industry standard. Although

water main breaks may occur, they rarely cause extensive damage to the city's water distribution system.

The City also monitors the aqueducts and tunnels that deliver water from the city's reservoirs. The Delaware Aqueduct, which runs 300 to 2,400 feet below surface, has confirmed leaks in two areas and leaks up to an estimated 36 million gallons per day. While the leaks are concerning, the situation in the tunnel and amount of water loss is stable. In the opinion of the professional engineering firm retained by the New York City Department of Environmental Protection (DEP) to investigate the status of the tunnel, there is very little immediate risk of failure of the tunnel.

DEP operates numerous dams in upstate New York and maintains a dam safety program that seeks to meet or exceed New York State Department of Conservation (NYSDEC) and federal dam safety guidelines.

There are two existing water siphons that provide potable water to Staten Island via Brooklyn. In preparation for the New York Harbor deepening project, both siphons will be replaced by one 72-inch siphon positioned deeper underground. Concerns have arisen that the 50-foot dredging of the Harbor might disrupt one or both of the existing siphons, so this replacement project is designed to ensure uninterrupted water service to Staten Island by adding a redundancy of 5 million gallons per day (MGD) of water supply under normal conditions. In addition to infrastructure improvements to connect the new siphon to existing water systems, a chlorine station will be constructed on the Staten Island side.

According to the *PlaNYC Progress Report 2013*, since 2002, the City has invested $186 million to investigate the leak in the Branch Tunnel of the Delaware Aqueduct and to develop the City's long-term plan, *Water for the Future,* to repair the leak and ensure reliable water. In addition, the City has invested more than $507 million to upgrade dams and related upstate assets and plans to commit another $283 million until 2021 to complete the dam reconstruction program.

Wastewater Treatment

As identified in the New York City's Hazard Environment, the city manages and operates 14 wastewater treatment plants that treat 1.3 billion gallons of wastewater daily before releasing it to local waterways. The city's wastewater treatment system is vulnerable to infrastructure failure during weather-related events, partly due to the combined sewer system that collects both stormwater and sanitary waste. For example, during periods of heavy rains or snow, flooding, and coastal storms, the combined volume of sewage and stormwater can exceed the capacity of wastewater treatment facilities. In the event of a power failure, wastewater treatment facilities may lose the ability to treat wastewater. As a result, combined sewer overflows (CS0s) would travel directly into the local waterways. DEP currently invests in "green" infrastructure and Bluebelt projects to

help absorb stormwater before it can enter the sewer system. For more information see New York City's Hazard Environment section.

Energy

Most of New York City gets its energy in the form of electricity, natural gas, and steam. An energy disruption can be defined as a loss of electrical service, gas, or steam supply due to equipment failure, natural hazards, sabotage, or accident.

Electricity Systems

The city's electrical distribution system consists of a combination of underground networks and overhead utility lines. As identified in New York City's Hazard Environment section, the Consolidated Edison Company of New York, Inc. (Con Edison) provides services nearly all of New York City, with the exception of the Rockaway Peninsula in Queens, which is serviced by utilities overseen by the Long Island Power Authority (LIPA).

An infrastructure failure in the electrical distribution system would be a power disruption or outage. Power disruptions are most common during extreme heat events in the summer, when residents and businesses have air conditioners turned on and power usage is at its peak, straining the system's capacity. They can also occur during a coastal storm or severe weather, when winds take down trees and overhead power lines or there is flooding of the underground electrical network. Electric generation plants are also vulnerable to flooding because a majority of the plants are located in the 100-year floodplain. In addition, power failures can occur during winter storms when power lines and poles are broken by accumulated ice or downed trees. (For more information, see Extreme Temperatures, Severe Weather, and Winter Storms.)

Natural Gas:

A common emergency with the natural gas distribution system is an indoor or outdoor leak, which can be caused by weather, equipment failures, or human error (such when a leak is caused by building contractors). Since natural gas has no odor, transmission line operators add an odorant to the gas. The use of the odorant allows members of the public to smell natural gas and to report that odor to first responders. Another indication of a gas leak is pressure loss. Repairs to leaks will often require closing valves or opening trenches to access underground pipes.

Steam:

As identified in the NYC Hazard Environment, approximately 1,700 customers in the city rely on the Con Edison district steam system, located in Manhattan south of 96th Street. The most concentrated steam distribution centers are in the Financial District and midtown Manhattan. Pipes require periodic repair and maintenance due to the age of the pipes and extreme service conditions, which include high temperatures and high

pressure conditions. Steam mains are maintained by Con Edison, and leaks are addressed immediately.

Emergencies can develop when potable water or rainwater surrounds steam pipes and the main must be turned off until the water condition is alleviated. Steam pipe explosions are rare, but when they do happen they can be catastrophic and severely impact human life and street infrastructure. Explosions can be a result of a phenomenon called "water hammer," whereby rapid cooling of the main creates excessive condensation that is not removed effectively from the steam pipe. Pooling condensate is picked up by flowing steam and driven—with great force—into pipe fittings.

(For more information on the energy system, see New York City's Hazard Environment)

Telecommunications

As identified, in New York City's Hazard Environment, the telecommunications sector is made up of physical properties (such as wireline, wireless, satellite, cable, and broadcasting equipment) as well as services (such as the Internet, information services, and cable television networks). Communication is vitally important and essential to health and public safety.

Telecommunication systems are vulnerable to weather events including flooding, coastal storms, high winds, and extreme heat. Since electricity is used to power telecommunications, the systems are also vulnerable to power failures.
Telecommunication failures can also occur as a result of congestion (call volumes and internet usage) overloading the communications system during a crisis or disaster.

An understanding of the risk of infrastructure failures in the telecommunications system requires an understanding of the major components of the system. It consists of critical facilities such as telephone central offices, colocation hotels (buildings where data are transferred from one provider to another), cabling, cell sites, and equipment in individual buildings. All of these components are interconnected and must function along the entire distribution route for communication to be successful. Critical facilities are responsible for transmitting services such as telephone, wireless, internet, and cable. Although critical facilities have back-up batteries and fuel-powered generators, these systems are vulnerable to flooding if located in the building basements. For example, Verizon's central office had generators and electrical switchgear located at or below grade. During Hurricane Sandy, these systems were inundated with salt water, which caused power failures that led to a loss of phone service over a wide swath of Lower Manhattan.

Critical facilities are also vulnerable to extreme heat events because these facilities are dependent on the city's power distribution system. These facilities contain computer-controlled digital and fiber optic equipment that are sensitive to dust, temperature, and

humidity. Although these facilities are equipped with ventilation and cooling systems, a long-lasting heat event may threaten the power grid and shorten the lifespan of electronic telecommunications equipment.

The distribution of telecommunications consists of cabling, which is located both above and below ground. Overhead cabling is subject to failure due to high winds, tornadoes, and ice storms and underground cables could be destroyed by earthquakes and flooding. As identified, in New York City's Hazard Environment, the three main types of cabling in the city's telecommunications system are lead-encased copper, coaxial, and fiber cables. The oldest cabling in the telecommunications system is lead-encased copper, which is in poor condition due to its age. Some of these cables have leaks, compromising the pressurized air system designed to keep water from inundating the copper wiring. A newer material, coaxial cable, is relatively resistant to water but used only for cable television and Internet distribution. Finally, fiber cables are the most reliable cabling type because they are both water-resistant and capable of carrying all types of service.

Due to the density of the city, cell sites in the city are most often placed on the rooftop of buildings. Because these sites depend on power supplied by energy providers and have only a four- to eight-hour backup life, they are at risk from power failures. In addition, cell sites are most often placed on private buildings, making it challenging to restore during power outages because power must first be restored to the individual building.

Although federal, state, and city agencies are involved in the regulation of the telecommunications industry, no single governmental entity has the full responsibility for the entire system nor has the jurisdiction to require that service is available in emergencies. The FCC does promote best practices for mitigation through the Communications Security, Reliability, and Interoperability Council; however, it does not require communication companies to comply with these standards or able to enforce mitigation practices across communication systems.

(For more information on the Telecommunications system, see New York City's Hazard Environment)

ii. Severity

Transportation

The severity of infrastructure failures for New York City's transportation system largely depends on the size and criticality of affected networks, their location, the number of people directly impacted, and the secondary impacts to essential services and the economy. A failure can range from a localized occurrence to a system-wide incident, depending on the type of failure.

Water Systems

The severity of water distribution and treatment failures can range from a localized event, such as a water main break, to a system-wide incident, such as a dam failure impacting the distribution of water for New York City residents. Severity is largely dependent on the location of the failure, the number of people impacted, the duration of the disruption, and impacts to essential services.

Energy

The severity of energy disruptions depends on the cause, location, duration, and time of year. It can range from localized events to city-wide power outages. Although New York City's power system is much more reliable than the national average, impacts from a failure of the city's grid system can be significant. During the Northeast Blackout of 2003, the New York City Fire Department (FDNY) rescued more than 800 people trapped in elevators and the subway system was halted, stranding 400,000 passengers traveling on 400 subway trains who were eventually evacuated by the MTA. Due to an absence of back-up power for the city's traffic signals, traffic disruptions, city tunnel closures, and congestion occurred.

The severity or extent of power failures also depends on the electrical distribution system. New York City's electrical distribution includes overhead utility lines and underground networks. Overhead utility lines are less reliable and are vulnerable to weather like high winds and ice storms. However, they can typically be restored faster than underground networks because the damage can be easily located, accessed, isolated, and repaired. Overhead utilities are found in more suburban areas of the city including Staten Island, the Rockaway Peninsula, and parts of Queens, Bronx, and Brooklyn. Manhattan is the only borough that relies exclusively on an underground network system.

Underground networks, on the other hand, are not vulnerable to high wind events but are more vulnerable to coastal flooding. This is especially true for underground transformers and cables as well as area substations (responsible for reducing voltage for distribution) located in the flood zone. Furthermore, underground networks take two to three times longer to restore than overhead lines. This is usually due to the time needed for crews to safely access underground manholes or transformers, find the location of the fault, electrically ground equipment for safety, and make repairs to wires and other power equipment. These repairs can be complicated by traffic, pedestrians, and proximity of the public and vehicular obstructions.

Historically, power outages are more likely to occur during extreme heat events in the summer, when peak load is at or above 11,000 megawatts (MW) per day. The record peak load of 13,322 MW was reached July 19, 2013. Outages may also occur as a secondary impact of a coastal storm, high wind event, or ice storm.

The severity of a power outage can be also be determined by the duration of the outage, and a longer outage can have a severe impact on the social environment. During the Queens blackout in 2006, 174,000 residents were without power for nine days. Four days after Hurricane Sandy hit, Con Edison was able to restore power to most customers in Manhattan; however, some customers were without power for two or more weeks. LIPA's electric service restoration took an average of 14 days, with some customers experiencing much longer outages.

Telecommunications

The severity of a telecommunications failure depends on the cause, location, and duration of the disruption. It can range from a localized disruption in service to a citywide failure. Since telecommunications services are dependent on the city's power grid, major energy disruptions could also result in citywide disruptions in telecommunications.

iii. Probability

Transportation

Due to the extent of New York City's transportation system combined with future population growth, it is likely that transportation failures will occur in the future. In addition, more frequent occurrences of extreme weather events (earthquakes, periods of extreme temperatures, coastal storms, and flooding) may increase the chance of failures. Operational errors and design flaws—which are not easy to predict—may also increase the risk of failures.

Water Systems

Based on the extent of New York City's water distribution and treatment system combined with future population growth, it is likely that water distribution and treatment failures will occur in the future. In addition, more frequent occurrences of extreme weather events (coastal storms, flooding, and severe weather) increase the threat to water-related infrastructure failures.

Energy

Based on the age and extent of New York City's energy distribution system combined with future population growth, it is likely that energy disruptions will occur in the future. More frequent occurrences of weather-related events (extreme temperatures, severe weather, coastal storms, and flooding) increase the chances of energy failures. In addition, human error or damage during equipment operation, maintenance, or construction—none of which is easy to predict—may increase the risk of failures.

Telecommunications

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If telecommunications companies do not invest in mitigation strategies—such as hardening facilities, switching to fiber cables, and elevating electrical equipment—infrastructure failures will continue to occur in the future. Due to the absence of a single entity overseeing telecommunication systems, mitigation regulations are not required or enforced increasing the likelihood of future communication failures.

iv. Location

Transportation

Locations in the city that are most vulnerable to transportation-related infrastructure failures include bridges, vehicular tunnels, subway and railroad tunnels, and retaining walls adjacent to roadways. These infrastructural systems are dispersed throughout the city. Major bridges that could be vulnerable to infrastructure failures include the George Washington Bridge, Verrazano-Narrows, Robert F. Kennedy (formerly Triborough), Hell Gate, Brooklyn, Manhattan, Williamsburg, and Ed Koch-Queensboro. In addition, the major underwater vehicular tunnels that could be vulnerable to infrastructure failures are the Holland, Lincoln, Queens Mid-town, and Hugh L. Carey (formerly the Brooklyn Battery Tunnel).

Water Systems

The city is also vulnerable to infrastructure failures in the water system, which includes the reservoirs, dams, aqueducts, water tunnels, and distribution mains. The Catskill/Delaware watersheds are located northwest of the city, and the Croton Watershed is north of the city in Westchester and Putnam Counties. Although the reservoirs, aqueducts, and dams are located outside the city's boundaries, there is redundancy built into the system to minimize impacts and occurrences of failures (leaks, cracks, or collapse).

Energy

Energy disruptions can occur anywhere in New York City. Nevertheless, depending on the cause, some areas are more vulnerable to power outages than others. For example, areas along the coast are more susceptible to power outages during a coastal storm. Areas that are serviced by overhead power lines are more vulnerable to outages during an ice storm or high wind event. Figure 1 shows New York City's power network system.

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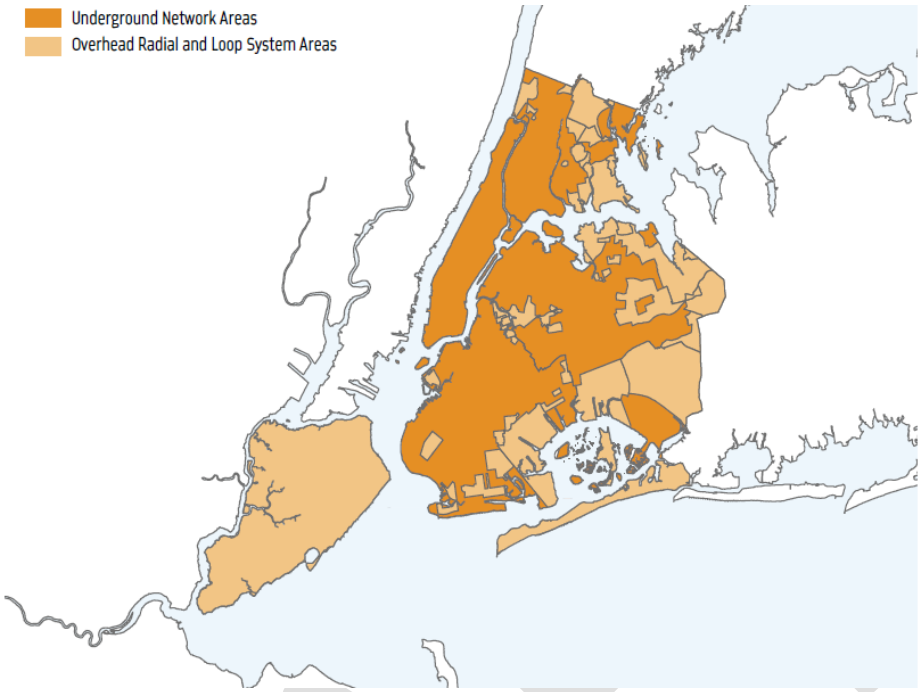

Figure 1: Electricity Distribution System Types (Source: Con Edison, LIPA, SIRR)

Telecommunications

Although New York City's telecommunications systems are generally reliable, a large volume of traffic is routed through a small number of colocation facilities in Lower Manhattan, increasing vulnerability. In addition, 13% of critical telecommunications facilities are located in the 100-year flood zone. Areas in the city that are serviced by overhead utility cables—including parts of the Bronx, Brooklyn, Queens, and Staten Island—are more vulnerable to telecommunication disruptions caused by high winds, ice storms, and tornadoes.

v. Historic Occurrences

Table 1 identifies major infrastructure failure occurrences by affected sector.

Date	Infrastructure Sector	Location	Description
August 24, 1928	Transportation	Manhattan	• Subway train derails in Times Square • 16 fatalities • 100 injuries
August 31, 1959	Energy	Manhattan	• Power outage for a 500-block radius around Central Park during an extreme heat event • 500,000 people lose power for nearly 13 hours

18. INFRASTRUCTURE FAILURES

Date	Infrastructure Sector	Location	Description
November 9, 1965	Energy	Citywide	• Several Northeastern states and parts of Canada experience blackouts • 800,000 subway riders are stranded • Major traffic disruptions • Planes unable to land
December 29, 1969	Transportation	Bronx	• Southbound IRT train derails near 180th Street • 48 injuries
May 18, 1973	Transportation	Manhattan	• Northbound No. 5 Lexington Avenue Express train derails south of Grand Central • First eight cars of the 10-car train derail
August 28, 1973	Transportation	Queens	• 20-foot chunk of concrete ceiling duct in Steinway Tunnel hits subway cars • One fatality • 18 injuries • Passengers trapped in 115-degree heat and heavy smoke
July 13, 1977	Energy	Citywide	• A series of lighting strikes initiates a 25-hour blackout • Leads to widespread looting • Estimated $300 million in damage
August 19, 1989	Energy (Steam)	Manhattan	• Explosion near Gramercy Park • Two steam workers and one resident killed • 200 residents evacuated from their building due to the release of asbestos

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18. INFRASTRUCTURE FAILURES

Date	Infrastructure Sector	Location	Description
Dec. 29, 1989	Energy (Natural Gas)	Bronx	• Natural gas main in South Bronx explodes, producing a tower of flames nearly 12 stories high • Explosion is caused by a backhoe truck striking a 26-inch underground main outside of a Con Edison distribution plant • Two fatalities (one Con Edison utility worker) • Forces a shudown of power and subway service in Bronx and areas of Manhattan
August 28, 1991	Transportation	Manhattan	• Southbound No. 4 train derails going over a switch north of Union Square • Five fatalities • 200 injuries • Service disrupted for 6 days • Considered the worst subway accident in 63 years
February 2, 1993	Telecommunications	Manhattan	• A bomb planted by terrorists explodes in the World Trade Center (WTC) underground garage, killing 6 and injuring over 1,000 • Breakdown of communications at WTC because of insufficient capacity in FDNY's radio network
June 5, 1995	Transportation	Manhattan/ Brooklyn	• Manhattan-bound M train on the Williamsburg Bridge is hit from behind by a J train • One fatality • 50 injuries • Spacing of signals and poor performance of train brakes contribute to the crash
August 13, 1996	Transportation	Brooklyn	• Brooklyn-bound D train derails while pulling out of DeKalb Avenue station • Caused by track work in the area

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18. INFRASTRUCTURE FAILURES

Date	Infrastructure Sector	Location	Description
August 31, 2000	Energy (Steam)	Manhattan	• Steam pipe explosion near Washington Square Park near New York University Bobst Library • Explosion scatters debris • Releases asbestos in the air
June 21, 2000	Transportation	Brooklyn	• Southbound B train derails at Dekalb Avenue • First three cars of train derail • 70 injuries • 70 feet of track need to be replaced
September 11, 2001	Energy/ Transportation/ Telecommunications	Citywide	• Terrorist attacks on the World Trade Center (WTC) cause major damage to infrastructure and disruptions to critical services • Bridges and tunnels close • Tracks and stations under the WTC shut down after first attack • Trains running to Lower Manhattan lose power and have to be evacuated • Two substations lose power • Portions of Con Edison's infrastructure in Lower Manhattan are destroyed • Disrupted broadcast capabilities because One WTC housed many television and radio broadcast antennas
August 15, 2003	Energy/ Transportation/ Telecommunications	Citywide	• Power surge causes power outages in some Northeastern states and parts of Canada • Subway riders are evacuated from tunnels • Airports suffer major disruptions
May 13, 2005	Transportation	Manhattan	• A 75-foot-high stone retaining wall built in 1908 collapses onto Henry Hudson Parkway • Wall in need of reinforcement

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18. INFRASTRUCTURE FAILURES

Date	Infrastructure Sector	Location	Description
July 18, 2006	Energy	Queens	• Major power outages in Astoria, Long Island City, Sunnyside, and Woodside during extreme heat event • 174,000 people lose power • Power is disrupted at LaGuardia Airport • Subway lines in Queens lose power
July 18, 2007	Energy (steam)	Manhattan	• Steam pipe explosion occurs at 41st Street and Lexington • Shakes nearby office buildings • 40-story-high shower of mud and debris • One fatality • 45 injuries
February 13, 2009	Transportation	Manhattan	• Coney Island-bound D train derails at 81st Street station • Two subway cars derail • Broken rail may have contributed to the accident
August 7, 2009	Water systems	Manhattan	• Water main break floods several building basements • Buildings are evacuated • Some streets are closed
September 29, 2009	Water systems/ Transportation	Manhattan	• Water main break causes street collapse • Forces evacuation of residents
July 8, 2010	Energy/Transportation	Manhattan	• Power outage in an Amtrak tunnel at Penn Station • Causes delays for Amtrak and NJ Transit
July 10, 2010	Water systems/Transportation	Manhattan	• Water main break near Union Square • Causes major street damage and transportation disruptions
Aug 7, 2010	Water Systems/Transportation	Manhattan	• Water main break occurs on E 59th St disrupts service for several hours • Causes transportation disruptions

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18. INFRASTRUCTURE FAILURES

Date	Infrastructure Sector	Location	Description
July 27 – August 1, 2011	Water Systems/Energy (natural gas)	Bronx	• 108 year-old water main break occurs in the Bronx and floods nearly a foot and a half on Jerome Avenue for several blocks near 177th St • Creates a 40 by 46 foot crater on Jerome Ave • Damages two nearby gas mains caused by water infiltration • Con Ed shuts down service to 500 customers • Disrupts vehicular traffice and subway/bus service
Aug. 12, 2011	Water/Energy (natural gas)	Manhattan	• Water main break causes big sinkhole and floods St Nicholas Ave and 152 Street (Washington Heights) • Creates a large sinkhole in the street • Gas main break is also damaged due to water infiltration • Disrupts gas and water service for days • Disrupts subway service
July 25, 2012	Energy	Citywide	• Storm knocks out power to approximately 4,800 people
September 18, 2012	Energy	Citywide	• Storm knocks out power to appoximately 4,500 people
October 29, 2012	All sectors	Citywide	• Hurricane Sandy knocks out power to millions of New York City residents • Tunnels are flooded and subway service suspended • Telecommunication networks disrupted • Increase in combined sewer overflows to local waterways
November 8, 2012	Energy	Citywide	• Nor'easter knocks out power to approximately 5,500 customers
July 18, 2013	Transportation	Bronx/ Manhattan	• CSX garbage train derails onto Metro North Hudson Line tracks • Causes widespread transportation disruptions to and from the city

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Date	Infrastructure Sector	Location	Description
September 25, 2013	Tranportation/Energy	Manhattan	• Feeder cable fails on the Metro North New Haven line • Disrupts service between Stamford, CT, and Grand Central Terminal in Manhattan for 12 days

Table 1: Infrastructure Failures in New York City 1928 to 2013

B. Vulnerability Assessment

i. Social Environment

Infrastructure failures can impact New York City residents by disrupting essential services. Depending on the severity of the incident, it may also cause fatalities and severe injuries.

Transportation

Transportation infrastructure failures can have primary and secondary impacts on the social environment, depending on the severity of the incident. Bridge and roadway collapses, retaining wall collapses, and tunnel leaks may cause injuries and fatalities. The secondary impacts of these failures include transportation disruptions, which would affect people's access to work, education, goods, and services. Low-wage workers are often hardest hit during mass transit disruptions because a majority of workers rely on public transportation to get to work. Furthermore, hourly workers lack job security, can easily be replaced, and are less likely to recover from the loss of wages during the disruption.

Water

Water infrastructure failures affect the social environment by disrupting water distribution and increasing risks to public health. For example, failures in the water distribution system for drinking water could be severe for city residents, particularly vulnerable populations such as the very young, the elderly, or those with compromised immune systems. Water system or dam failures north of the city could cause a water shortage. Since water is needed for flushing toilets, bathing, and washing hands, water shortages could increase the risk of communicable diseases (see Drought Hazard Analysis). Water infiltration into basements from water main breaks might also cause mold issues.

The public may also be exposed to contaminated water during a flood or coastal storm. Wastewater treatment plants may not be able to handle the influx of sanitary and stormwater, causing pollutants to discharge directly into the local waterways.

Energy

Electricity

Since electricity is essential to daily life, a power outage is not only a nuisance, it can be life-threatening and cause major economic losses.

People who are most at risk during an electricity failure include seniors, the homebound, young children, individuals with disabilities or those who require power-dependent medical equipment, and people who are dependent on medicines that must be refrigerated. Non-functioning elevators or the inability to charge cell phones may make it difficult for some vulnerable populations to access health care services. Older New York City Housing Authority (NYCHA) developments, which typically consist of high-rise buildings, are more sensitive to power outages and power voltage reductions, which would impact low-income populations who typically live in these developments. During Hurricane Sandy, approximately 80,000 NYCHA residents in 423 buildings lost power, heat, and/or hot water. Restoration of these services to all NYCHA buildings took place over a 20 day period after the storm hit and was completed for all developments by November 18.

During outages, people who use backup generators, charcoal grills, gas stoves, ovens, and grills indoors improperly for cooking or heating are at risk of carbon monoxide poisoning. Power outages that occur during winter months may prompt people to use this equipment inappropriately to generate heat. New York City requires carbon monoxide alarms with battery backup in residences. However, immigrant populations with limited English proficiency may not be aware of this safety requirement and may be at greater risk.

Widespread power outages impair the operations of healthcare facilities. During the 2003 Northeast Blackout, 4 out of 75 New York City hospitals lost power despite having back-up power generators. During Sandy, three hospitals lost power due to internal equipment problems and had to evacuate patients during or after the storm. In addition, 61 nursing homes and adult care facilities were located in areas impacted by power outages (some due to internal equipment problems) and/or flooding. Around half of these facilities were able to continue operating at first, but within a week of the storm, 26 had to shut down and five were partially evacuated.

Loss of power at healthcare facilities may compromise medical supplies and medications that need appropriate temperature control, putting patients' lives at risk. Disruptions to steam distribution can also be problematic for hospitals, which rely on steam to sterilize equipment.

Electricity failures are detrimental for vulnerable populations that rely on life-sustaining equipment (LSE) and residents who depend on medicine that must be refrigerated. Con Edison and LIPA/National Grid currently notify these customers of potential or actual

power outages so they can use back-up equipment. Chronically ill or homebound people who live on upper floors of high-rise apartments are also vulnerable to power failures, which disrupt elevator service, making it difficult to evacuate them.

Power disruptions can also have an impact on the public safety. They may lead to civil disturbances (looting and arson), cause traffic and subway accidents, and trap people in elevators and subways. Electricity disruptions can affect water and food supplies. For example, electric pumps are needed to provide water to upper floors in buildings over six stories. In the event of a power outage, tenants in high-rise buildings may lose water and suffer from dehydration. In addition, lack of water for flushing toilets and washing hands increases the risk of the spread of communicable disease.

According to a study by the Department of Health and Mental Hygiene (DOHMH) on the impact of power outages on public health, food-borne illnesses may also result from consuming food spoiled due to lack of refrigeration. In August 2003, the time of the Northeast Blackout, 70% of emergency department visits were for diarrheal syndrome, which was above the normal daily average, and worker absenteeism increased by 29% due to gastrointestinal illness.

DOHMH's study also found that mortality rates increased during energy failure events. In August 2003, an increase in both accidental and natural deaths resulted in 90 excess deaths. Researchers theorize that some of the deaths can be attributed to the added physical demands on vulnerable people due to non-functioning elevators, A/C units, and subways; closed stores and pharmacies; and air pollution. Loss of power also hinders the ability of first responders to charge equipment, utilize computer networks, and operate communication devices. In the event of a power or utility outage during hot or cold weather, many more people may be at risk of illness or death due to lack of air conditioning or heat.

Power disruptions also impact the economy of the city. For example, financial markets and the service industry would all be affected, resulting in lost revenue for the city. Furthermore, electricity failures would cause transportation disruptions, preventing people from going to work and resulting in lost productivity.

Steam

Steam pipe explosions can cause injuries and fatalities as well as impact air quality. Since asbestos was used to insulate steam pipes when they were constructed in the late 1800s, explosions can release asbestos into the air. This happened during the 1989 steam pipe explosion in Gramercy Park, prompting a vacate order for 200 residents who lived near the site of the explosion. This same explosion also killed two Con Edison employees and a neighborhood resident. In 2007, a steam pipe explosion caused a 40-story-high cloud of flying mud and debris, resulting in one death and 45 injuries. This

explosion also caused interruptions in telephone and Internet services, and businesses in the area of the explosion were said to have suffered financial losses of $30 million.

Civil disturbances have occurred during previous blackouts in the city. The blackout of 1977, occurring at a time of socioeconomic instability in the city, saw significant looting, disorderly conduct, vandalism, and arson in many areas. According to several New York Times articles, 1,600 stores were damaged, 1,000 fires reported, and 3,700 people arrested. These events resulted in $300 million worth of damage.

Telecommunications

Telecommunications disruptions are damaging to preparedness, response, and relief efforts. These disruptions can be detrimental for the general public and particularly for vulnerable populations during or after an emergency. They could cause failures in emergency messaging and communication to the general public and vulnerable groups disrupting their ability to send a text message to a family member or make a 911 call. For example, people harmed or trapped in their homes after a hazard event would have difficulties contacting local emergency services (FDNY or NYPD). This would also cause a breakdown in communication between friends and family networks.

During the 9/11 attacks, congestion in the telecommunications system led to breakdowns in response ability. For example, the radio system used by the New York City Emergency Medical Service was damaged due to increased demand on the communications system.

During Hurricane Sandy, telecommunications system failures were generally short-term, but flood damage at critical facilities in individual buildings and to cable infrastructure led to longer outages. These outages mostly occurred in southern Manhattan, Staten Island, southern Brooklyn, and the Rockaway Peninsula. Furthermore, backup power systems in critical facilities in these areas were damaged by floodwaters, causing services to go out in areas they served.

Telecommunication failures can create a flow of misinformation both into and out of the impacted area. It is usually easier to communicate out from a disaster than to reach someone located within an affected area. If people who are located in a disaster area are cut off from communications, they will be less informed. During these occurrences, rumors and false warnings could lead to widespread panic.

ii. Built Environment

Transportation, Water Systems, Energy, and Communications

Infrastructure failures can compromise the structural stability bridges, tunnels, and the water distribution system. This could result in the collapse of bridges and tunnels (transportation and water). Energy disruptions can also impact the built environment by

severely damaging property and streets. Steam pipe explosions and water main breaks can destroy streets and compromise the structural stability of surrounding buildings. For instance, the steam pipe explosion in 2007 inflicted severe damage on the streets and caused several buildings to shake. Natural gas leaks can cause explosions in homes and in major natural gas distribution plants.

iii. Natural Environment

Transportation, Water Systems, Energy, and Telecommunications

Infrastructure failures may affect the natural environment by destroying the natural landscape or causing air, land, or water contamination. For example, the release of asbestos during a steam pipe explosion can contaminate the air. Infrastructure failures can also cause hazardous materials spills, resulting in land or water contamination, and they can cause fires that damage the natural environment. Systems that filter water or air may be interrupted.

Power outages can increase the risk of sewage discharges to surface waters around the city. During the 2003 Northeast Blackout, backup generators at some sewage treatment plants failed, causing the release of untreated sewage into surrounding waters. During Sandy, 10 of DEP's 14 wastewater treatment plants were damaged or lost power. Three of the facilities were non-operational: Coney Island (two hours), North River (seven hours), and Rockaway (three days). As a result, approximately 560 million gallons of untreated sewage mixed with stormwater and seawater and another approximately 800 million gallons of partially treated and disinfected wastewater were released into local waterways. Not only were wastewater treatment plants impacted, but drainage systems were clogged with sand and debris due to storm surge, slowing the city's drainage process. According to the city's 311 service, most drainage-related calls after Sandy came from the highly developed areas along the waterfront. In the three weeks following the storm, DEP cleaned more than 3,500 catch basins and flushed more than 190,000 linear feet of sewer lines.

iv. Future Environment

Transportation, Water Systems, Energy, and Telecommunications

If the city does not invest in new infrastructure or maintain and repair existing infrastructure, failures will continue to occur. Furthermore, as the population grows, the demands on aging infrastructure will increase, amplifying the impacts on transportation, water, energy, and telecommunication systems.

While well-maintained, the city's transportation, water, energy, and telecommunications systems are located in a dense urban environment, and these systems can fail for a variety of reasons. Con Edison has invested billions to upgrade all systems, and the age of equipment is not necessarily an indicator of its reliability. In

addition, DEP, NYC DOT, NYS DOT, MTA, and PANYNJ have made significant investments in repairing, maintaining, and enhancing the city's infrastructure. Constant maintenance and replacement improve reliability and safety.

Climate change and sea level rise amplify the risk of more intense and more frequent coastal storms and floods, which also heightens the probability of more power outages. Currently 88% of the city's steam, 53% of electric generation, 37% of transmission substation, and 12% of large distribution substation capacity is located in the 100-year floodplain. Sea level rise can also pose issues for wastewater treatment plants because they are located along the waterfront at low elevations.

Although critical telecommunications facilities are generally located farther inland, 13% of these sites are in the 100-year floodplain, according to the Preliminary Flood Insurance Rate Maps (see Flooding Hazard Analysis). Due to climate change and sea level rise, it is projected that by the 2020s the number of facilities in the floodplain will grow to 18% of the total, and by the 2050s it is expected to grow to 24%. Moreover, by the 2050s it is expected that 31 inches of projected sea level rise will occur, increasing the risk of flooding to these telecommunication facilities.

According to the New York City Panel on Climate Change, in the future more frequent and intense heat waves will likely occur. This will increase the electricity demand, straining electric generation and distribution equipment. Population growth combined with these more frequent and intense weather-related events will place the city at greater risk of infrastructure failures.

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SECTION IV: MITIGATION STRATEGY

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1. Introduction

The Mitigation Strategy section consists of programs, plans, projects, and policies to reduce or eliminate potential losses from hazards identified in the Risk Assessment section. The Strategy includes existing and potential mitigation actions that will minimize the effects of a hazard event on New York City's population, economy, property, building stock, and infrastructure. It is the result of a coordinated effort by 41 New York City agencies and partners to develop and implement a comprehensive range of inventive and effective ways to mitigate hazards.

A. Mitigation Strategy Approach

- Establish mitigation goals and objectives that aim to reduce or eliminate New York City's long-term vulnerability to hazard events
- Identify and analyze a comprehensive range of hazard-specific mitigation actions to achieve the goals and objectives of the Mitigation Strategy
- Analyze the feasibility of these mitigation actions
- Describe how New York City will prioritize these mitigation actions
- Develop an implementation strategy

B. FEMA and New York State OEM Requirements Addressed in this Section

New York City's Mitigation Strategy was developed consistent with the process and steps presented in the Federal Emergency Management Agency (FEMA) *How-To-Guide: Developing the Mitigation Plan* (FEMA 386-3). This section satisfies the following FEMA requirements:

- **FEMA Requirement §201.6(c)(3):** [The hazard mitigation strategy ***shall*** include a] blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

- **FEMA Requirement §201.6(c)(3)(i):** [The hazard mitigation strategy ***shall*** include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

- **FEMA Requirement §201.6(c)(3)(ii):** [The mitigation strategy ***shall*** include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program (NFIP), and continued compliance with NFIP requirements, as appropriate.

- **FEMA Requirement: §201.6(c)(3)(iii):** [The mitigation strategy section ***shall*** include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized,

implemented, and administered by the local jurisdiction. Prioritization ***shall*** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

The following New York State OEM (NYS OEM) requirements are also addressed in this section:

- **NYS OEM Requirement §2:** The plan ***should*** identify any critical facility that has ever sustained flooding, even if it is not located in the 100-year floodplain on a current (adopted) or draft FEMA Flood Insurance Rate Map (FIRM). The plan ***should*** also analyze and document:

  a) The mitigation strategy cost, and damages avoided since implementation;
  b) Other options considered, their estimated costs, why they are deemed not feasible;
  c) How well the project performed in subsequent events, if your basic assumptions were accurate, and what you'd change if you were doing it again;
  d) Social, economic or environmental considerations that support/challenge the project.

- **NYS OEM Requirement §3:** Counties and communities containing a 100-yr floodplain on either (adopted) or draft FEMA FIRM ***should*** identify:

  a) Sites for placement of temporary housing units to house residents displaced by a disaster.
  b) Potential sites within the community suitable for relocating houses out of the floodplain, or building new houses once buildings in floodplain have been raised.

- **NYS OEM Requirement §4:** Communities with residential neighborhoods or critical facilities that have been flooded, inundated, or isolated by water, even if they are not located in the 100-year floodplain on a current or draft FEMA Flood Insurance Rate Map (FIRM), ***should*** develop evacuation routes and procedures and identify shelters, including provisions for a range of medical needs, accommodation for pets, and compliance with the Americans with Disabilities Act.

- **NYS OEM Requirement §5.a:** The Plan ***should*** include all mitigation projects on community's wish list even if they do not meet FEMA eligibility of Benefit-Cost Analysis requirements, since funding should be sought from multiple sources to achieve a community's mitigation goals most quickly. Each project ***should*** include a brief description of:

  a) The problem and estimated annual damages;
  b) The preferred option, its estimate cost, and the estimated annual damages that will be avoided if it is implemented;
  c) How the proposal might be eligible under grant criteria other than mitigation (coastal, sustainability or climate change initiatives, brownfield funds);

d) Other options considered, their estimated costs, why they are deemed not feasible;
e) The social economic or environmental considerations that support/challenge it;
f) Any steps that need to be taken (e.g. engineering studies) before the project can be implemented, the person or organization with lead and supporting roles in completing those steps, and an estimated timetable for completion.

- **NYS OEM Requirement §5.b:** The Plan ***should*** include a list of potential local, State, and Federal funding sources that apply to the projects identified as well as public-private partnerships worth pursuing.

- **NYS OEM Requirement §5.c:** The plan ***should*** include a section that documents previous mitigation projects completed by the county or the jurisdiction within the community's borders, whether funded locally or by private, state or federal agencies and organizations. Each project should include a description of:

  a) The original problem and estimated annual damage;
  b) The project, its cost, and the damages avoided since implementation;
  c) How well the project performed in subsequent events, if your basic assumptions were accurate, and what you'd change if you were doing it again;
  d) The social, political and environmental considerations that supported/challenged the proposal, and the stakeholders, approaches and other factors that contributed to its successful implementation.

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2. Developing Goals and Objectives

The first step in developing a hazard mitigation strategy for New York City was to establish goals and objectives. Mitigation goals are general guidelines about what New York City wants to achieve in terms of hazard and loss prevention. Objectives are specific, measurable strategies or implementation steps to achieve those goals. Developing clear goals and objectives helped reinforce New York City's overall purpose and mission for undertaking mitigation planning.

To this end, the Planning Team developed preliminary hazard mitigation goals and objectives based on the Risk Assessment findings and the New York State Multi-Hazard Mitigation Plan and presented them to the Steering Committee. The Planning Team also presented the goals at community involvement meetings. Incorporating input and suggestions from the Steering Committee, the Planning Team revised and refined the goals and objectives, producing the final five goals and 28 objectives (see Table 1). These goals and objectives provide the necessary framework to develop a mitigation strategy. New York City will re-evaluate its goals and objectives during each plan maintenance cycle to ensure they continue to represent New York City's hazard mitigation priorities.

Goal 1: Protect public health and safety	
Objective 1.1	Identify and reduce the impacts of hazards on vulnerable populations
Objective 1.2	Improve and promote systems that provide early warning and emergency communications
Objective 1.3	Strengthen state and local building and health code enforcement
Objective 1.4	Train emergency responders
Objective 1.5	Reduce public health risk from natural and non-natural hazards
Objective 1.6	Improve community engagement and outreach by organizations and agencies that provide services to vulnerable/special needs populations
Goal 2: Preserve property	
Objective 2.1	Implement mitigation programs that protect critical facilities and services and promote reliability of lifeline systems to minimize impacts from hazards, maintain operations, and expedite recovery from an emergency
Objective 2.2	Consider known hazards when identifying a site for new facilities and systems
Objective 2.3	Create redundancies for critical networks such as water, sewer, digital data, power, and communications
Objective 2.4	Adopt and enforce public policies to minimize negative impacts of development and enhance safe construction in high-hazard areas
Objective 2.5	Integrate new hazard and risk information into building codes and land use planning mechanisms
Objective 2.6	Educate public officials, developers, realtors, contractors, building owners, and the general public about hazard risks and building requirements

Objective 2.7	Promote appropriate mitigation actions for all public and privately owned property within the City's jurisdiction including, but not limited to, residential units, commercial structures, educational institutions, healthcare facilities, cultural facilities, and infrastructure systems
Objective 2.8	Incorporate effective mitigation strategies into capital improvement projects within the city
Objective 2.9	Promote post-disaster mitigation as part of restoration and recovery
Objective 2.10	Encourage the development and incorporation of innovative technological solutions without compromising neighborhood or building character
Goal 3: Promote a sustainable economy	
Objective 3.1	Form partnerships to leverage and share resources
Objective 3.2	Develop feasible plans to continue critical business operations post-disaster
Objective 3.3	Partner with the private sector, including small businesses, to promote structural and non-structural hazard mitigation as part of standard business practices
Objective 3.4	Educate businesses about citywide contingency planning, targeting small businesses and those businesses located in high-risk areas
Objective 3.5	Partner with the private sector to promote employee/employer education about disaster preparedness at work and at home
Goal 4: Sustain a healthy environment	
Objective 4.1	Advance understanding of the relationship between climate change and natural hazards
Objective 4.2	Increase social resiliency by improving knowledge about climate-related hazards and promoting adaptive mitigation strategies
Objective 4.3	Develop hazard mitigation policies that protect the environment
Objective 4.4	Promote climate change adaptation strategies that protect against long-term effects on the environment
Goal 5: Encourage public preparedness for disasters	
Objective 5.1	Improve public outreach and access to hazard information, data, and maps to enhance understanding of natural hazards and the risks they pose
Objective 5.2	Improve hazard information, including databases and maps, by using the latest available data and scientific analysis about hazards and vulnerabilities
Objective 5.3	Improve public knowledge of hazards and protective measures so individuals are able to appropriately respond during hazard events

Table 1: Hazard Mitigation Goals and Objectives

3. Identification and Analysis of Mitigation Actions

Mitigation actions include programs, plans, projects, and policies that help reduce or eliminate the risk to human life and property from hazards. This plan presents a comprehensive range of hazard-specific mitigation actions for New York City, focusing on actions that affect new and existing buildings and infrastructure, that are the result of a careful identification and analysis process.

A. Identification of Actions

Mitigation Planning Council (MPC) members identified existing and potential mitigation actions for their respective agencies and organizations that meet the following criteria:

- Reduce or eliminate the risk to human life and property from at least one of the 13 hazards identified in the Risk Assessment section
- Fall under one or more of the six FEMA mitigation action categories
- Achieve one or more of the five hazard mitigation goals and 28 objectives

Of the 41 MPC members, 38 submitted preliminary mitigation actions to OEM for inclusion in the Mitigation Strategy. The New York City Housing Recovery Office (HRO) and the Regional Plan Association (RPA) submitted capabilities (see Table 12, "Capability Assessment") and provided guidance throughout the planning process but did not submit mitigation actions. Nor did the New York City Office of Management and Budget (OMB), though OMB is involved in the process of determining and overseeing funding for projects submitted by other MPC members. The Planning Team held one-on-one meetings with each MPC member to discuss its mitigation actions in detail and suggest potential changes and additions. The MPC then submitted final lists of actions to OEM, which resulted in a total of 626 mitigation actions (293 existing and 333 potential) that met the criteria above.

i. Mitigation Action Categories

FEMA organizes mitigation actions into six broad categories. These categories allow mitigation actions to be compared and provide a standardized method for eliminating unsuitable actions. All mitigation actions identified in the HMP fall within one of the FEMA mitigation action categories below:

1. **Prevention and Policy**: Government, administrative, or regulatory actions and processes that influence the way land and buildings are developed and built. These actions also include public activities that reduce hazard losses. Examples of this category include building and construction code revisions, zoning regulation changes, and hazard computer modeling.

2. **Property Protection**: Actions that involve the modification of existing buildings or structures to protect them from a hazard, or removal from the hazard area. Examples: seismic retrofits, roadway elevations, and flood-proofing.

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3. **Education and Awareness**: Actions to inform and educate citizens, elected officials, businesses, and property owners about the hazards they face and protective measures they can take to best prepare for or respond to hazards. Examples: programs that target severe repetitive loss properties and vulnerable populations.

4. **Coastal/Natural Resource Protection**: Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural or coastal systems. Examples: projects that create open space, greenbelts, Bluebelts, or wetlands.

5. **Emergency Services**: Actions that protect people and property, or increase the capacity of emergency response during and immediately following a disaster event. Examples: enhancements that provide advanced warning and redundant communications.

6. **Infrastructure Projects**: Actions that involve the engineering of infrastructure systems to be more resistant to the impacts of hazards. Examples: projects that control floodwater, reconstruct dams and seawalls, and construct green roofs.

ii. Mitigation Action Summary

The final list of mitigation actions includes many structural projects that apply to both new and existing buildings and infrastructure. Many of the actions protect public health and safety, promote a sustainable economy, protect the environment, and increase public preparedness for disasters. Table 2 summarizes New York City's mitigation actions by hazard, mitigation action category, and goals/objectives addressed.

Category	Existing	Potential	Total
Number of Mitigation Actions	293	333	***626***
Mitigation Actions by Hazard Addressed*			
CBRN releases	5	7	12
Coastal erosion	2	3	5
Coastal storms	18	31	49
Cyber threats	1	2	3
Disease outbreaks	4	1	5
Drought	7	4	11
Earthquakes	3	8	11
Extreme temperatures	9	5	14
Flooding	97	77	174
Infrastructure failures	6	20	26
Severe weather	0	5	5
Wildfires**	0	0	0
Winter storms	2	2	4
Multi-hazard	139	168	308
Total	***293***	***333***	***626***

Category	Existing	Potential	Total
Mitigation Actions by Category			
Prevention and policy	98	55	153
Property protection	68	91	159
Public education and awareness	31	30	60
Coastal/natural resource protection	17	8	25
Emergency services	45	91	136
Infrastructure projects	34	58	92
Total	***293***	***333***	***626***
Mitigation Actions by Goal/Objective Addressed* **			
1.1	48	93	141
1.2	11	11	22
1.3	6	3	9
1.4	2	3	5
1.5	25	19	44
1.6	8	16	24
2.1	138	230	368
2.2	11	39	50
2.3	96	78	174
2.4	18	16	34
2.5	35	28	63
2.6	5	15	20
2.7	77	124	201
2.8	36	49	85
2.9	16	19	35
2.10	20	30	50
3.1	29	7	36
3.2	2	8	10
3.3	1	25	26
3.4	2	13	15
3.5	1	10	11
4.1	4	4	8
4.2	9	0	9
4.3	44	24	68
4.4	11	20	32
5.1	10	28	38
5.2	21	33	54
5.3	20	18	38
Total	***704***	***963***	**1667**

*Since many actions address multiple hazards but are listed here only in connection with a single hazard, actions for each hazard may appear to be underrepresented.
**Although wildfires are not individually addressed by any actions, they are addressed by the multi-hazard actions.
***Many mitigation actions address more than one goal and/or objective.

Table 2: Mitigation Actions Summary Table

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For both existing and potential actions, projects are assigned an index reference which consists of an abbreviation of the primary hazard addressed (see y.
Table 3) followed by a number listed in the order the actions appear in the table.

	Hazard	Abbreviation
Hazards	CBRN releases	CB
	Coastal erosion	CE
	Coastal storms	CS
	Cyber threats	CY
	Disease outbreaks	DO
	Drought	D
	Earthquake	EQ
	Extreme temperatures	ET
	Flooding	F
	Infrastructure failures	IF
	Multi-hazard*	MH
	Severe weather	SW
	Winter storms	WS
Project Status	Existing	E
	Potential	P

*Includes existing or potential actions addressing wildfires individually.

Table 3: Hazard Abbreviations for Mitigation Action Tables

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iii. Existing Mitigation Actions

New York City has programs, plans, projects, and policies currently underway to mitigate hazards. These "existing" mitigation actions are either already being implemented or have already been approved and appropriated the necessary funding for implementation. By assessing what the city is currently doing to mitigate hazards, the Planning Team was able to determine how the city might expand or improve upon those programs.

The MPC identified 293 existing mitigation actions. Table 4 shows further details on the fields displayed in the table. Each mitigation action is assigned an index value to indicate the hazard addressed and whether it is an existing ("E") or potential ("P") action. The hazards are placed in alphabetical order. Within each hazard, actions are listed according to the alphabetical order of the lead agencies associated with the actions. For example, the mitigation action with the index F.E.1 is the first existing mitigation action that addresses flooding, which is being implemented by Con Edison, the first MPC agency in alphabetical order.

Not included in the table are actions that were listed as "existing" in the 2009 Hazard Mitigation Plan and since implemented, completed, or are no longer in effect. These actions are located in the Appendix not considered to be "existing" and appear in a separate table in the Appendix, entitled "NYC HMP (2014) Retired Mitigation Actions."

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Column Header	Description
Action Type	The associated mitigation action category (Prevention, Property Protection, Education and Awareness, Coastal/Natural Resource Protection, Emergency Services, and Infrastructure Projects)
Mitigation Action Description	Title and description of the action
Lead	The agency that has primary jurisdiction over the mitigation action and the primary point of contact for the mitigation action
Support	Supporting entities that will assist in the implementation, funding, or maintenance of the mitigation action
Timeline	Estimation of when the project will begin and approximately how long it will take to complete; "ongoing" refers to actions that are either under way or have no definitive end date
Cost Estimate	Estimated costs associated with implementing a mitigation action
Possible Funding Source(s)	Possible sources of funding including capital funding, grants, and bonds
2009 Action Progress Status	N/A or Blank: New No Change: Action has not changed since the 2009 Other text indicates a status update on the action since the 2009 HMP
Goals and Objectives	Hazard mitigation goals and objectives addressed by the mitigation action
Priority	Results of the mitigation action prioritization

Table 4: Implementation Key

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
CBRN									
CB.E.1	Education & Awareness	**Pro-bono environmental services**: Provide expert services through the NYC Brownfield Partnership.	OER	N/A	In place for 12 months	No cost	Staff time	N/A	4.3
CB.E.2	Prevention & Policy	**NYC Brownfield Cleanup Program:** Clean up contaminated properties throughout NYC. Includes installation of vapor mitigation systems, protection of building inhabitants in the event of hazardous materials release; installation of cover systems, providing containment in the event of hazardous materials releases/spills; and groundwater remediation, improving groundwater quality for potential use during drought.	OER	N/A	In place since January 2011	No cost	Staff time	N/A	1.1, 2.3, 4.3
CB.E.3	Property Protection	**NYC Brownfield Incentive Grant (BIG) program:** Provide financial assistance to property owners seeking to investigate and clean up contaminated properties.	OER	EDC, USEPA	In place 12 months	$200,000 for petroleum assessment and $1.4 million cleanup loans and grants	Funding in place (USEPA)	N/A	4.3
CB.E.4	Education & Awareness	**"Cleaning Up New York City" community education video series**: Educate the public about environmental investigation, cleanup, and community protection and engagement	OER	N/A	In place 18 months	$40,000	Funding from Rockefeller	N/A	4.3, 5.1

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
		during the cleanup process.					Brothers Fund		
CB.E.5	Education & Awareness	**NYC Green Property Certification**: Increase public understanding and awareness of cleanup sites by recognizing that cleanup properties are the "safest places in NYC to live and work."	OER	EDC	In place 24 months; funding in place for 6 more months	$10,000/ year	Current funding provided by Rockefeller Brothers Fund	N/A	4.3, 5.1
COASTAL EROSION									
CE.E.1	Coastal/Natural Resource Protection	**Protection of Rikers Island north shoreline**: Rebuild and mitigate the north shoreline. This northerly exposure to the East River is the most vulnerable to erosion.	DOC	N/A	Design began January 2013; construction to be completed by December 2016	$25 million	Capital, FEMA	Project design is 60% complete	1.1, 2.1, 2.7
CE.E.2	Property Protection	**Rikers Island north shore administrative modular units**: Relocate modular units currently located on the north shore, which was affected by Hurricane Sandy, from low-lying areas on the Island. Due to proximity to shoreline and temporary nature of construction, Rikers Island trailers, are vulnerable to extreme weather events.	DOC	N/A	This project must be implemented in conjunction with the	$19 million	Capital, FEMA	No change	1.1, 2.1, 2.2, 2.7

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
					rehabilitation of the north shoreline				
COASTAL STORMS									
CS.E.1	Education & Awareness	**Urban Waterfront Adaptive Strategies report**: Provide a systematic assessment of the coastal flood hazards that face New York City, a thorough survey of coastal protection and adaptation strategies that may be suitable for different shoreline and neighborhood types, and a framework for evaluating coastal protection alternatives. The report is intended to serve as a resource for planners, policymakers, and communities within New York City, the region, and elsewhere in the coastal United States.	DCP	Parks, DEP, DOB	2013	TBD	TBD	N/A	2.7, 4.2, 4.4
CS.E.2	Infrastructure Project	**Drainage improvements**: Expand use of green infrastructure (street trees, Greenstreets, right-of-way bioswales, etc.), in concert with DDC, DEP, and Parks partners, within the public right-of-way to capture and detain stormwater, thereby reducing loads on sewage treatment plants and consequent combined sewer overflows.	DOT	DDC, Parks, DEP	Ongoing	$700-750 million	HMGP, TEP/TAP grants, City Capital Budget, City Expense Budget	Ongoing	2.1, 2.3, 2.10, 4.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
CS.E.3	Property Protection	**Far Rockaway multi-family design competition**: Launch competition to enhance resiliency of planned Arverne East project.	HPD	N/A	Estimated date of completion October 2013	$80,000	Grants	N/A	2.5, 2.6
CS.E.4	Property Protection	**Build It Back**: Work with private property owners (of small homes and multi-family housing) to secure funds to address storm damage and allow for resiliency upgrades including system and material enhancements or replacements.	HPD,HRO	HRO for 1-4 units, HPD for multi-family housing	4 years	$160,000,000	Grants	N/A	1.1, 2.9, 3.1
CS.E.5	Education & Awareness	**Annual Hurricane Tabletop Exercise**: Challenge the agencies to respond to various hurricane scenarios. Response includes restoration, logistics, and communications	LIPA	NYS OEM, Nassau County OEM, Suffolk County OEM, NYC OEM	Annually	$25,000	LIPA	N/A	1.4
CS.E.6	Emergency Services	**Backup generator at Governors Island:** Install a standby emergency generator at the Governors Island ventilation building for Hugh L. Carey Tunnel to provide capacity for pumps and other equipment in case of power outage.	MTA (Bridges and Tunnels)	N/A	1-2 years	$3 million	HMGP, also seeking FEMA 406 funding	N/A	2.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
CS.E.7	Infrastructure Project	**Mitigation of Hugh L. Carey and Queens Midtown Tunnels:** Install flood gates, tunnel plugs, and water-filled barriers; extend plaza retaining walls; protect vulnerable ingress locations and building openings; harden generators with flooding protection; and perform other associated mitigation work. At minimum, ABFE + 1 foot + additional elevation needed to account for wave action (additional study will be needed to complete design).	MTA (Bridges and Tunnels)	N/A	2-3 years	$50 million	Seeking FEMA 406 mitigation funding	N/A	2.1, 2.7, 2.8
CS.E.8	Property Protection	**Harlem River lift bridge:** Replace facility houses and circuit break houses at higher elevations to protect from flooding. (Design under way through Sandy ER Program with construction to follow.)	MTA (MNR)	N/A	Complete within 2.5 years	$5 to 10 million	Sandy Emergency Relief Program-Restoration, capital budget	N/A	2.1, 2.7
CS.E.9	Property Protection	**Hudson Line substations (including Riverdale location):** Replace and raise substations damaged by Hurricane Sandy to protect from flooding. (Design under way through Sandy ER Program with construction to follow.)	MTA (MNR)	N/A	Complete within 2.75 years	$40 million	Sandy Emergency Relief Program-Restoration	N/A	2.1, 2.3, 2.7, 2.9
CS.E.10	Property Protection	**Power and C&S infrastructure improvements:** Replace critical power and C&S components damaged by Sandy and protect as feasible. (Preliminary design to be awarded through Sandy ER program with design-build to follow.)	MTA (MNR)	N/A	Complete within 5 years	$237 million	Sandy Emergency Relief Program-Restoration	N/A	2.1, 2.3, 2.7, 2.9

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
CS.E.11	Property Protection	**Flood mitigation at MJ Quill, Castleton, Yukon, Casey Stengel, Ulmer Park depots**: Relocate equipment to higher levels; install backflow preventers and high-capacity permanent pumps; reinforce/harden openings/entrances and other water-penetration points.	MTA (Buses)	N/A	TBD	TBD	TBD	N/A	2.1, 2.7
CS.E.12	Property Protection	**Flood mitigation at Far Rockaway depot**: Relocate equipment to higher elevation; install backflow preventers (10 feet above BFE).	MTA (Buses)	N/A	TBD	TBD	TBD	N/A	2.1, 2.7
CS.E.13	Infrastructure Project	**NYC Clean Soil Bank:** Launch full operation of the soil bank for use in elevating grades or creating natural barriers to mitigate impacts of storm surge or sea level rise.	OER	Many	In place for 7 months	$125,000 /year (staff)	This action saves city $5 million per year; 2% credit of savings to OER to hire staff	N/A	4.3
CS.E.14	Prevention & Policy	**NYS 2100 Commission**: Support the goals of the Commission to protect New York State, consumers, and businesses.	OLTPS	N/A	TBD	$0	N/A	N/A	3.3, 5.3
CS.E.15	Prevention & Policy	**Overhead utility lines:** Work with utilities and the PSC to harden vulnerable lines against winds.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.1, 2.3, 2.7, 3.1
CS.E.16	Infrastructure	**Oakwood Beach (SI) levee and tidegate:** Repair the levee and tidegate.	USACE, NYSDE	DEP	2 months	$500,000	USACE	N/A	2.7, 2.9

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
	Project		C						
CS.E.17	Infrastructure Project	**Plumb Beach groins and breakwater:** Complete work to protect Belt Parkway.	USACE, Parks	Parks	3 months	$6,000,000	USACE, NYC	N/A	2.7
CS.E.18	Infrastructure Project	**Study of South Shore of SI with recommendation for wall and levees**: Complete Phase 1 (Ft. Wadsworth to Oakwood Beach) final draft report scheduled for spring 2014. Phase 2 (Great Kills Harbor to Tottenville) is in initial phase.	USACE, Parks	Parks	3-6 years	$300,000,000	USACE, NYS, NYC	N/A	2.7, 5.2
CYBER THREATS									
CY.E.1	Property Protection	**Protection of City's data, systems and services from cyber attack:** Install advanced penetration technology and build a security operations center.	DoITT	N/A	24 months	$4.4 million	UASI grant	N/A	2.1, 2.3
DISEASE OUTBREAKS									

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
DO.E.1	Education & Awareness	**CUNY stakeholder outreach:** Conduct university-wide hazard mitigation and awareness regarding mass prophylaxis initiatives (scope: all 24 CUNY campuses with a population of 450,000+ students). Publish and disseminate information to university stakeholder populations.	CUNY	CUNY, NYC Department of Health, DOHMH, New York City Medical Reserve Corps (NYC MRC)	Ongoing, with an annual awareness campaign to university stakeholders	Nominal cost	CUNY Central Office (CO) and campus operating budgets, CUNY internal CO and campus staff time, outside agency staff time, where applicable	N/A	1.5, 5.1, 5.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
DO.E.2	Prevention & Policy	**Maven Electronic Disease Surveillance and Outbreak Management**: Install pre-configured surveillance, case management, and electronic workflow software system that supports over 80 reportable conditions including vaccine-preventable diseases, communicable diseases, STDs, and TB. Maven allows for follow-up care and management of cases and contacts, enables outbreak detection and management, and designs architecture for a flexible workflow case management**.**	DOHMH	DOHMH	Ongoing need	Approximately $800,000 per year	Department of Homeland Security UASI grant. Future funds unclear so additional funding sources are sought.	N/A	1.1, 1.2, 1.5

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
DO.E.3	Prevention & Policy	**StarLIMS**: Invest in state-of-the-art Laboratory Information Management System (LIMS) essential to maintaining and strengthening DOHMH's ability to rapidly perform the laboratory testing required to detect and manage disease outbreaks of significant public health concern. This investment will provide the labs the ability to test for new emerging diseases, provide for OCME integration (electronic interface with the Chief Medical Examiner), and allow more tests to be performed during a biological or terrorist event where mass causalities may occur.	DOHMH	N/A	Ongoing need	$500,000 per year	Funded by Department of Homeland Security UASI grant. Future funds unclear, seeking additional funding sources.	N/A	1.2, 1.5

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
DO.E.4	Emergency Services	**Pandemic plan:** Provide guidance in the event of a pandemic outbreak in LIPA's service territory. This plan addresses prevention, response, and recovery due to a pandemic outbreak.	LIPA	NYS OEM, Nassau County OEM, Suffolk County OEM, NYC OEM	As required	TBD	LIPA TBD	N/A	5.3
DROUGHT									
D.E.1	Prevention & Policy	**Hands-free sensors in restroom sinks:** Install during renovations to 55 City-owned buildings.	DCAS	N/A	Ongoing	$2,000,000	Capital budget	No change	2.3, 2.10, 4.3
D.E.2	Prevention & Policy	**Low water-use toilets and flush sensors:** Install during renovations to 55 City-owned buildings.	DCAS	N/A	Ongoing	$2,000,000	Capital budget	No change	2.3, 2.10, 4.3
D.E.3	Infrastructure Project	**Croton filtration facility:** Activate this new filtration facility. Historically, 10% of the city's average daily water demand has been provided by the Croton system, although in times of drought it may supply significantly more water. While this part of the system has been offline, the new filtration facility will allow the city to use it once again.	DEP	Parks	Plant activation in 2014	$145 million	Capital budget	N/A	2.2, 2.3
D.E.4	Prevention & Policy	**Water Demand Management Plan and water shortage rules:** Adopt new plan to conserve water citywide and the rules to impose use restrictions during drought and emergencies	DEP	FDNY, DOE, CUNY, NYCHA, Parks, DCAS	Plan will be implemented by 2021	$146 million	Capital budget, operating budget	N/A	2.1, 2.3, 4.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
D.E.5	Prevention & Policy	**Hydrant locking program:** Fit critical fire hydrants in the city with locks to limit water usage during a drought.	DEP	FDNY	Ongoing	Included in regular agency o/m budget	Operating budget	No change	2.1, 2.3, 2.7, 2.8
D.E.6	Infrastructure Project	**179th Street pumping station rehabilitation:** Provide additional redundancy for water supply operations by allowing DEP to move water between the Croton and Catskill/Delaware systems to supplement the local distribution system.	DEP	N/A	2023	$12 million	Capital budget	No change	2.3
D.E.7	Prevention & Policy	**Gouverneur Healthcare Services facility water conservation:** Replace existing water fixtures with new code-compliant low water-use fixtures.	HHC	DASNY	4 years	$680,000	General obligation bonds	This phase of the project is ongoing	1.1, 2.1, 2.3, 2.5, 2.8
EARTHQUAKE									
EQ.E.1	Property Protection	**Wastewater treatment plant facility seismic retrofit:** Retrofit wastewater treatment facilities and methane gas storage systems to withstand seismic activity. Design facilities to meet current building codes (most of the facilities were designed and constructed prior to current seismic standards).	DEP	N/A	Ongoing	Included in regular agency capital budget	Capital budget	No change	2.4, 2.5, 2.8, 4.3
EQ.E.2	Infrastructure Project	**City Tunnel 3**: Construct a seismically resistant and redundant third water tunnel. City Tunnels 1 and 2 currently distribute water to all five boroughs of New York City. These tunnels are nearly 90 and 70 years old, respectively, and have never been taken	DEP	DDC	Manhattan section of Phase 2 complete	$389 million	Capital budget	No change	2.3, 2.5

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
		out of service.			d in 2013, Brooklyn and Queens section to be complete d in 2023				
EQ.E.3	Property Protection	**Seismic studies and retrofit:** Identify and incorporate seismic requirements in bridge and tunnel restoration projects**.**	MTA (Bridge s and Tunnel s)	N/A	ongoing			These studies are being done for each facility under various projects	2.5, 2.7, 2.9
EXTREME TEMPERATURES									
ET.E.1	Preventio n & Policy	**Power conservation:** Install energy-saving light fixtures in 55 City-owned buildings.	DCAS	N/A	5 years	$10,000, 000	Capital budget, PlaNYC	No change	2.3, 2.10, 4.3
ET.E.2	Preventio n & Policy	**Peak load management program:** Conserve power during summer peak demand hours, usually noon to 6:00 p.m., on days designated by NYPA.	DCAS	DDC	9 years: 2013-2022 (fiscal years)	TBD	Expense budget	No change	2.1, 2.3, 4.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
ET.E.3	Coastal/Natural Resource Protection	**Wastewater treatment tanks upgrade:** Increase blower output and diffuser density. During periods of extreme heat, increased levels of dissolved oxygen are necessary for safe and balanced wastewater treatment. The blower sends dissolved oxygen to the tank, and the diffuser distributes it throughout the tank.	DEP	N/A	2023	$25 million	Capital budget	No change	2.1, 2.3, 2.8
ET.E.4	Education & Awareness	**Code Blue and Code Red extended outreach:** Coordinate personnel to increase efforts to keep New York City's street homeless population safe during extreme cold and heat weather events.	DHS	DOHMH, NYPD	Ongoing	$120,000	City tax levy	Implemented: Added Code Red outreach for extreme heat events	1.1, 1.6
ET.E.5	Prevention & Policy	**Construction Code Revision:** Encourage more "cool roofs" installations.	DOB	N/A	In effect since July 2009	TBD	Staff time	N/A	2.5, 4.3
ET.E.6	Prevention & Policy	**AC bed space:** Build additional and/or upgrade existing AC in various facilities to accommodate different classifications pursuant to requirements imposed under Benjamin litigation.	DOC	N/A	TBD	$20 million	Capital	N/A	1.1, 1.5, 2.5
ET.E.7	Property Protection	**Protection of engines from heat-related damage:** Protect engines and prepare for response to heat-related incidents including increased switch, bridge, signal, catenary (MNR only), and track circuit failures, as well as heat kinks.	MTA (LIRR/ MNR)	N/A	TBD	TBD	TBD	Ongoing	2.1, 2.7

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
ET.E.8	Prevention & Policy	**Summer Operations Manual:** Write guide on how to perform pre-trip bus inspections to confirm windows and hatches are closed and the air conditioning system is working properly. Provide bus operators with summer uniforms and information about heat stress.	MTA (Buses)	OEM	TBD	TBD	Agency operating budget	No change	2.1, 5.2
ET.E.9	Emergency Services	**Communications Redundant System -** Communications system is with surge protection to allow uninterrupted operation during potential power surges due to rolling black-outs or electrical storms. Additional system include steam generator back-up and "failsoft" computer based protection.	MTA (Buses)	N/A	TBD	TBD	TBD	No change	2.3
FLOODING									
F.E.1	Prevention & Policy	**Mapping of flooding vulnerability data:** Evaluate latest flooding information available post-Sandy to potentially update infrastructure maps to more accurately define flooding vulnerability of company assets.	Con Ed	N/A	Ongoing	N/A	Agency operating budget	No change	2.5, 2.9, 5.2
F.E.2	Education & Awareness	**Designing for Flood Risk report:** Identify key principles to guide the design of new buildings in flood zones to promote construction that can not only withstand coastal flood events, but also supports the vibrancy of the public realm. Recognizing the distinct character and needs of higher-density urban environments, such as New York City, the report provides recommendations for how regulations and	DCP	DOB	2013	TBD	TBD	N/A	2.2, 2.4, 2.5, 2.6

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
		individual project design can incorporate resilient design principles.							
F.E.3	Infrastructure Project	**High-level storm sewers:** Supplement existing combined sewers with high-level storm sewers in certain areas near the water's edge. High-level storm sewers are able to capture 50% of rainfall before it enters combined sewers, reducing street flooding, sewer backups, and combined sewer overflows.	DEP	DDC, DOT	Ongoing	$255 million	Capital budget	No change	2.3, 2.8, 2.10, 4.3
F.E.4	Infrastructure Project	**Stormwater sewers in areas of Queens with limited drainage systems:** Continue to build out the storm sewer systems in Queens locations in conjunction with DOT street improvements and other community infrastructure projects, including in areas with street flooding.	DEP	DOT, DDC	Ongoing	$148 million	Capital budget	N/A	2.3, 2.8, 4.3
F.E.5	Coastal/Natural Resource Protection	**Watershed Protection Program:** Acquire land strategically in the watershed and continue stream, farm, and forestry programs.	DEP	NYS DEC, NYS DOH	Ongoing. Programs are regulated under 2007-	$286 million	Capital budget	N/A	4.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
					2017 Filtration Avoidance Determination				
F.E.6	Property Protection	**Valve installation/plumbing improvements through enhanced outreach and education:** Encourage appropriate installation of check valves and other property protection systems to mitigate flooding risk.	DEP	DOB	Ongoing	Funded by property owners	N/A	No change	2.1, 2.3, 2.7, 2.8, 5.3
F.E.7	Property Protection	**Drainage improvement plan and design:** Identify inland flood- and coastal flood-prone areas and determine appropriate improvements to drainage services and levels of stormwater management.	DEP	N/A	Ongoing	Included in regular agency O/M budget	Operating budget	N/A	2.2
F.E.8	Infrastructure Project	**Sewer infrastructure upgrade:** Make regulator improvements for sewer outfalls around East River, Westchester Creek, Hutchinson Creek, Flushing Bay, and Newtown Creek. Improved regulators will control releases from the sewer system during storms, reduce street flooding, and prevent sewer backups.	DEP	N/A	Project funded through 2015	$94 million	Capital budget	N/A	2.1, 2.3, 2.7, 2.8, 4.3
F.E.9	Emergency Services	**Drainage system maintenance and pre-storm inspections:** Perform regular maintenance and repair of sewers and catch basins citywide. Perform pre-storm inspections of Bluebelt facilities and targeted areas of the city with potential for	DEP	Parks, DOT	Ongoing operation	Included in regular agency O/M budget	Operating budget	N/A	2.1, 2.3, 4.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
		flooding to facilitate proper function during normal operations and storm events.							
F.E.10	Prevention & Policy	**Dam inspection program**: Implement New York City dam inspection program on both monthly and yearly cycles to facilitate appropriate maintenance and attain state of good repair.	DEP	N/A	Ongoing	Included in regular agency o/m budget	Operating budget	No change	2.4
F.E.11	Prevention & Policy	**Property and infrastructure protection:** Prepare large area drainage plans for the following locations that lack a fully built system or require upgrades: southeast Queens, Rockaway Peninsula, Coney Island, and Whitestone. These plans will examine and optimize how storm and floodwater is managed in these areas.	DEP	N/A	Ongoing	Included in regular agency o/m budget	Operating budget	No change	2.2, 2.5
F.E.12	Education & Awareness	**Stormwater/flooding public outreach and education:** Develop school curricula and public outreach materials to educate the public about flooding and stormwater.	DEP	N/A	Ongoing	Included in regular agency o/m budget	Operating budget	No change	2.6, 5.1, 5.3
F.E.13	Infrastructure Project	**Sewage pumps upgrade:** Replace main sewage pumps with higher-head units to overcome hydraulic resistance created by a flooding event.	DEP	N/A	2018	$26 million	Capital budget	No change	2.1, 2.3, 2.7, 2.8

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.14	Prevention & Policy	**Construction code revision:** Clarify current flooding regulations and adopt the latest national standards.	DOB	N/A	Council has not voted, revision was expected to pass fall 2013	TBD	Staff time	Implemented and ongoing	2.4, 2.5
F.E.15	Property Protection	**Facility protection:** Execute flood-elimination capital projects at 20 sites that need long-term solutions for recurring flood damage due to groundwater infiltration.	DOE	DOE-SCA	1 year	TBD	FEMA	No change	2.1, 2.8
F.E.16	Property Protection	**Protection of NYCDOT facilities from flood impacts:** Reconstruct bulkhead at Harper Street facilities; elevate mechanical equipment in flood-prone areas whenever possible; use mold-resistant building materials whenever possible at sites in flood zones; improve stormwater management through measures such as containment systems and green infrastructure (Some individual projects are completed, others are ongoing).	DOT	DDC, DEP, DCAS	TBD	TBD	TBD	N/A	2.1, 2.7
F.E.17	Property Protection	**Protection of DOT tunnels in Lower Manhattan (BPU + WSU) from Flooding:** Install permanent structures to mitigate against future flooding of the tunnels and damage to its electrical and mechanical systems by minimizing the entry of potential floodwater into the tunnels' structure via its openings.	DOT	MTA	5 years	$7 million	FHWA	N/A	2.1, 2.7

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.18	Coastal/Natural Resource Protection	**Wetland or upland habitat restoration:** Improve ability of land to absorb and retain water. Prevent flooding and release of silt and dirt into sewers and habitat. Parks' Natural Resources Group oversees upland and wetland restoration.	Parks	N/A	5 years	$10,000 to $50,000 per acre	HMGP, other grants	No change	4.3
F.E.19	Prevention & Policy	**Water and air quality protection:** Assess vulnerability of existing wetlands and identify additional policies to protect them.	Parks	NPS, EDC, DCP, EPA	8 years	TBD	TBD	No change	4.3
F.E.20	Emergency Services	**Sandbagging of all fuel fill ports and man-ways**: Prevent water intrusion, thereby ensuring fuel viability for continuity of operations.	DSNY	N/A	Duration of emergency/ immediate	Manpower absorbed by agency	TBD	N/A	2.1, 2.3
F.E.21	Emergency Services	**Roof drains and gutters:** Have garage personnel do inspections and take action to clear roof drains, gutters, etc. to ensure facilities are protected from water intrusion.	DSNY	N/A	Duration of emergency/ immediate	Manpower absorbed by agency	TBD	N/A	2.1, 2.7
F.E.22	Coastal/Natural Resource Protection	**Wetlands restoration:** Include wetlands restoration as part of waterfront development projects to comply with aesthetic permitting or stormwater management requirements.	EDC	NYSDEC	TBD	TBD	NYSDEC, City Capital	No change	4.3, 4.4
F.E.23	Coastal/Natural Resource	**Flushing Airport wetlands restoration:** Implement Flushing Airport Wetlands Mitigation Project in College Point, Queens.	EDC	NYSDEC	TBD	$6,000,000	NYSDEC, City Capital	Currently in design and under review by	4.3, 4.4

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
	Protection							NYSDEC	
F.E.24	Property Protection	**Flood-resistant construction and materials for HPD-assisted projects:** Revise construction specifics for substantial rehabilitation and new construction projects.	HPD	N/A	Estimated completion: 2014	$20,000	City TL	N/A	2.4, 2.5
F.E.25	Property Protection	**Temporary flood mitigation measures:** Protect substations/equipment flooded during Sandy from future floods until permanent measures are completed.	LIPA	N/A	Completed September 2013	$ 850,000 for NYC substation protection	FEMA 406, NYS CDBG fund, LIPA	N/A	2.1, 2.3, 2.7
F.E.26	Property Protection	**Flood study of Long Island floodplain:** Perform study and develop mitigation strategies based on findings.	LIPA	NYPA	Completed December 2013	$125,000 prorated for NYC substations	FEMA 406, NYS CDBG fund, LIPA	N/A	5.2
F.E.27	Property Protection	**Flood sensors:** Install information-based sensors to aid transmission operations during a flood event.	LIPA	N/A	Completed September 2013	$ 120,000 for NYC substation detection	FEMA, NYS CDBG fund, LIPA	N/A	2.3, 2.10, 5.2

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.28	Property Protection	**Emergency generators for contingency support to flood-damaged substations:** Install mobile generators and secure additional capacity to ensure customers in the Rockaways do not experience long power outages should flood-damage substation equipment fail before it can be replaced.	LIPA	N/A	May 2013 start, December 2014 completion	$3,500,000	FEMA 406, LIPA	N/A	2.3
F.E.29	Property Protection	**Marine Parkway Bridge protection:** Perform substructure and underwater work to prevent damage from flooding, including scour.	MTA (Bridges and Tunnels)	N/A	2 years	$14 million	Capital; applying for FEMA 406	In procurement phase of construction	2.1, 2.7, 2.8
F.E.30	Infrastructure Project	**Perimeter protection/drainage improvements and flood barriers for West Side Yard and East River tunnels:** Implement improvements for flood protection at these critical facilities.	MTA (LIRR)	Amtrak	TBD	$58.3 million	Potential FTA Local Priority Resiliency Funds	N/A	2.1, 2.7, 2.8
F.E.31	Property Protection	**LIRR critical facilities protection**: Define flood elevation criteria required to standardize ongoing and future flood protection projects throughout the network. Revise LIRR design standards, which would influence future construction projects.	MTA (LIRR)	N/A	TBD	TBD	TBD	N/A	2.1, 2.5, 2.7

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.32	Infrastructure Project	**Electrification of Tracks 7 and 8 in Long Island City Yard:** Allow LIRR to divert more trains to Hunterspoint Avenue station when there is a service disruption at Penn Station/East River tunnels. This allows Manhattan-bound LIRR customers access to Hunterspoint Avenue to connect with #7 subway service to Manhattan. Project also restores damaged assets and improves drainage in the yard.	MTA (LIRR)	N/A	TBD	$33.8 million	FTA Pro-Rated Recovery / Local Priority Resiliency	N/A	2.3, 2.9
F.E.33	Infrastructure Project	**Portal floodgates for the East River tunnels:** Install flood barriers in lieu of extensive tunneling dewatering improvements.	MTA (LIRR)	N/A	TBD	TBD	TBD	N/A	2.1, 2.7
F.E.34	Infrastructure Project	**Drainage mitigation in LIRR track system:** Design and install stormwater pump stations to relieve major flood-prone areas.	MTA (LIRR)	N/A	Ongoing	TBD	LIRR capital program, LIRR Operating budget	Ongoing	2.1, 2.3, 2.8
F.E.35	Prevention & Policy	**Track drainage on the Harlem Line:** Install drainage improvements at the Mott Haven Interlocking, located near 149th and 159th Streets in the Bronx, to improve drainage and reduce impact of flooding in this area.	MTA (MNR)	N/A	Completion - 1.5 years	$9.0 million	Capital budget	N/A	2.1, 2.7, 2.8
F.E.36	Property Protection	**Baisley Park depot drainage improvement:** Implement corrective actions to mitigate repetitive flooding caused by moderate to heavy rain.	MTA (Buses)	DEP, FTA, NYSDEC	2 years	$8,000,000	Capital budget	No change	2.1, 2.7, 2.8

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.37	Prevention & Policy	**Dewatering of oil-water separators at East New York, Castleton, Michael J. Quill, and Grand Avenue depots:** Provide additional capacity for incoming rainwater. Drain 200,000-gallon stormwater retention tank to accept incoming rainwater. (This tank is normally full and used for bus washing.)	MTA (Buses)	N/A	Ongoing	TBD	TBD	No change	2.1
F.E.38	Infrastructure Project	**JFK depot drainage improvement:** Include on-site stormwater management improvements at new parking facilities to decrease flow to DEP treatment facilities during high-volume precipitation events.	MTA (Buses)	DEP, FTA, NYSDEC	2 years	$3,234,000	Capital budget	No change	2.1, 2.8
F.E.39	Prevention & Policy	**NYCT Hurricane Plan:** Perform pre-storm flood mitigation actions in pre-identified flood-prone areas. Actions include checking drains, vents, and installed pumps as well as deploying covers and sandbags to pre-identified sites to cover vents and protect subway entrances.	MTA (NYCT-Subway)	NJT, PATH (PANYNJ)	Ongoing	TBD	TBD	Hurricane plan developed and is used as needed and updated periodically	2.1, 2.7
F.E.40	Prevention & Policy	**Flood plan:** Finalize plan, including mapping of critical areas, mitigation plan, and contingency plan.	MTA (NYCT-Subway)	DEP	Ongoing	TBD	Operating budget	Complete	5.2
F.E.41	Prevention & Policy	**DEP/NYCT station inspection and cleaning program**: Implement program featuring cleaning of catch basins, sewers, and siphons at locations in flood-prone areas.	MTA (NYCT-Subway)	NYCT	Ongoing	TBD	Agency operating budget	Ongoing	2.1, 2.8

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.42	Property Protection	**Stormwater drainage improvement:** Raise vent grating and subway entrances at five locations: (1) Broadway-7th Avenue Line: 77th to 96th Street; (2) Broadway-7th Avenue Line: Chambers Street; (3) 8th Avenue Line: 34th Street; (4) Hill Avenue Line; and (5) Broadway Line.	MTA (NYCT-Subway)	DEP	Ongoing	TBD	NYCT, capital budget	Partially complete, with balance not currently funded	2.1, 2.7, 2.8
F.E.43	Property Protection	**Station mitigation**: Seal system openings from floodwaters through closure/hardening of stairs, elevators, vents, emergency exits, and manholes. Enhance emergency communication within stations.	MTA (NYCT-Subway)	MTA/FTA	2-6 years	$184,000,000 currently allocated	FTA-Sandy grants	N/A	2.1, 2.7
F.E.44	Property Protection	**Line equipment mitigation**: Make improvements to pumping system including discharge lines, upsizing of pumps, power redundancy for pumps, mobile pump equipment and generators, and emergency equipment deployment. Harden subway equipment in flood-prone areas including hardening of fans, communication/EDR/relay rooms, subway equipment, and power supply equipment.	MTA (NYCT-Subway)	MTA/FTA	2-6 years	$800,000,000 currently allocated	FTA-Sandy grants	N/A	2.1, 2.7, 2.8
F.E.45	Property Protection	**Subway structures mitigation:** Internally seal tunnels and station complexes through inflatable bladders, pre-engineering, and site mobilization for temporary structures to prevent flood damage along vulnerable service lines.	MTA (NYCT-Subway)	MTA/FTA	2-6 years	$1,893,400,000 currently allocated	FTA-Sandy grants	N/A	2.1, 2.7

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.46	Property Protection	**Subway signals and communications mitigation**: Make system improvements for subway service flexibility, including major and minor interlocking enhancements for short-turn terminal operations, additional interlocking reconfigurations, power redundancy improvements in underwater tubes, feeder redundancy and/or power storage for critical operations, passenger capacity enhancements at interim terminal stations and stations affected by reduced service levels, and new passenger transfer facilities. Add and enhance communications systems and technologies for improved coordination of emergency response and customer information.	MTA (NYCT-Subway)	MTA/FTA	2-6 years	$850,000,000 currently allocated	FTA-Sandy grants	N/A	2.1, 2.3, 2.7
F.E.47	Property Protection	**Traction power mitigation**: Harden power cables and ducts to provide grid resiliency for critical locations.	MTA (NYCT-Subway)	MTA/FTA	2-6 years	$300,000,000 currently allocated	FTA-Sandy grants	N/A	2.1, 2.3, 2.7
F.E.48	Property Protection	**Subway car shops and yards mitigation:** Perform flood mitigation at yard complexes, including protection of perimeters and portals.	MTA (NYCT-Subway)	MTA/FTA	2-6 years	$325,000,000 currently allocated	FTA-Sandy grants	N/A	2.1, 2.7
F.E.49	Property Protection	**Flood mitigation at miscellaneous facilities:** Perform mitigation at police, revenue control, and administrative facilities, including backup power and employee emergency reporting flexibility.	MTA (NYCT-Subway)	MTA/FTA	2-6 years	$137,700,000 currently allocated	FTA-Sandy grants	N/A	2.1, 2.3, 2.7

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F.E.50	Property Protection	**Staten Island Railway flood mitigation**: Protect critical stations, facilities, and tunnels from flood damage.	MTA (NYCT-Subway)	MTA/FTA	2-6 years	$100,000,000 currently allocated	FTA-Sandy grants	N/A	2.1, 2.7
F.E.51	Property Protection	**Incremental standards mitigation**: Continue ongoing upgrade of design standards to improve resilience to seismic activity, wind, and fire events, and apply to new and existing facilities as capital work is performed.	MTA (NYCT-Subway)	NYCT	Ongoing	TBD	Core and future capital programs	N/A	2.1, 2.5, 2.7, 2.8
F.E.52	Property Protection	**Flood mitigation and backup power for OCME Forensic Biology Laboratory:** Install emergency generator and transfer switches and elevate petroleum bulk storage.	OCME	Con Ed, FDNY	Unknown	$2,350,000.00	Capital	N/A	2.1, 2.3, 2.7
F.E.53	Property Protection	**Flood mitigation and backup power for OCME main office (Manhattan Morgue) at 520 First Ave.:** Install emergency generator and transfer switches, elevate petroleum bulk storage, and install flood barriers.	OCME	DDC	Unknown	$6,263,000.00	Capital	N/A	2.1, 2.3, 2.7
F.E.54	Prevention & Policy	**FEMA 100-year floodplain maps for New York City**: Update maps reflecting current weather conditions and topography/bathymetry.	OLTPS	DOB, DCP, EDC, OEM	8 years	TBD	TBD	Ongoing	5.2
F.E.55	Prevention & Policy	**Flood resiliency for buildings in the 100-year floodplain:** Improve regulations for new and substantially improved buildings.	OLTPS	DOB, DCP	TBD	$0	N/A	N/A	2.2, 2.4, 2.5
F.E.56	Prevention & Policy	**FEMA flood mapping:** Work with FEMA to improve the flood-mapping process.	OLTPS	DOB	TBD	$0	N/A	N/A	3.1, 5.2

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.57	Education & Awareness	**Communication of flood risks**: Work with FEMA to improve the communication of current risks.	OLTPS	N/A	TBD	$1 million	CDBG, HMGP	N/A	3.1, 5.3
F.E.58	Prevention & Policy	**Future flood mapping:** Explore improved approaches for mapping future flood risks, incorporating sea level rise.	OLTPS	N/A	TBD	$0	N/A	N/A	4.1, 5.2
F.E.59	Infrastructure Project	**Flood protection in Coney Island:** Install armor stone shoreline protection (revetments).	OLTPS	N/A	TBD	$32 million	CDBG	N/A	2.1, 2.5
F.E.60	Infrastructure Project	**Bulkhead improvements:** Raise bulkheads in low-lying neighborhoods across the city to minimize inland tidal flooding.	OLTPS	N/A	TBD	$80 million	CDBG + City Capital	N/A	2.1, 2.5
F.E.61	Infrastructure Project	**Hospital Row flood protection:** Install an integrated flood protection system.	OLTPS	N/A	TBD	$60.3 million	CDBG	N/A	1.1, 2.1
F.E.62	Prevention & Policy	**Comprehensive flood protection study of New York Harbor**: Continue to work with the USACE to complete its study.	OLTPS	N/A	TBD	$0	N/A	N/A	5.2
F.E.63	Prevention & Policy	**USACE comprehensive study**: Identify a lead entity for overseeing the collaboration on the study and the implementation of coastal flood protection projects.	OLTPS	N/A	TBD	$0	N/A	N/A	5.2
F.E.64	Prevention & Policy	**Flood protection project standards:** Call on and work with the USACE and FEMA to collaborate more closely on standards.	OLTPS	N/A	TBD	$0	N/A	N/A	2.1, 2.4, 2.5
F.E.65	Prevention & Policy	**Enclosed hazardous substances mitigation:** Develop a catalog of best practices for storing hazardous substances in the 100-year floodplain.	OLTPS	OER	TBD	$0	N/A	N/A	1.1, 4.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.66	Prevention & Policy	**New hospitals:** Improve hospital design and construction.	OLTPS	N/A	TBD	$0	N/A	N/A	1.1, 1.3, 2.5
F.E.67	Property Protection	**Existing hospitals in the 500-year floodplain:** Require the retrofitting of hospitals in the 500-year floodplain.	OLTPS	N/A	TBD	$785 million	FEMA, CDBG, VA, NY State, Gap	N/A	1.1, 1.3, 2.4, 2.5
F.E.68	Prevention & Policy	**New nursing homes and adult care facilities**: Improve the design and construction of new nursing homes and adult care facilities.	OLTPS	N/A	TBD	$0	N/A	N/A	1.1, 1.3, 2.5
F.E.69	Property Protection	**Existing nursing homes in the 100-year floodplain:** Require the retrofitting of nursing homes in the 100-year floodplain.	OLTPS	N/A	TBD	$91 million	FEMA PA/406 (partially funded)	N/A	1.1, 1.3, 2.4, 2.5
F.E.70	Property Protection	**Existing adult care facilities in the 100-year floodplain:** Require the retrofitting of existing adult care facilities in the 100-year floodplain.	OLTPS	N/A	TBD	$1 million	Federal	N/A	1.1, 1.3, 2.4, 2.5
F.E.71	Prevention & Policy	**Affordability issues related to reform of the NFIP:** Support federal efforts to address NFIP affordability issues.	OLTPS	DCP	TBD	$1.1 million	CDBG	N/A	2.4
F.E.72	Property Protection	**Flood protection standards and certifications**: Develop FEMA-endorsed standards and certifications for existing urban buildings.	OLTPS	DOB, DCP	TBD	$0	N/A	N/A	2.4
F.E.73	Property Protection	**Mixed-use buildings as a building category:** Call on FEMA to recognize such buildings as a distinct building category in relation to flood insurance.	OLTPS	DOB, DCP	TBD	$0	N/A	N/A	2.5

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.74	Property Protection	**Mitigation credits:** Call on FEMA to develop mitigation credits for resiliency measures.	OLTPS	DOB, DCP	TBD	$0	N/A	N/A	2.7
F.E.75	Prevention & Policy	**Higher deductibles for residential policyholders:** Call on FEMA to allow flood insurance policyholders to select higher deductibles.	OLTPS	DOB, DCP	TBD	$0	N/A	N/A	2.4
F.E.76	Prevention & Policy	**Flood Insurance Policy Awareness:** Call on New York State to improve flood insurance policyholder awareness at the point of sale or renewal	OLTPS	N/A	TBD	$0	N/A	N/A	2.4, 5.3
F.E.77	Education & Awareness	**Flood Insurance Engagement Campaign:** Launch an engagement campaign targeting insurers	OLTPS	N/A	TBD	$0	N/A	N/A	2.4, 5.3
F.E.78	Infrastructure Project	**Dunes on the Rockaway Peninsula:** Complete short-term dune improvements.	OLTPS	N/A	TBD	$9 million	FEMA	N/A	2.7, 2.9
F.E.79	Infrastructure Project	**Sea Gate oceanfront protections:** Call on and work with the USACE to study additional protections in Sea Gate.	OLTPS	N/A	TBD	$0	N/A	N/A	2.2, 2.7
F.E.80	Prevention & Policy	**Coney Island/Brighton Beach nourishment:** Continue to work with the USACE to study strengthening the beach nourishment.	OLTPS	Parks	TBD	$0	N/A	N/A	2.2, 2.7
F.E.81	Prevention & Policy	**Manhattan Beach oceanfront protections:** Call on and work with the USACE to study protections for the Manhattan Beach oceanfront.	OLTPS	N/A	TBD	$0	N/A	N/A	2.2, 2.7
F.E.82	Prevention & Policy	**Study of mitigation of inundation risks through Rockaway Inlet:** Call for USACE to develop an implementation plan to mitigate	OLTPS	DEP	TBD	$0	N/A	N/A	2.2, 2.7

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
		inundation risks through Rockaway Inlet in Southern Brooklyn and South Queens, exploring a surge barrier and alternative measures**.**							
F.E.83	Prevention & Policy	**CUNY study and pilot of new technologies for high-rise buildings**: Support CUNY launch of study and pilot.	OLTPS	N/A	TBD	$0	N/A	N/A	2.10
F.E.84	Prevention & Policy	**Resiliency of private cogeneration facilities**: Study options to ensure resiliency of such facilities.	OLTPS	N/A	TBD	$0	N/A	N/A	2.1, 2.3, 2.7
F.E.85	Infrastructure Project	**Reinforcement of Belt Parkway edge protections**: Call for the USACE to develop an implementation plan for the reinforcement of existing Belt Parkway edge protections.	OLTPS	DOT, Parks	TBD	$0	N/A	N/A	2.1, 2.7
F.E.86	Prevention & Policy	**Flood protection standards for telecommunications equipment:** Develop standards for placement of telecommunications equipment in buildings.	OLTPS	N/A	TBD	$0	N/A	N/A	2.1, 2.3
F.E.87	Prevention & Policy	**Hardening power generators against flooding**: Work with power suppliers and regulators to harden key power generators.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.1, 2.3, 2.7, 3.1
F.E.88	Prevention & Policy	**Hardening electric transmission and distribution infrastructure:** Work with utilities and the PSC to harden key infrastructure against flooding.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.1, 2.3, 2.7, 3.1
F.E.89	Prevention & Policy	**Hardening the natural gas system against flooding**: Work with utilities, regulators, and gas pipeline operators to harden the natural gas system.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.1, 2.3, 2.7, 3.1

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F.E.90	Prevention & Policy	**Hardening steam plants against flooding**: Work with plant operators and the PSC to harden steam plants.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.1, 2.3, 2.7, 3.1
F.E.91	Property Protection	**Drainage improvements for Pump House # 4 and # 6 at LaGuardia Airport:** Upgrade pumps and electrical power supply, and modify structural walks and platform decks.	PANYNJ (Aviation)	PANYNJ	3 years	$7,500,000	Capital plan, HMGP, FEMA 406	Sandy 406 mitigation project	2.1, 2.7
F.E.92	Property Protection	**Backflow preventers** at **PANYNJ-controlled buildings at Kenney Airport:** Install backflow prevention devices and water meter upgrades in accordance with the New York State sanitary code and City regulations. Perform water meter upgrades as required.	PANYNJ (Aviation)	NYC, NYS	6 years	$19,203,000	Capital budget, HMGP	No change	2.1, 2.3
F.E.93	Property Protection	**Drainage improvement at Kennedy Airport:** Install synthetic material at two locations at the intersection of runways 4L and 31L to increase permeable surfaces and enhance stormwater runoff capacity .	PANYNJ (Aviation)	FAA	8 years	$29,998,000	Capital budget	No change	2.1, 2.3
F.E.94	Property Protection	**Drainage improvement at Kennedy Airport:** Retrofit and/or rebuild stormwater outfalls, including replacing terminating section of concrete triple box culvert to enhance drainage capacity.	PANYNJ (Aviation)	NYCDEP, NYSDEC	5 years	$8,434,000	Capital budget, HMGP	No change	2.1, 2.3
F.E.95	Property Protection	**Facility upgrade at Kennedy Airport:** Redesign and retrofit runways 13R-31L, including raising existing grade, modifying existing drainage, and installing new lighting and concrete pavement.	PANYNJ (Aviation)	FAA	4 years	$218,063,000	Capital budget	No change	2.1, 2.3

Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
F.E.96	Property Protection	**Storm drainage rehabilitation at LaGuardia Airport, Phase III:** Upgrade existing storm drainage pipe system by replacing pipe or installing an inner lining system to eliminate leaks in the stormwater pipe system.	PANYNJ (Aviation)	PANYNJ	8 years	$12,000,000	Capital budget, HMGP	No change	2.1, 2.3
F.E.97	Property Protection	**World Trade Center resiliency improvements:** Make mitigation improvements to the WTC site including flood panels and site-wide ejector pumping to enhance the existing surcharged storm drain system.	PANYNJ(WTC)	PANYNJ	5 years	$100,000,000	Capital budget, HMGP, FEMA 406	N/A	2.1, 2.3
INFRASTRUCTURE FAILURE									
IF.E.1	Emergency Services	**Cogeneration equipment at North River Wastewater Treatment Plant:** Install cogeneration equipment while hardening electrical assets. Using methane generated by the wastewater treatment process, cogeneration will produce electric power to keep wastewater treatment processes at North River online during power outages or peak summer load periods, when Con Ed may request that the facility reduce its power usage.	DEP	N/A	Design complete by 2015; construction timeline pending specifications	$212 million	Capital budget	N/A	2.1, 2.3, 2.7, 2.8, 2.10, 4.3
IF.E.2	Prevention & Policy	**Citywide VOIP:** Allows users to move to a different location with minimal reconfiguration and have regular phone numbers restored within hours if a City office building becomes inaccessible due to severe impact to both the PBX and Centrex lines.	DoITT	N/A	TBD	$10 million	TBD	N/A	2.1, 2.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
IF.E.3	Prevention & Policy	**Smart utility location:** Explore the feasibility of consolidating utilities within the public right-of-way (e.g. into multi-utility corridors consistently located within the roadway cross-section) to protect them from hazard events and speed response and recovery times by removing the uncertainty and physical conflicts between utility locations.	DOT	DDC	1 year (consultant study)	$500,000	HMGP, City Capital Budget, City Expense Budget	N/A	2.1, 2.3
IF.E.4	Property Protection	**Breezy Point storm damage restoration**: Rebuild distribution infrastructure throughout the fire-damaged section of Breezy Point in the Rockaway Peninsula (~ 150 homes)	LIPA	N/A	September 2013 start, November 2013 completion	$630,000	Insurance, FEMA, LIPA	N/A	2.1, 2.3, 2.9
IF.E.5	Prevention & Policy	**Fuel infrastructure hardening**: Call on the federal government to convene a regional working group to develop a fuel infrastructure hardening strategy.	OLTPS	N/A	TBD	$0	N/A	N/A	2.1, 2.7
IF.E.6	Prevention & Policy	**Post-emergency restoration for fuel infrastructure**: Develop a reporting framework for fuel infrastructure operators to support restoration.	OLTPS	N/A	TBD	$0	N/A	N/A	2.9
MULTI-HAZARD									

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.1	Emergency Services	**Improved weather forecasting:** Develop and enhance high-resolution weather forecasting technology to forecast weather-caused damage at a micro-geographic level. Utilize various weather parameters (such as rain, wind speed and direction, and temperature) to assist in advance warning capabilities.	Con Ed	N/A	Ongoing	Aproximately $200,000/year	Agency operating budget	No change	1.2, 4.2, 5.2
MH.E.2	Coastal/Natural Resource Protection	**Vegetation Management Program:** Continue performing vegetation management to ensure infrastructure, as well as the public, is secure during and after a natural hazard event. Proper pruning and thinning of the tree canopy is important to minimize damage during hurricanes and wind events and cleanup after storms.	Con Ed	N/A	Ongoing	Approximately $5 million/year	Agency operating budget	No change	2.1, 4.3
MH.E.3	Emergency Services	**Improved Con Edison communications:** Continue to provide and enhance communications on forecasted impact to Con Ed's system and updates on outages to customers, community leaders, and regulators. This includes notifications to customers on life-support equipment.	Con Ed	N/A	Ongoing	N/A	Agency operating budget	N/A	1.1, 1.2, 5.3
MH.E.4	Prevention & Policy	**Load-reduction programs:** Continue contingency and peak shaving demand response programs to mitigate constraint during times of high demand and electric infrastructure failure.	Con Ed	N/A	Ongoing	N/A	Agency operating budget	N/A	2.1

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.5	Prevention & Policy	**Con Edison cyber security:** Continue ensuring network and data integrity by implementing security measures; limiting access; maintaining traditional fire walls; deploying additional IPS/web and database monitoring technologies; segmenting the network; monitoring cyber attacks; and sharing information with local, state, and federal agencies.	Con Ed	N/A	Ongoing	N/A	Agency operating budget	N/A	2.1, 2.3
MH.E.6	Education & Awareness	**CUNY stakeholder outreach:** Conduct CUNY University-wide "all-hazards" mitigation training and awareness initiatives (Scope: all 24 CUNY campuses with a population of 450,000+ students). Publish and disseminate information to university stakeholder populations.	CUNY	CUNY, OEM, FEMA, DHS	Ongoing, with an annual awareness campaign to university stakeholders	Nominal cost	CUNY Central Office (CO) and campus operating budgets; CUNY internal CO and campus staff time; outside agency staff time, where applicable	N/A	5.1, 5.3

Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.7	Emergency Services	**Protection of City's fuel supply:** Procure additional mobile fueling trucks, generators, light towers, forklifts, and water pumps to permit the City to harden its own fuel supply infrastructure and put in place emergency fueling operations immediately following a disruption in the supply chain. Light towers have been delivered.	DCAS	NYPD, OEM, DSNY, DOT, Parks, DEP	Fuel trucks, forklifts, generators and water pumps are in the specification process.	$25,800,000.00	City-funded	N/A	2.1, 2.3, 2.9
MH.E.8	Emergency Services	**Resiliency of food supply:** Expand current pilots to backstop DCAS food procurement to strengthen resiliency and redundancy in case of future climate hazards. DCAS will work so that its supplier contracts for DOC, DYFJ, and HRA (food pantries and soup kitchens) have backstops in place by the end of 2013.	DCAS	DOC, ACS, HRA	Sysco contract available for use currently	N/A	Operating/emergency expense funds	N/A	1.1, 2.1, 2.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.9	Emergency Services	**City fueling during emergencies:** Harden municipal fueling stations and enhance mobile fueling capability to support City government and critical fleets. DCAS is increasing its mobile fueling fleet, negotiating with fuel suppliers and the NY National Guard to enhance emergency fueling operations, and the NYPD to prioritize fueling of city vehicles at select retail fueling locations. A new Fuel Operations Playbook was finalized and submitted to the City Council by OEM as required by law.	DCAS	NYPD, OEM, OLTPS, DSNY, DOT, Parks, DEP	Ongoing	$8,750,000 (included in the $25.8 million resiliency project above)	DCAS funded	N/A	2.1
MH.E.10	Emergency Services	**Inter-agency fueling:** Support inter-agency fueling citywide through fuel management system. DCAS is currently implementing the EJ Ward fuel tracking system Citywide. Agencies will have the ability to fuel at other agency locations and track fuel reserves electronically.	DCAS	N/A	Technology will be rolled out over FY 2014	$6,750,000	DCAS funded	N/A	2.1, 3.1

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MH.E.11	Prevention & Policy	**Open Industrial Uses Study:** Promote a more sustainable and resilient working waterfront by assessing cost-effective, pollution-prevention controls for unenclosed industrial facilities. The study also recommends stronger safeguards for open activities and the storage of hazardous and non-hazardous materials along the waterfront and in flood zones.	DCP	EDC, DEP, DSNY, OLTPS, OER, DOB	2013	TBD	TBD	N/A	2.4, 4.3
MH.E.12	Coastal/Natural Resource Protection	**Green infrastructure:** Construct green infrastructure to capture the first inch of runoff in 10% of impervious surfaces citywide in areas within the combined sewer system by 2030. Green infrastructure is constructed primarily to reduce combined sewer overflows but can have co-benefits for flooding and the urban heat island effect.	DEP	Parks, DOT	Ongoing through 2030	$1,026 million	Capital budget, private developers, HMGP	N/A	2.7, 2.8, 2.10, 4.3, 4.4
MH.E.13	Coastal/Natural Resource Protection	**Bluebelts:** Implement and accelerate Bluebelt drainage program to preserve and enhance natural areas, including streams, ponds, and other wetlands.	DEP	Parks	Ongoing	$360 million	Capital Budget, HMGP, Emergency Watershed Protection Program (USDA), wetland mitigatio	Action F.E. 15 from 2009 HMP is folded into this action	2.3, 2.8, 2.10, 4.3

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							n banking		
MH.E.14	Infrastructure Project	**Interconnection between the Catskill and Delaware Aqueducts:** Construct the Shaft 4 connection, a new engineered connection between the Catskill and Delaware Aqueducts at the Delaware Aqueduct's Shaft 4 location, where the two aqueducts cross. This connection will allow DEP to divert Delaware system water into the Catskill Aqueduct, thereby allowing DEP to reduce the flow of water from Ashokan Reservoir when turbidity is elevated while still maintaining sufficient flow to provide service to outside communities and meet overall demand. This increases operational flexibility, reduces turbidity levels entering Kensico, and improves water quality for outside communities.	DEP	N/A	Project complete in 2015	$21 million	Capital budget	N/A	1.5, 2.3, 4.3
MH.E.15	Property Protection	**Bridge reconstruction and stabilization:** Reconstruct and stabilize DEP-owned bridges and culverts located in the Croton, Catskill, and Delaware watersheds. Adhere to NYSDOT bridge safety standards to meet 50-year storm event design standards and withstand seismic loading.	DEP		Ongoing project scheduled through 2022	$233 million	Capital budget	N/A	2.4, 2.5, 2.7, 2.8

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MH.E.16	Infrastructure Project	**Dam reconstruction:** Reconstruct seven high-hazard dams to safely pass the probable maximum flood criteria in accordance with NYS dam safety guidelines and withstand seismic loading based on NYSDEC seismic guidance. The following dams are being reconstructed: Gilboa Dam (impounding Schoharie Reservoir), Olivebridge Dam (impounding Ashokan Reservoir), New Croton Dam (impounding New Croton Reservoir), Cannonsville Dam (impounding Cannonsville Reservoir), Merriman Dam (impounding Rondout Reservoir), Downsville Dam (impounding Pepacton Reservoir) and Neversink Dam (impounding Neversink Reservoir).	DEP		Ongoing project scheduled through 2023	$352 million	Capital budget	No change	2.4, 2.5, 2.7, 2.8
MH.E.17	Infrastructure Project	**Drainage improvements:** Develop plan for drainage enhancements based on flooding and sewer backup issues.	DEP		Ongoing	Included in regular agency o/m budget	Operating budget	No change	2.1, 2.3, 2.8, 4.3
MH.E.18	Emergency Services	**Mapping and analysis enhancement:** Continue to leverage GIS data with modeling capabilities to provide information on areas experiencing issues, faster diagnostics of issues, and alternative analysis to weigh benefits of potential mitigation actions.	DEP		Ongoing	Included in regular agency o/m budget	Operating budget	No change	2.10, 5.2

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.19	Property Protection	**Facility and infrastructure protection:** Reconstruct and harden sludge-vessel docks and piping to ensure continuity of treatment and protection of marine fleet assets.	DEP	N/A	2023	$20 million	Capital budget	No change	2.1, 2.7
MH.E.20	Education & Awareness	**Public education on emergency preparedness and hazard mitigation actions:** Develop and conduct educational forums or seminars.	DFTA	OEM	2 years	$10,000	TBD	No change	1.1, 1.6, 5.3
MH.E.21	Education & Awareness	**Public outreach to seniors:** Increase enrollment in Carrier Alert program to prepare seniors to meet the challenges of disasters.	DFTA	Alzheimer's Foundation, HRA, MOPD, NYPD, USPS	2 years	TBD	Agency operating budget	No change	1.1, 1.6, 5.3
MH.E.22	Education & Awareness	**Emergency planning and hazard mitigation literature:** Reach 45,000 clients with literature in multiple languages.	DFTA	OEM, DOHMH	2 years	$15,000	TBD	N/A	1.1, 1.6, 5.3
MH.E.23	Emergency Services	**Communications equipment:** Purchase/obtain (through DoITT) 600 radios to provide redundant 800 MHz communications to support agency and citywide communications. Develop pre-event radio operations training program.	DHS	OEM, HHC, DOHMH,	Ongoing	$600,000	TBD	No change	1.1, 1.2, 2.3
MH.E.24	Emergency Services	**Park Slope Armory garage facility improvements:** Centralize emergency supply storage and logistics hub to support agency and citywide emergency operations.	DHS	N/A	Ongoing	$250,000	TBD	N/A	1.1, 2.1

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.25	Prevention & Policy	**Existing building code revision:** Develop a building code that will promote the inclusion of natural hazard mitigation measures into existing building design and retrofit projects.	DOB	N/A	TBD	$475,000	Agency operating budget	No change	2.5
MH.E.26	Prevention & Policy	**Interagency coordination:** Participate in regular interagency coordination with OEM to discuss natural hazard mitigation.	DOB	OEM	Ongoing	Staff time	Agency operating budget	No change	3.1
MH.E.27	Prevention & Policy	**DOB staff development:** Participate in natural hazard mitigation code and standards development by sending staff to national events and training sessions that focus on seismic, wind, and flood codes.	DOB	N/A	Ongoing	$25,000	Agency operating budget	Implemented and ongoing	2.6
MH.E.28	Prevention & Policy	**DOB training:** Send staff to national training sessions and seminars on hazards and mitigation practices.	DOB	N/A	Ongoing	$25,000	Agency operating budget	Implemented and ongoing	2.6
MH.E.29	Prevention & Policy	**Construction Code revision:** Develop Construction Code amendments to reduce energy demand and reliance on fossil fuels as part of PlaNYC. These amendments will apply to both existing and new buildings and in some cases may result in energy reductions beyond the requirements of the Energy Conservation Construction Code of New York State. Review literature on how climate change will impact New York City, and review provisions developed by other jurisdictions to mitigate the anticipated effects of climate change.	DOB	OLTPS	2 years	$5,800,000	Agency operating budget	Implemented and ongoing	2.5, 4.1, 4.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.30	Emergency Services	**Cogeneration plant:** Install cogeneration plant to reduce reliance on Con Ed power while complying with the GreeNYC Plan for DOB.	DOC	N/A	Completion by December 2014	$125 million	Capital	Project construction 60% complete. Planned construction completion December 2014	1.1, 2.3, 2.10, 4.3
MH.E.31	Property Protection	**Emergency power upgrades and replacements:** Install emergency generator ports to allow immediate portable generator installation. Purchase 10 900KW portable generators.	DOC	N/A	TBD	$15 million	Capital	N/A	1.1, 2.3, 2.7
MH.E.32	Emergency Services	**Redundant communications:** Establish a redundant emergency communications system.	DOE	OEM	2 years	$5,000,000	FEMA	No change	2.3
MH.E.33	Emergency Services	**NYC Community Air Survey (NYCCAS):** Collect integrated air quality data in response to emergencies and environmental hazards including combustion emissions, structural fires or brush fires, demolition and debris removal from storm damaged areas, and extensive use of temporary generators and boilers following widespread utility disruption. Use real-time ambient fine particulate matter (PM2.5) monitors to enhance agency preparedness capabilities.	DOHMH	Parks, DEP	Since 2008	$200,000 /year for staffing, equipment maintenance, and data communications	Staff time, grants	N/A	1.5, 5.2

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.34	Emergency Services	**Citywide health and safety program for large-scale emergencies**: Coordinate the development of an Incident Health & Safety Plan using the Citywide Health & Safety Plan (CHASP) as a model. The new plan would provide multi-agency health and safety guidance during large-scale emergencies. Program also provides training and symposia for City agencies to build capacity and disaster preparedness.	DOHMH	N/A	Ongoing	TBD	Operating budget, grants	N/A	1.1, 1.2, 1.5
MH.E.35	Emergency Services	**Environmental emergency preparedness:** Develop risk characterization and communication; training for multi-agency biological incident environmental sampling teams and guidance for emergency response staff; guidance and plans for biological and radiological remediation for agencies and other stakeholders including building owners, employers, and the public.	DOHMH	N/A	Ongoing		Operating budget, grants	N/A	1.1, 1.2, 1.4, 1.5

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.36	Prevention & Policy	**Real-time surveillance of health outcomes:** Utilize data about health-related behaviors that are already stored in an electronic format for syndromic surveillance, i.e., recognizing diseases based on signs and symptoms.	DOHMH	FDNY, 59 of 61 NYC hospital emergency departments, OCME	Ongoing need	Approximately $2 million per year	Currently funded by CDC Public Health Emergency Preparedness and Epi and Lab capacity grants. Long-term sustainability of these funds is unclear so additional funding sources are needed.	Ongoing	1.1, 1.5

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.37	Emergency Services	**Public health information for healthcare providers:** Disseminate information, checklists, and specific guidance and provide timely and accurate health alerts, advisories, and updates to healthcare providers and agencies that provide services to vulnerable populations on extreme weather events and other environmental hazards like pollen, air pollution, and vector-borne disease. Use the Health Alert Network, Dialogic NXT Communications System, and blast fax to assist them in preparing themselves to protect their clients during extreme events and improve messaging coordination.	DOHMH	DFTA, OEM, HRA, organizations in the Health Alert Network	Ongoing	TBD	Operating budget, staff time	No change	1.1, 1.2, 1.5, 1.6
MH.E.38	Education & Awareness	**Public health risk communication for the general public:** Raise public awareness on how to reduce or prevent illness and mortality from extreme weather events and other environmental hazards including air pollution and environmental exposures (such as carbon monoxide releases, mold, toxic spills and other toxic releases). Use 311, nyc.gov, printed materials, media, and public forums and presentations.	DOHMH	NWS, OEM, DFTA, HRA	Ongoing	TBD	Operating budget, staff time	No change	1.5, 5.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.39	Emergency Services	**Interagency field and environmental data gathering and exchange:** Facilitate environmental data capture, exchange, and storage among government agencies using web-based data systems. Interagency data exchange supports timely identification and characterization of potential hazards and provides a means to mitigate impacts of natural disasters and emergencies.	DOHMH	OEM, FDNY, DEP	Ongoing	TBD	Staff time, grants	No change	1.5, 3.1, 5.2
MH.E.40	Education & Awareness	**Interagency environmental data workshop:** Host annual conference to improve interagency coordination, promote best practices, and introduce emerging tools for data sharing, risk analysis, and vulnerability assessment.	DOHMH	OEM	Ongoing	TBD	Staff time, grants	No change	1.5, 3.1, 5.2
MH.E.41	Prevention & Policy	**Health Code revisions**: Examine the New York City Health Code to identify what elements can be revised to bolster natural hazard mitigation and improve public safety and health during extreme weather events.	DOHMH	N/A	Ongoing	TBD	Staff time	No change	1.1, 1.3, 1.5
MH.E.42	Prevention & Policy	**Climate change and public health assessment:** Assess health risks of climate-related events, conduct vulnerability assessments, implement enhanced surveillance systems for climate-sensitive conditions, and promote climate-health strategies and interventions.	DOHMH	N/A	3-year program, just renewed for 3 years	$173,000 - $250,000 /year (not fully funded)	Grants	N/A	1.1, 1.5, 4.2

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.43	Education & Awareness	**Climate and health community resilience:** Conduct workshops and disseminate public health information and educational tools through community stakeholders, professional associations, faith-based coalitions, and agencies that provide services to vulnerable populations (children, seniors, inmates, the homeless, and the mentally ill). Workshops provide targeted instruction on how to reduce illness and mortality impacts of extreme weather on affected populations.	DOHMH	DFTA, OEM, HRA, external partners	3-year program, just renewed for 3 years	$173,000 - $250,000 /year (not fully funded)	Grants	N/A	1.1, 1.5, 1.6, 4.2
MH.E.44	Education & Awareness	**Environmental health tracking portal:** Facilitate environmental data dissemination to the public using web-based data systems. Data dissemination supports community preparedness, public education, and characterization of potential environmental hazards.	DOHMH	OLTPS	3-year program currently on its third year	$753,000	Grants, staff time	N/A	1.1, 1.5, 5.1
MH.E.45	Emergency Services	**Environmental monitoring information telemetry system:** Implement wireless transmission of handheld and vehicle-mounted environmental monitoring data from field to office. Identification and characterization of radiological environmental hazards, including air emissions data, provides a means to mitigate public health impacts.	DOHMH	N/A	Ongoing	TBD	Grants	N/A	1.1, 1.5, 5.2

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.46	Education & Awareness	**Assessing and communicating risks from drinking and recreational waters:** Issue public advisories on health hazards from flooding/storm impacts to water supply and public waters/beaches, using 311, nyc.gov, printed materials and media.	DOHMH	DEP, Parks	Ongoing	TBD	Operating budget	N/A	1.1, 1.2, 1.5, 5.3
MH.E.47	Education & Awareness	**Public education on mental health**: Conduct a "Mental Health First Aid" education program to introduce the public to risk factors and warning signs of mental health problems, build understanding of their impact, and overview common treatments to increase individual and community resilience.	DOHMH	N/A	Immediately and ongoing	$150,000	TBD	N/A	1.1, 1.5
MH.E.48	Emergency Services	**Mental health system IT record redundancy:** Convert paper records to electronic formats to prevent damage and loss in the event of a disaster and facilitate remote accessibility of client records. Include off-site backup capacity.	DOHMH	N/A	One year to implement	$6,000,000	One-time expense to initiate project, followed by capital allocation	N/A	1.1, 1.5, 2.1

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.49	Prevention & Policy	**Green Streets program**: Transform unused road space into open (green) space to reduce volume of stormwater runoff by absorbing or storing water and reduce the impact of extreme heat events. The goal of this project is to add 40 Green Streets totaling 75 acres of open space with a storage capacity of four million gallons of stormwater.	Parks	DOT	8 years	$15,000,000	Private donors	No change	1.5, 2.1, 4.3
MH.E.50	Prevention & Policy	**Street trees:** Fill every available street tree opportunity in New York City, thus improving drainage across the city and reducing the effects of extreme temperatures. The goal is to raise the street stocking level from 74% to 100%.	Parks	DOT, DOB	8 years	$246,900,000	TBD	No change	1.5, 2.1, 4.3
MH.E.51	Property Protection	**Conversion of asphalt fields to natural or synthetic turf fields:** Convert 24 fields to asphalt or natural or synthetic turf with new drainage systems. Both scenarios would result in improved drainage and possible reduction of the urban heat island effect in large park areas.	Parks	HHC, DOHMH	8 years	$42,100,000	TBD	No change	2.1, 4.3
MH.E.52	Coastal/Natural Resource Protection	**Reforestation:** Reforest 2,000 acres of parkland.	Parks	NPS	10 years	$118,000,000	TBD	No change	4.3
MH.E.53	Coastal/Natural Resource Protection	**Tree pruning:** Implement a 5-year program to prune or remove old and overgrown trees. This program is designed to reduce the impact of severe weather including tornadoes, windstorms, and coastal storms.	Parks	N/A	5 years	$5,000,000	TBD	No change	2.1, 4.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.54	Coastal/Natural Resource Protection	**Wetlands protection:** Assess the vulnerability of existing wetlands and identify additional policies to protect them.	Parks	DEP, OLTPS, NPS, EDC, DCP, EPA	8 years	TBD	TBD	No change	4.3
MH.E.55	Coastal/Natural Resource Protection	**Tree planting:** Partner with stakeholders to help plant one million trees by 2017. Trees reduce temperatures, absorb additional stormwater, and decrease flooding.	Parks	OLTPS, DOT, DOB, NPS	9 years	TBD	TBD	No change	1.5, 2.1, 4.3
MH.E.56	Infrastructure Project	**Public safety land-mobile radio communications at the World Trade Center:** Protect and enhance the reliability and resilience of communications infrastructure by installing redundant radio antenna and related equipment at the World Trade Center.	DoITT	N/A	18 months	$1.8 million	FEMA grant	N/A	2.3
MH.E.57	Emergency Services	**311 upgrade:** Support future high call-volume events including re-architecture of the 311 platform, provide production environment for call center-specific version of applications, and implementing cloud-based mapping.	DoITT	N/A	18 months	$29.3 million	TBD	N/A	2.1, 2.3, 2.8
MH.E.58	Emergency Services	**311 alternate site:** Build out an operating environment in a hardened facility to insure that 311 operations can relocate to an alternate site should primary facility be impacted.	DoITT	N/A	12 months	$13 million	TBD	N/A	2.1, 2.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.59	Prevention & Policy	**Hardening the optical backbone:** Implement new omni-directional optical technology to enable DoITT to remotely switch the light and route traffic around failed fiber path. Citynet, the City's dedicated optical fiber backbone, is already undergoing a significant upgrade to increase its capacity and resiliency. While the network has the ability to dynamically switch the IP at the ethernet layer, it does not have ability to remotely switch the light through multiple fiber paths during emergencies.	DoITT	N/A	6 months	$17 million	TBD	N/A	2.1, 2.3, 2.8
MH.E.60	Prevention & Policy	**Internet/DMZ management:** Sustain advanced bandwidth management devices to regulate appropriate usage of ISP links during emergencies.	DoITT	N/A	TBD	$1.55 million	TBD	N/A	2.1, 2.3
MH.E.61	Property Protection	**Protection of New York City bridges from hazards:** Implement measures including seismic retrofits, structural hardening, inspections, and retrofits to protect moveable bridge machinery.	DOT		10 years	$1 billion	Federal, city, state	Construction under way on Brooklyn, Manhattan, and Williamsburg Bridges	2.1, 2.7, 2.8
MH.E.62	Prevention & Policy	**Toolbox of climate resiliency features for ROW capital projects:** Develop a toolbox of hazard-resilient design treatments that can be incorporated into right-of-way capital projects (streets, bulkheads/seawalls, retaining walls) and a selection process/methodology for applying the most appropriate and cost-effective	DOT	DDC	1 year (consultant study)	$1,000,000	HMGP, City Capital Budget, City Expense Budget	Ongoing	2.8, 2.10, 5.2

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
		treatments to particular locations based on the hazards those locations face.							
MH.E.63	Property Protection	**Climate resiliency features in future capital projects:** Apply the toolbox of hazard-resilient design treatments developed in MH.E.62 to an initial set of existing capital projects in high-risk areas. As these strategies are refined and their effectiveness and cost-effectiveness are demonstrated, apply them in a standardized way to all right-of-way capital projects going forward.	DOT	DDC	2 years (design, construction)	$20,000,000 per year	HMGP, TEP/TAP grants, City Capital Budget	Ongoing	2.8
MH.E.64	Infrastructure Project	**Resiliency in DOT Planning and Project Development:** Integrate resiliency in planning and project development.	DOT	N/A	1 year (in-house study) plus ongoing (1 new staff person focused on infrastructure resiliency	$150,000 per year	HMGP, City Expense Budget	N/A	2.7

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MH.E.65	Property Protection	**Protection of ferry terminals:** Protect terminals from flooding and storm damage.	DOT	N/A	6 years	$200,000,000	FTA ER	N/A	2.1, 2.7
MH.E.66	Infrastructure Project	**Ferry use during emergencies**: Deploy the Staten Island Ferry's Austen Class vessels on the East River Ferry during transportation disruptions.	DOT	N/A	As necessary	$100,000/week/vessel	Expense	N/A	2.1
MH.E.67	Property Protection	**Traffic signal equipment:** Elevate equipment in flood zones.	DOT	N/A	3 years	$ 3,000,000	HMGP, FHWA	N/A	2.1, 2.7
MH.E.68	Prevention & Policy	**Traffic management measures in emergencies:** Plan for measures including HOV restrictions, temporary transit services, special bike/pedestrian routes, and emergency public information protocols. Conduct resiliency planning exercises.	DOT	PD, MTA	Ongoing	$ 10,000,000	HMGP	N/A	2.1
MH.E.69	Infrastructure Project	**Pedestrian and bicycle facilities**: Plan for and install new facilities to improve connectivity to key transportation hubs.	DOT	DDC	Ongoing	$ 10,000,000	CMAQ, FHWA	N/A	2.1, 4.3
MH.E.70	Prevention & Policy	**Bus priority strategies**: Expand Select Bus Service and other bus priority strategies.	DOT	MTA, DDC	Ongoing	$ 20,000,000	CMAQ, FTA	N/A	2.1
MH.E.71	Emergency Services	**Emergency power generators:** Provide five large and 60 small emergency power generators to facilities during a hazard event.	DSNY	N/A	Duration of emergency/ immediate	Fuel/equipment cost only/absorbed by agency	TBD	No change	2.3

Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.72	Property Protection	**Green roofs:** Install green roofs on facilities where appropriate to reduce the volume of stormwater runoff by absorbing or storing water and help reduce the urban heat island effect.	EDC	NYCDEP	TBD	TBD	TBD	No change	2.8, 2.10, 4.3, 4.4
MH.E.73	Emergency Services	**EDC emergency power generators:** Provide emergency power generators to facilities during a natural hazard event.	EDC	N/A	Ongoing	TBD	EDC, OEM	No change	2.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.74	Infrastructure Project	**Expansion of ferry landings available for regular and emergency use**. Design and procure two new ferry landing barges that are outfitted with the required equipment for providing basic ferry service, including self-contained generators. These barges will be stored in a secure and protected location. When the need arises, they will be deployed within 24 to 48 hours as temporary landings, allowing for the rapid establishment of interim service. Deploy four new permanent ferry landings at strategic locations selected based on the results of the ongoing Citywide Ferry Study. The landings will be designed to be mobile so that, in an extreme situation, they can be temporarily relocated to provide alternative transit services where needed.	EDC	DOT	5 years	$15,000,000.00	FTA	N/A	2.1, 2.2
MH.E.75	Emergency Services	**Backup water main system:** Develop system to transmit fire suppression water throughout the city if existing infrastructure is disrupted due to a drought or earthquake.	FDNY	DEP, DDC, OEM	TBD	TBD	TBD	Ongoing	2.3, 2.7
MH.E.76	Emergency Services	**Power redundancy at FDNY facilities:** Install backup electrical power generators	FDNY	OEM, DDC	TBD	TBD	Capital budget	Ongoing	2.3

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		in all FDNY facilities.							
MH.E.77	Emergency Services	**Water supply redundancy:** Increase water drafting capabilities citywide. Drafting, which entails the suction of water from a body of water to a fire apparatus, can decrease the demand on the water supply system and provide redundant fire suppression water in the event of a drought or earthquake-induced water supply disruption.	FDNY	DEP, U.S. EPA	TBD	TBD	Grants	Ongoing	2.3
MH.E.78	Property Protection	**Enterprise Asset Management System:** Develop and implement the system for equipment tracking and digital inventorying.	FDNY	N/A	First quarter 2014	TBD	TBD	N/A	2.1
MH.E.79	Emergency Services	**Continuity of Operations Plan (COOP):** Create, distribute, and implement a COOP plan to ensure continuity of all FDNY operations in the event of a disaster.	FDNY	OEM	TBD	$810,000	Grants	N/A	2.1, 2.3
MH.E.80	Emergency Services	**Emergency Action Plans:** Require non-fire emergency plans for office buildings.	FDNY	N/A	TBD	$1,400,000	Grants	N/A	2.1, 2.5
MH.E.81	Emergency Services	**IT disaster recovery:** Create, distribute, and implement a recovery plan to ensure continuity of IT operations in the event of a disaster.	FDNY	DOITT	TBD	$2,400,000	Grants	N/A	2.1, 2.3
MH.E.82	Emergency Services	**Redundant emergency generators:** Install generators for Group 2, 3, and 4 general hospitals, D&TC centers, and nursing facilities.	HHC	Dormitory Authority of the State of New	5 years	$90,000,000	General obligation bonds	Ongoing	1.1, 2.1, 2.3

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				York					
MH.E.83	Education & Awareness	**Annual NYC/LI Emergency Management Conference:** Provide emergency management professionals with an opportunity to explore and discuss concerns, issues, and initiatives for effective emergency preparedness and planning.	LIPA	NYS OEM, Nassau County OEM, Suffolk County OEM, NYC OEM	May 2013	$25,000	LIPA and other sponsors of the event	N/A	5.3
MH.E.84	Education & Awareness	**Flooding technical assistance to owners of landmarked structures:** Provide technical assistance to owners of locally landmarked structures affected by flooding and other hazards.	LPC	DOB, DOT	Ongoing	TBD	LPC expense budget	Implemented (scope has been revised)	2.9
MH.E.85	Coastal/Natural Resource Protection	**Tree Pruning (LIRR):** Reduce probability of downed trees or limbs due to tornadoes, windstorms, and coastal storms along active rail lines through preventive tree pruning.	MTA (LIRR)	N/A	Ongoing	TBD	LIRR operating budget	Ongoing	2.1
MH.E.86	Coastal/Natural Resource Protection	**Tree Pruning (MNR):** Reduce probability of downed trees or limbs due to tornadoes, windstorms, and coastal storms along active rail lines through preventive tree pruning.	MTA (MNR)	N/A	Immediate, 2-year contract duration	$1.6 million	Capital budget, operating budget, Sandy Emergency Relief Program	Ongoing	2.1

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							- Resiliency		
MH.E.87	Infrastructure Project	**Harlem River lift bridge:** Develop threat scenario report, threat vulnerability and risk assessment, and prioritized list of security projects. This single point of failure for all MNR traffic into/out of the CBD is vulnerable to a broad spectrum of threats.	MTA (MNR)	N/A	Completion May 2014	$2.6 million	2011 TSGP	N/A	5.2
MH.E.88	Emergency Services	**Operations/communications redundancy:** Use secondary facility at North White Plains to create redundancy for the Operations Control Center, allowing for continued operational capability for the railroad.	MTA (MNR)	N/A	TBD	$25-30 million	TBD	N/A	2.3
MH.E.89	Emergency Services	**Contingency planning for substitute bus service**: Purchase mobile emergency command center vehicles, fuel tank trucks, and mobile and fixed equipment for bus operations including electronic variable message signs, pumps, portable generators, and portable tower lights.	MTA (Buses)	N/A	TBD	TBD	TBD	N/A	2.1, 2.3
MH.E.90	Emergency Services	**Bus command center and radio system:** Replace obsolete facility and system with state-of-the-art command center and radio communication system.	MTA (Buses)	N/A	TBD	TBD	TBD	N/A	2.1
MH.E.91	Emergency Services	**Contingency bus fleet:** Establish fleet of approximately 50 buses to support emergencies.	MTA (Buses)	N/A	TBD	TBD	TBD	N/A	2.1
MH.E.92	Property Protection	**Emergency generators:** Install at depots at Kennedy and LaGuardia Airports and	MTA (Buses)	N/A	TBD	TBD	TBD	N/A	2.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
		Baisley Park to provide electrical power backup.							
MH.E.93	Property Protection	**Emergency Action Plan:** Revise plan including lessons learned from Sandy. Include necessary NYCHA operational actions required 7 days, 72 hours, 48 hours, and 24 hours prior to a forecasted weather event and within the first 24 hours following the event.	NYCHA	TBD	TBD	TBD	TBD	N/A	1.1, 2.1, 5.2
MH.E.94	Property Protection	**Protective roofing:** Install new flashing and four-ply torch-applied modified bitumen roofing with high-reflective coating over polyisocyanurate tapered insulation in 46 developments (524 buildings) citywide. This project, which will involve removal of existing roofing and insulation and asbestos abatement, will increase storm resiliency and reduce the impacts of extreme heat events.	NYCHA	DOE-SCA	1 year	$126,184,945	Capital improvement budget	No change	1.1, 2.5, 2.7, 2.8, 2.10
MH.E.95	Property Protection	**Window protection:** Install new shatter-resistant operable windows and frames and repair lintels and sills in nine developments (62 buildings) citywide. Remove existing windows and conduct asbestos abatement.	NYCHA	DOE-SCA	2 years	$14,388,787	Capital improvement budget	No change	1.1, 2.5, 2.7, 2.8, 2.10
MH.E.96	Property Protection	**Copping:** Remove all loose and damaged brick, stucco, and copping to reduce flying debris during wind storms, coastal storms, and tornadoes. Install new brick and copping in 34 developments (313 buildings) citywide.	NYCHA	N/A	2 years	$237,141,686	Capital improvement budget	No change	1.1, 2.5, 2.7, 2.8

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.97	Emergency Services	**Continuity of Operations (COOP):** Ensure City agencies can provide essential services to the public during emergencies while maintaining internal critical functions. Develop plans that build contingencies around essential services, mitigate the impact of disruptions to services, and enhance the ability to provide CIMS operations, social services, and government operations.	OEM	DoITT	Ongoing	$1.5 million	U.S. Dept. of Homeland Security Urban Area Security Initiative Grant	Ongoing	2.1, 2.3
MH.E.98	Emergency Services	**Advance warning system integration:** Integrate Notify NYC and NY-ALERT advance warning and emergency capabilities. When fully operable, this system will provide advance warning to New York City residents prior to hazard events. The public is able to enroll in Notify NYC and receive messages via e-mail, phone calls, text message, or by subscribing to the RSS feed. Messages are also sent via Twitter and Twitter Alert. Depending on the severity of the emergency, Wireless Emergency Alerts and Emergency Alert System can be activated to broaden the audience that receives the notification.	OEM	DoITT, FEMA SEMO	TBD	TBD	HMGP	On-going (scope is expanding to include additional alert mechanisms including Blackberry Messenger, Instant Messenger, and TTY/TDD)	1.1, 1.2

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.99	Education & Awareness	**Incident-based distribution project:** Implement program to track and study areas impacted by natural disasters using OEM Watch Command data and Geographic Information Systems technology. Target affected areas for post-disaster outreach and Ready New York materials. Encourage property owners to incorporate mitigation measures during recovery.	OEM	N/A	Ongoing	$25,000	U.S. Dept. of Homeland Security Urban Area Security Initiative Grant	The program has been increasing its capacity. By 2013, it was regularly sending several thousand guides each month.	1.1, 2.9, 5.1, 5.2, 5.3
MH.E.100	Education & Awareness	**Insurance Working Group:** Leverage the insurance industry and regulators to partner with the private sector and provide information on insurance-related mitigation measures.	OEM	NYS Insurance Department	TBD	TBD	TBD	OEM's Public/Private and Legal units held several meetings with representatives of the insurance industry under the auspices of the Insurance Working Group. The information that came from these conversations informed the language used during presentations to businesses and residents. The New York State	3.1, 3.5

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
								Department of Insurance was designated as the industry's primary link to OEM's based on its ability to share information widely	
MH.E.101	Education & Awareness	**Public education through Ready New York guides:** Promote Ready New York guides as a tool to educate New Yorkers about natural hazards. This program offers all-hazards guides; hazard-specific guides for hurricanes, floods, and heat; and guides geared specifically for seniors and people with disabilities, children, and businesses. Guides contain information on how to mitigate, prepare for, and respond to an emergency, and are offered in up to 14 languages as well as audio tapes and braille. In 2012/13 OEM mailed over 2.2 million hurricane guides to households that lie in the city's hurricane evacuation zones.	OEM	DOE, DEP, Mayor's Office, SBS, DFTA, Mayor's Office for People with Disabilities	Ongoing	$1,060,000	U.S. Dept. of Homeland Security Urban Area Security Initiative Grant	The program has been increasing its capacity. By 2013 it was regularly sending out several thousand guides each month.	1.1, 5.1, 5.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.102	Education & Awareness	**Public outreach through Ready New York program:** Provide public outreach throughout the city by presenting and tabling at community and private-sector events. Encourage communities to understand the impact of hazards so they may better mitigate, prepare, and respond to hazards.	OEM	N/A	Ongoing	$50,000	U.S. Dept. of Homeland Security Urban Area Security Initiative Grant	From 400-500 outreach events annually, the program is now closing in on doubling its capacity. During hurricane/coastal storm season, mailings of around 1,500 pieces target elected officials, non-profits, senior centers, houses of worship, and schools around the city. In 2013, OEM mailed the updated hurricane guide to 1.4 million households and businesses in the city's hurricane evacuation zones.	1.1, 5.1, 5.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.103	Prevention & Policy	**Hazard mitigation grant program planning:** Pursue grant funding to support additional analysis for NYC Hazard Mitigation Plan.	OEM	DCP, OLTPS	3 years	$1 million	HMGP	N/A	2.9
MH.E.104	Emergency Services	**Regulatory actions on liquid fuel shortages**: Develop a package of city, state, and federal regulatory actions to address shortages during emergencies.	OEM	DCAS	Ongoing	TBD	Agency operating budget	N/A	2.3
MH.E.105	Education & Awareness	**Urban Post-Disaster Housing Prototype Program:** Develop a series of tools and public education programs that build capability to supply post-disaster housing that meets the unique needs of urban areas. Create an option for interim housing that will provide more suitable living spaces for New Yorkers displaced by disaster than existing federal interim housing solutions.	OEM	DDC	1 year	$100,000	FEMA, city tax levy, U.S. Dept. of Homeland Security Regional Catastrophic Preparedness Grant Program	N/A	1.1, 1.6
MH.E.106	Prevention & Policy	**Urban Post-Disaster Housing prototype:** Evaluate phases of implementation of rapidly deployable solution that provides proof-of-concept for providing interim housing at the speed and scale NYC may need.	OEM	FEMA, USACE, DOB, DEP, DOT, MTA	1 year	$1,600,000	FEMA, city tax levy, U.S. Dept. of Homeland Security Regional Catastrophic	N/A	1.6, 2.10

Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
							Preparedness Grant		
MH.E.107	Prevention & Policy	**Performance specifications for Urban Post-Disaster Housing:** Mitigate population loss after disaster by providing NYC with operational details for procuring manufactured housing that has stringent requirements for safety, environmental quality, durability, and universal design.	OEM	FEM, HUD, USACE, DDC, DOB, DEP, DOT, private sector	4 years	$50,000	FEMA, city tax levy, U.S. Dept. of Homeland Security Regional Catastrophic Preparedness Grant	N/A	1.1, 2.5, 2.10
MH.E.108	Education and Awareness	**Ready New York Mobile App:** Develop Mobile iPhone and Android application for the City's Ready New York preparedness program to help New Yorkers prepare for emergencies, build emergency plans, and utilize during emergencies.	OEM	DOHMH	1 year	$50,000	CDC PHEP	N/A	1.5, 5.1, 5.3
MH.E.109	Prevention & Policy	**Brownfield climate change resiliency:** Launch audits and improve storm preparedness of brownfields.	OER	OLTPS	In place for 2 months	$40,000	Funding in place (OMB)	N/A	4.3
MH.E.110	Prevention & Policy	**Building Code amendments**: Amend the Building Code to address the impacts of climate change.	OLTPS	DOB	8 years	TBD	TBD	Ongoing	2.5, 4.4

Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.11 1	Prevention & Policy	**Coordination on local climate change projections**: Call on the state and federal governments to coordinate with the City on local climate change projections**.**	OLTPS	N/A	TBD	$0	N/A	N/A	3.1, 4.1
MH.E.11 2	Prevention & Policy	**Local climate change projection improvements**: Continue to refine projections to inform decision-making.	OLTPS	N/A	TBD	$0	N/A	N/A	4.1, 4.2
MH.E.11 3	Prevention & Policy	**Food distribution system:** Study the system to identify vulnerabilities.	OLTPS	N/A	TBD	$3M	CDBG	N/A	1.1, 2.3
MH.E.11 4	Education & Awareness	**Preparedness guidelines for retailers:** Call on New York State to issue retailer preparedness guidelines for extreme weather events.	OLTPS	N/A	TBD	$0	N/A	N/A	3.1, 3.4
MH.E.11 5	Infrastructure Project	**Pipeline booster stations:** Work with Buckeye and New York State to safely build pipeline booster stations in New York City to increase supply of liquid fuel and withstand extreme weather events.	OLTPS	N/A	TBD	$0	N/A	N/A	2.1, 2.3, 2.7
MH.E.11 6	Prevention & Policy	**Hardening gas stations:** Work with New York State to provide incentives for hardening of gas stations to withstand extreme weather events.	OLTPS	N/A	TBD	$0	N/A	N/A	2.1, 2.3, 2.7
MH.E.11 7	Prevention & Policy	**Transportation fuel reserve:** Explore the creation of a fuel reserve to temporarily supply the private market during disruptions.	OLTPS	N/A	TBD	$0	N/A	N/A	2.3
MH.E.11 8	Prevention & Policy	**Fuel availability during disruptions:** Call on New York State to modify price gouging laws and allow flexibility of gas station supply contracts to increase fuel availability	OLTPS	N/A	TBD	$0	N/A	N/A	2.3

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
		during disruptions.							
MH.E.119	Prevention & Policy	**Strategies to address climate change threats:** Call on non-City agencies to implement strategies to address climate change threats.	OLTPS	N/A	TBD	$0	N/A	N/A	3.1, 4.2, 4.4
MH.E.120	Prevention & Policy	**Utility system upgrade plan**: Work with utilities and regulators to develop a cost-effective system upgrade plan to address climate risks.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	3.1, 4.2, 4.4
MH.E.121	Prevention & Policy	**Utility system design and equipment**: Work with utilities and regulators to reflect climate risks in design and equipment standards.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	3.1, 4.2, 4.4
MH.E.122	Prevention & Policy	**Performance metrics for climate risk response:** Work with utilities and regulators to establish performace metrics for climate risk response.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	3.1, 4.2, 4.4
MH.E.123	Prevention & Policy	**New York City power supply:** Work with industry partners, New York State, and regulators to strengthen the city's power supply.	OLTPS	N/A	TBD	$0	N/A	N/A	2.1, 2.3, 2.7, 3.1
MH.E.124	Prevention & Policy	**Plant capability:** Require more in-city plants to be able to restart quickly in the event of blackout.	OLTPS	N/A	TBD	$0	N/A	N/A	2.3
MH.E.125	Prevention & Policy	**Resiliency plan for the electric distribution system:** Work with Con Ed and the PSC to develop a long-term resiliency plan.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.1, 2.3, 2.7, 3.1

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.126	Prevention & Policy	**Minimizing electric outages**: Work with utilities and regulators to minimize outages in areas not directly affected by climate impacts.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.1, 2.3, 3.1
MH.E.127	Prevention & Policy	**Smart grid technology:** Work with utilities and regulators to implement smart grid technology to assess system conditions in real time.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.3, 2.10, 3.1
MH.E.128	Prevention & Policy	**Utility service restoration for critical customers:** Work with utilities and regulators to speed service restoration for critical customers via system configuration.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.3, 3.1
MH.E.129	Prevention & Policy	**Utility service restoration for mobile substations:** Work with utilities and regulators to speed service restoration via pre-connections.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.3, 3.1
MH.E.130	Prevention & Policy	**Natural gas supply:** Work with pipeline operators to expand and diversify supply.	OLTPS	N/A	TBD	$0	N/A	N/A	2.3, 3.1
MH.E.131	Prevention & Policy	**Gas transmission and distribution system:** Work with utilities and regulators to strengthen the in-city system.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.3, 3.1
MH.E.132	Prevention & Policy	**Utility demand response programs:** Work with utilities and regulators to expand such programs citywide.	OLTPS	Con Ed, PSC, DCAS	TBD	$0	N/A	N/A	2.3, 3.1
MH.E.133	Prevention & Policy	**Building energy efficiency:** Work with government and private sector partners to expand building energy efficiency.	OLTPS	DOB	TBD	$0	N/A	N/A	3.1, 4.3, 4.4
MH.E.134	Prevention & Policy	**Electric vehicles:** Incorporate resiliency into the design of City electric vehicle initiatives and pilot storage technologies.	OLTPS	Con Ed, PSC	TBD	$0	N/A	N/A	2.10

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Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.135	Emergency Services	**Emergency notification system at Kennedy Airport:** Install advanced automated early warning and emergency notification system in the Green and Blue quadrants of the central terminal area. System includes variable message signs along main access roads.	PANYNJ (Aviation)	DOT	5 years	$18,033,000	Capital budget	No change	1.2
MH.E.136	Education & Awareness	**Emergency response unit**: Support team of business counselors that assist businesses in recovering and reopening in the wake of a disaster or emergency. Team can provide information on mitigation practices.	SBS	OEM, other city, state, and federal partners as necessary	Ongoing	TBD	Agency operating budget	No change	3.2, 3.4
MH.E.137	Emergency Services	**SBS Continuity of Operations Plan (COOP)**: Maintain plan to ensure critical agency functions and services are available after a hazard.	SBS	OEM and other City partners as necessary	Ongoing	TBD	Agency operating budget	N/A	2.3, 3.2
MH.E.138	Coastal/Natural Resource Protection	**Emergency restoration of the Rockaway shoreline:** Restore to pre-Sandy conditions and to originally authorized beach profile. Mitigation of long-term impacts will require periodic beach maintenance.	USACE, NYSDEC	Parks	4 months	$26,000,000	USACE	N/A	2.7, 2.9

Index	Mitigation Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Funding Source(s)	2009 Progress Status	Goals and Objectives
MH.E.139	Coastal/Natural Resource Protection	**Emergency restoration of the Coney Island shoreline:** Restore to pre-Sandy conditions and to originally authorized beach profile. Mitigation of long-term impacts will require periodic beach maintenance.	USACE /NYSDEC	Parks	5 months	$7,000,000	USACE	N/A	2.7, 2.9
WINTER STORMS									
WS.E.1	Prevention & Policy	**Construction Code revision:** Apply the latest national standards for the determination of snow load, snow drift loads, and sliding snow loads.	DOB	N/A	In effect since July 2009	TBD	Staff time	Implemented	2.5
WS.E.2	Property Protection	**Infrastructure and equipment protection for subway trains:** Store trains underground when forecast calls for temperatures 10 degrees below zero, ice storms, icing conditions, or greater than five inches of snow.	MTA (NYCT-Subway)	N/A	Ongoing	$220,000 /per year	Agency operating budget	Winter operations plan developed and is used as needed and updated periodically	2.1, 2.7

Table 5: New York City Hazard Mitigation Action Table (Existing)

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iv. Potential Mitigation Actions

Potential mitigation actions are programs, plans, projects, or policies New York City may implement to help reduce or eliminate the risk to human life and property from hazards. The MPC Planning Team, Steering Committee, and membership identified, analyzed, and prioritized the potential actions in the table below. (For further details on the fields displayed in this table, see Table 4) Each mitigation action is assigned an index value to indicate the hazard addressed and its alphabetized placement by agency in the list. For example, the mitigation action with the index EQ.P.8 is the eighth potential mitigation action that addresses earthquakes. The Planning Team prioritized these actions by using a FEMA (STAPLEE) evaluation tool in addition to looking at other criteria. For more information about the prioritization process please see section Prioritization.

The following table of potential actions is for planning purposes only and creates no obligation on agencies to fulfill the potential actions listed. Potential actions may be undertaken or fulfilled should appropriate funding become available at a future date. Prioritization of potential actions is required under FEMA grant guidelines; it will not be used to determine eligibility for funding or implementation of potential projects in the future.

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
CBRN										
CB.P.1	Property Protection	**Construction Code revision:** Adopt improved fire protection standard and emergency egress standard for buildings over 420 feet from recent International Building Code.	DOB	N/A	Latest revision expected to be passed by City Council in fall 2013 and go into effect by fall 2014	TBD	Staff time	N/A	2.5, 2.7, 1.5	High
CB.P.2	Infrastructure Project	**Harlem River lift bridge:** Design and build security and hardening measures including fencing, lighting, access control and CCTV, structural hardening, stand-off measures, alternate alignment plans, alternate operations plans, and consequence management plans for this single point of failure for all MNR traffic into/out of the CBD.	MTA (MNR)	N/A	10-15 years	$35 million	TSGP, capital budget	N/A	2.1, 2.2, 2.3	Medium
CB.P.3	Prevention & Policy	**NYCHA fresh water supply:** Outfit all 334 NYCHA developments with oversized water storage tanks so that in the event of a water-contamination event, the buildings can be shut off from the city supply while fresh water is provided to residents for an extended period.	NYCHA	TBD	TBD	TBD	TBD	N/A	1.1, 2.1, 2.3	Medium

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
CB.P.4	Coastal/Natural Resource Protection	**Brownfield cleanup in the 100-year floodplain:** Establish bonus cleanup grant for projects in flood zones to accelerate cleanup to prevent release of pollutants during floods.	OER	OMB, NYSEDC, NYCEDC	3 months pending funding	$150,000/ year	Budget allocation, state Regional Economic Development Council (REDC) grant	N/A	2.1, 2.4	High
CB.P.5	Prevention & Policy	**Environmental research:** Update SPEED, the City's online environmental research engine.	OER	DoITT	3 months	$200,000	CDBG grant	N/A	5.1, 5.2, 5.3	High
CB.P.6	Education & Awareness	**BrownfieldWORKS!**: Support placement of green job trainees on brownfield cleanup sites throughout New York City.	OER	Law Department, OMB	3 months pending funding	$100,000/ year	Budget allocation	N/A	2.1, 2.4	Medium

The table of potential actions is for planning purposes only and creates no obligation on agencies to fulfill the potential actions listed. Potential actions may be undertaken or fulfilled should appropriate funding become available at a future date. Prioritization of potential actions is required under FEMA grant guidelines; it will not be used to determine eligibility for funding or implementation of potential projects in the future.

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
CB.P.7	Education & Awareness	**Environmental Project Information Center (EPIC):** Develop this online public environmental communication portal and cleanup project tracking database for developers, industry, and community to speed projects while also hosting a public document repository, information sharing portal, bulletin boards, dialogue centers, and other community resources.	OER	DoITT, EDC	Expected completion summer 2014	$400,000	Seeking $200,000 from NYS DOS and $200,000 CDBG grant	N/A	5.1, 5.2, 5.3	High
Coastal Erosion										
CE.P.1	Coastal/Natural Resource Protection	**Protection of Rikers Island east, west, and south shorelines**: Rebuild and mitigate shorelines.	DOC	N/A	FY 2017-2021	$38 million	Capital	No change	1.1, 2.1, 2.7	Medium
CE.P.2	Coastal/Natural Resource Protection	**Beach restoration:** Conduct repairs to Parks beaches and infrastructure damaged in recent nor'easters. Beaches and roadways have been subject to severe erosion from these storms.	Parks	TBD	TBD	$10,000,000 total ($4,500,000 for Rockaway Beach)	TBD	No change	2.1, 2.7, 4.3	Medium

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
CE.P.3	Coastal/Natural Resource Protection	**Renourishment of Orchard Beach, Bronx**: Periodically renourish Orchard Beach to prevent greater erosion and protect infrastructure. (USACE classifies this project as "Recreational" and not for flood damage reduction.)	USACE,Parks	NYSDEC	3 years	$1,000,000	USACE	No change	4.1, 4.3, 4.4	Medium
COASTAL STORMS										
CS.P.1	Prevention & Policy	**Resilient neighborhoods planning studies:** Identify and address vulnerabilities specific to communities in flood zones, as designated by new federal flood maps, and those neighborhoods severely affected by Hurricane Sandy. Goals include: reducing risk from natural hazards such as flooding and coastal storms, fostering economically and socially vibrant communities that are able to adapt to changing conditions, coordinating land use planning with rebuilding activities and infrastructure investment, and including a robust stakeholder-engagement process.	DCP	N/A	N/A	N/A	N/A	N/A	1.1, 1.6, 2.4, 2.5, 3.3	High

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
CS.P.2	Prevention & Policy	**DCP planning support and technical assistance for Sandy disaster recovery:** Support a variety of rebuilding and resilience activities with data analysis and mapping, coastal resilience planning, legal and technical support, community outreach and coordination, demographic analysis, tracking of housing permit activity, NYCHA resilience and replacement housing, and open space and Bluebelt planning.	DCP	N/A	N/A	N/A	N/A	N/A	2.1, 2.5, 5.2	Medium
CS.P.3	Emergency Services	**Emergency contracts**: Have contracts (tree removal, sidewalk and roadway repair, etc.) ready in advance to reduce response times when hazards occur.	DDC	OMB, DOT	TBD	TBD	TBD	N/A	2.1	Medium
CS.P.4	Infrastructure Project	**Hardening pumping stations:** Retrofit pumping stations for resiliency including raising or flood-proofing critical equipment, constructing barriers, and installing backup power supplies. Preliminary estimates indicate that there are currently 58 at-risk pumping stations.	DEP		Ongoing	$128 million	Capital budget, HMGP, Public Assistance	N/A	2.1, 2.7, 2.8	Medium

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
CS.P.5	Infrastructure Project	**Hardening wastewater treatment plants:** Protect critical facilities by raising or flood-proofing assets that are critical to the treatment process, constructing barriers, improving waterfront infrastructure, or implementing redundancy measures to avoid failure of critical treatment systems. All 14 of the City's wastewater treatment facilities are located along the waterfront and are therefore at risk in the event of a coastal storm.	DEP	N/A	Ongoing	$190 million	Capital Budget, HMGP, Public Assistance	N/A	2.1, 2.2, 2.7, 2.8	High
CS.P.6	Infrastructure Project	**Alternatives for Rockaway Wastewater Treatment Plant:** Consider conversion to a pumping station, which would be less expensive to protect, and potentially transferring treatment to a less vulnerable wastewater treatment facility elsewhere in the city.	DEP	N/A	Initiate feasibility study in 2014	$150 million	Capital budget	N/A	2.1, 2.2, 2.7, 2.8	Medium

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
CS.P.7	Property Protection	**Vernon C. Bain Center (VCBC) Mooring System and site access improvement:** Build marine vessel mooring above the FEMA 500-year flood advisory elevation of 15.36 feet. Currently VCBC mooring arm is designed at maximum 10.3 feet.	DOC	N/A	TBD	$25 million	Capital/HMGP	No change	1.1, 2.1, 2.7	High
CS.P.8	Property Protection	**Division I, II and III storehouse:** Build a replacement for this main warehouse, which is condemned, beyond asset design life, and does not adequately support storage space for up to four weeks of isolated operation.	DOC	N/A	This is a long-term project and will not be implemented in the near future (FY17-21)	$25 million	Capital	N/A	2.1	Medium
CS.P.9	Property Protection	**FDNY storehouse improvement:** Expand and create additional storehouses that would assist in ensuring continuity of basic agency operations as well as response operations.	FDNY	DCAS	TBD	TBD	TBD	N/A	2.1, 2.3	Medium

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
CS.P.10	Emergency Services	**EMS Battalion:** Relocate part of EMS Battalion 43 due to damage sustained during Hurricane Sandy.	FDNY	DCAS	TBD	TBD	TBD	N/A	2.1, 2.2	Medium
CS.P.11	Emergency Services	**EMS fallback sites:** Identify fallback sites within the EMS facility network for EMS stations (23 percent of FDNY EMS stations) located in or near flood zones. Sites would be equipped with basic technology and sufficient storage capacity to allow EMS staff to initiate operations in the event of a catastrophe.	FDNY	DCAS	TBD	TBD	TBD	N/A	2.1, 2.3	Medium
CS.P.12	Emergency Services	**FDNY emergency services:** Expand FDNY capabilities to respond to natural hazards. In the wake of Hurricane Sandy, the FDNY identified initiatives that would enhance its capabilities—including GPS for apparatus, additional boats for high-water rescue and pumping, and other all-weather vehicles—and ultimately allow the FDNY to act as the City's primary response agency.	FDNY	DHS	TBD	TBD	DHS	N/A	2.1, 2.3	Medium

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CS.P.13	Education & Awareness	**Outreach to residential building owners:** Develop a methodology and technology solution to provide pre- and post-disaster outreach and information to residential building owners.	HPD	N/A	2 years	$5,000,000	Grants	N/A	1.6, 2.6, 2.9, 2.10, 5.1	High
CS.P.14	Property Protection	**Resilient home design competition:** Launch a competition for resilient 1- to 4-family homes.	HPD	N/A	N/A	$80,000	Grants	N/A	2.1, 2.9	Medium
CS.P.15	Infrastructure Project	**Bridge and tunnel improvements and study:** Design and install floodgates and barriers at Brooklyn-Battery Tunnel and Queens-Manhattan Tunnel (AW-98). Determine the coastal storm vulnerability of the Triborough Bridge.	MTA (Bridges and Tunnels)	TBD	TBD	TBD		BBT/QMT work has been subsumed into "Mitigation of Hugh L. Carey Tunnel and Queens Midtown Tunnel," above. Triborough Bridge work is under "Detailed Engineering Flood Studies at Non-Tunnel Facilities," above.	2.1, 2.7, 2.8, 2.9	Medium

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CS.P.16	Property Protection	**Flood-hardening of vital communications, substations, transformers, mechanical equipment, revenue equipment, and other electronic systems at all MTA B&T facilities:** Perform work to harden those areas that are required to maintain B&T operations and relocate electronic systems to less vulnerable locations at the respective service buildings. Facilities will be elevated above ABFE + 1 foot.	MTA (Bridges and Tunnels)		2-3 years	$15 million	Applying for funding from FEMA HMGP. Also seeking 406 funding.	Conceptual stage	2.1, 2.2, 2.10	Medium
CS.P.17	Infrastructure Project	**Raising Governors Island seawall for Hugh L. Carey Tunnel:** Raise the seawall around the artificial island on which the Governors Island ventilation building is located to prevent stormwater from entering the tunnel through the vents.	MTA (Bridges and Tunnels)		5 years	$18 million	Applying for funding from FEMA HMGP. Also seeking 406 funding	Conceptual stage; design study will be needed	2.1, 2.2, 2.9	Medium

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CS.P.18	Emergency Services	**Water-level monitoring/alarm systems/CCTV:** Provide for water-level monitoring/alarm systems/CCTV throughout Metro-North's right-of-way. Install water-level monitoring and alarm devices, including cameras, at critical key locations such as power substations, central instrument locators, yards, and stations to provide Metro-North management with information to facilitate power shutoff to avoid equipment damage and risks to customer and employee safety.	MTA (MNR)	FTA	3-4 years	$25 million	Sandy Emergency Relief Program Resiliency	N/A	2.1, 2.10	High
CS.P.19	Property Protection	**Power and communications/signal infrastructure mitigation:** Elevate power supply components including sectionalizing switches, snowmelters, and bond boxes; explore making equipment watertight; raise critical substation equipment at key locations; and elevate central instrument locators, signal boxes, and other on-ground signal apparatus to minimize equipment susceptibility to flooding.	MTA (MNR)	FTA	4 years	$25 million	Sandy Emergency Relief Program Resiliency	N/A	2.1, 2.2	Medium

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CS.P.20	Property Protection	**Hardening of vulnerable healthcare facilities:** Assess facilities' risk for water intrusion and power loss from a coastal storm (including those considered to be receiving facilities for surge patients) to identify gaps and inform future planning.	NYS DOH	DOHMH	Potentially 2 years	$1.12 million	SSBG is being pursued	N/A	1.1, 2.1	High
CS.P.21	Property Protection	**Protection of hurricane shelter windows:** Retrofit windows to withstand winds associated with coastal storms.	OEM	DOE, FEMA, NYS OEM	TBD	TBD	HMGP, PDM-C	No change	1.1, 2.2, 2.7	Medium
CS.P.22	Emergency Services	**Hazards U.S. Multi-Hazard (HAZUS-MH) modeling:** Use HAZUS-MH computer modeling to determine losses generated by a coastal storm/hurricane and engineering effectiveness and cost-benefit of various coastal storm mitigation measures. Evaluate various flood and wind design enhancements for prototypical New York City building types.	OEM	DOB	3 months	TBD	Agency operatin g budget	No change	2.5, 5.1, 5.2	High

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CS.P.23	Emergency Services	**Backup power for evacuation centers:** Install 30 permanent generators and 30 quick-connects for the 60 schools that also serve as evacuation centers and/or hurricane shelters during a hurricane evacuation or other large-scale citywide emergency. Install eight permanent generators at schools that serve as "special medical needs shelters."	OEM	DOE, SCA, CUNY	3 years	TBD	HMGP	N/A	1.1, 2.1, 2.3	Medium
CS.P.24	Emergency Services	**Storm shutters for the Emergency Operations Center:** Protect the City's Emergency Operations Center from hurricane-force winds and flying debris by installing storm shutters at 165 Cadman Plaza East, Brooklyn**.**	OEM	DCAS	2 years	$2,600,000	HMGP	No change	2.1, 2.7	High
CS.P.25	Emergency Services	**Storm surge/tidal gauge real-time monitoring system:** Install first set of gauges well offshore to act as an early warning system; install second set at the coastline so surge levels can be assessed as surge makes landfall; install third set inland to assess expanse and height of surge impacts.	OEM	USACE, FEMA, USGS, DCAS	TBD	TBD	TBD	N/A	5.2	Medium

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CS.P.26	Property Protection	**Evacuation center/ hurricane shelter ADA retrofit program for DOE facilities:** Upgrade key elements of the Coastal Storm Plan's facilities to ensure access by individuals with special needs and disabilities. Retrofit entrances and restroom facilities in compliance with Americans with Disabilities Act (ADA).	OEM	DOE, SCA	1 year	$10,000,000	Capital, CDBG	N/A	1.1, 2.1, 2.7	Medium
CS.P.27	Prevention & Policy	**Updates to Urban Post-Disaster Interim Neighborhood Design Guidelines:** Incorporate lessons learned from Sandy into playbook developed with DCP in 2010 for post-disaster interim housing construction and site selection. Address permitting processes and legal requirements for implementation of deployable housing on a large scale, thereby creating a way to keep communities together.	OEM	DCP, DDC, DOB, HRO	1 year	$100,000	FEMA, U.S. Dept. of Homeland Security Regional Catastrophic Preparedness Grant, private foundation funds	N/A	1.1, 2.5, 2.6	

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CS.P.28	Prevention & Policy	**Cleanup standards for waterfront brownfields:** Explore strengthened cleanup standards for waterfront brownfields.	OER	Law Department	3 months	No cost	Staff time	N/A	1.5, 2.1, 2.4, 2.6, 5.2	High
CS.P.29	Prevention & Policy	**Building Code update for wind resiliency in new buildings:** Amend the Building Code and complete studies to improve wind resiliency for new and substantially improved buildings.	OLTPS	N/A	TBD	$5 million	Funding not yet secured	Not started	1.3, 2.4, 2.5, 5.2	High
CS.P.30	Prevention & Policy	**Building Code update for wind resiliency in existing buildings:** Amend Building Code to improve wind resiliency for existing buildings and complete studies of potential retrofits.	OLTPS	N/A	TBD	$5 million	Funding not yet secured	Ongoing	1.3, 2.4, 2.5, 5.2	High
CS.P.31	Emergency Services	**Power exercises**: Continue to conduct power exercises. The 249th Engineering Battalion, OEM and other municipalities and counties on the Regional Catastrophic Disaster Team will conduct emergency generator power assessments throughout the NYC metro Area.	USACE, OEM, RCPT	NYSDEC, NYCDPR	TBD	TBD	USACE, RCPT	N/A	2.1, 2.3	Medium
CYBER THREATS										

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CY.P.1	Prevention & Policy	**Supplementation of IT security**: Develop plan to potentially utilize a future DoITT backup facility and/or identify cloud services that satisfy security concerns.	HRA	DoITT	2-year plan	TBD	Expense budget	N/A	1.1, 2.10	Medium
CY.P.2	Prevention & Policy	**Cyber-security strategy:** Develop MNR-wide cyber-security strategy and operational plan to identify threats and vulnerabilities to all cyber systems (including SCADA, communications, signals, corporate data, security networks) and put operational plans in place to mitigate those threats and reduce vulnerabilities.	MTA (MNR)	N/A	Indefinite/12 months	$500,000	Staff time	N/A	2.1, 2.3, 2.10	Medium
DISEASE OUTBREAKS										
DO.P.1	Prevention & Policy	**Pandemic planning**: Develop plans and procure PPE addressing protection of employees; maintenance of essential functions and services; support for local, state, and federal response; and communication with customers about pandemic planning and response.	MTA (MNR)	TBD	TBD	TBD	TBD	N/A	1.1, 2.1	Medium
DROUGHT										

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D.P.1	Infrastructure Project	**Maximizing capacity for water delivery from the Catskill/Delaware system:** Pressurize the Catskill Aqueduct between Kensico Reservoir and DEP's ultraviolet disinfection facility to give DEP the ability to maximize use of water from Kensico Reservoir and flow to Hillview Reservoir.	DEP	N/A	Project deferred until after repair of Delaware Aqueduct leak	$535 million	Capital budget	N/A	2.1, 2.7, 2.8	Medium
D.P.2	Infrastructure Project	**Catskill Aqueduct capacity:** Increase capacity to allow movement of water out of the Catskill systems, thereby providing up to 60 million gallons per day of additional flow from the Catskill Watershed in the event of a localized drought or loss of access to the Croton and Delaware systems.	DEP	N/A	Project completed by 2021	$196 million	Capital budget	No change	2.1, 2.7, 2.8	Medium
D.P.3	Prevention & Policy	**Construction Code revision:** Provide standards to encourage water recycling.	DOB	N/A	Latest revision expected to be passed by City Council in fall 2013 and go into effect by fall 2014	TBD	Staff time	Ongoing	2.5, 4.3	High

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D.P.4	Prevention & Policy	**Drought effects monitoring:** Measure, monitor, and enforce the effects of droughts on hydrant use and availability.	FDNY	DEP	TBD	TBD	TBD	N/A	1.1, 1.5, 2.1	Medium
EARTHQUAKE										
EQ.P.1	Property Protection	**Mechanical equipment seismic upgrade:** Install new mechanical equipment to resist seismic forces in 55 City-owned buildings.	DCAS	N/A	Ongoing	$500,000	Capital budget, New York Power Authority	No change	2.1, 2.7	High
EQ.P.2	Property Protection	**Seismic protection for sewers:** Inspect and repair structural deficiencies in intercepting sewers to reduce the impact of seismic activity.	DEP	N/A	Ongoing	Unknown	Capital/expense budget	No change	2.1, 2.7, 2.8	High
EQ.P.3	Property Protection	**Seismic inspection and retrofit for drinking water distribution system:** Conduct study to determine seismic design standards and seismic resiliency of drinking water distribution system (tunnels, piping, clean water pump stations, dams, shafts, and tanks). Use study results to prioritize and retrofit distribution	DEP	N/A	Ongoing	Unknown	Capital/expense budget	No change	2.1, 2.7, 2.8, 5.2	High

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		infrastructure to appropriate seismic standards as needed.								
EQ.P.4	Property Protection	**Seismic study and retrofit for tall buildings:** Perform seismic study of existing tall buildings, and retrofit buildings to exceed new Building Code seismic provisions.	DOE	DOE-SCA, DOB	10 years	TBD	FEMA	No change	1.1, 2.1, 2.5, 2.7	High
EQ.P.5	Prevention & Policy	**Building upgrades to seismic codes:** Retrofit MLK, Ron Brown, and Kountz pavilion superstructures at the Harlem Hospital Campus to meet new seismic codes.	HHC	DASNY	12 months	$12,986,500	General obligation bonds	Scope expanded to include MLK, Ron Brown and Kountz pavilions	1.1, 2.1, 2.7	Medium

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EQ.P.6	Property Protection	**HPD facility improvement:** Retrofit HPD site offices to withstand a magnitude 8 earthquake.	HPD	DCAS	2 years	$10,000,000	Grants	N/A	2.1, 2.7	Medium
EQ.P.7	Property Protection	**UPACA (Site 6):** Reinforce building to meet earthquake codes.	NYCHA	TBD	TBD	TBD	TBD	N/A	1.1, 2.1, 2.7	Medium
EQ.P.8	Emergency Services	**HAZUS-MH modeling:** Evaluate various seismic building design enhancements using HAZUS-MH to identify enhancements that reduce losses generated by earthquakes.	OEM	DOB	3 months	TBD	Agency operating budget	No change	2.5, 5.1, 5.2	High
EXTREME TEMPERATURES										

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ET.P.1	Emergency Services	**Power redundancy in City-owned buildings:** Install generators in select buildings to provide power during blackouts and emergency operations.	DCAS	N/A	5 years	$10,000,000	Capital budget	Ongoing	2.1, 2.3	Medium
ET.P.2	Emergency Services	**AC upgrade for senior centers:** Continue to monitor status of AC systems at senior centers to help mitigate the effects of heat. Provide for repair or replacement as required.	DFTA	NYCHA	2 years	TBD	TBD	Ongoing	1.1, 1.5, 2.7	Medium
ET.P.3	Prevention & Policy	**AC availability and affordability:** Advocate for state and city funding to make ACs available and affordable to qualified seniors and people with disabilities and chronic disease.	DOHMH	City: OEM, Mayor's Office, DFTA, HRA. State: NYSDOH, OTDA	TBD	TBD	Staff time	No change	1.1, 1.5, 1.6	Medium

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ET.P.4	Prevention & Policy	**Urban heat island effect mitigation:** Map and evaluate mitigation strategies implemented in New York City.	DOH MH	OLTPS, Parks, NYC Service/ Mayor's Office, NPCC, academ ic partner	3 years	$1 million	CDBG funding	N/A	1.1, 1.5, 5.2	High
ET.P.5	Prevention & Policy	**Cooling centers**: Classify all NYCHA community centers as resident cooling centers and retrofit with enhanced AC systems.	NYCH A	TBD	TBD	TBD	TBD	N/A	1.1, 2.7	Medium
FLOODING										
F.P.1	Prevention & Policy	**Flooding Prevention:** Avoid occupying space near or in SLOSH zones A and B, even if the HRA-General Support Services program can accept the space from DCAS.	DCAS	HRA	TBD	TBD	Agency lease budget	Ongoing	2.1, 2.2	Medium

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F.P.2	Property Protection	**Infrastructure flood protection:** Create spill vaults to minimize damage from flooding in below-grade fuel- storage containers.	DCAS	DOE	TBD	TBD	FEMA	No change	2.1, 2.7	Medium
F.P.3	Education & Awareness	**Flood Resilient Building Design Manual:** Provide guidance for planning and design of new construction and retrofit of existing buildings in areas subject to flooding. Guidance will mitigate property damage and life safety dangers posed by structurally and superficially damaged buildings.	DCP	DOB	2014	N/A	N/A	N/A	2.4, 2.5, 2.6, 2,7, 2.8, 2.10	High
F.P.4	Prevention & Policy	**Zoning for flood-resistant construction, Phase I and II:** Make text amendments to modify zoning to encourage flood-resistant construction. The regulations would be consistent with updated flood area construction practices and the need for greater resilience in the larger flood zones established by FEMA.	DCP	DOB	2013	N/A	N/A	N/A	2.4, 2.5	High

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F.P.5	Coastal/Natural Resource Protection	**Ecologically sensitive industrial area planning:** Conduct area plans for ecologically significant maritime and industrial areas that have significant environmental contamination. Work with Brownfield Opportunity Area grant recipients, local communities, and elected officials to identify next steps, and seek funding for further studies of existing conditions and strategies to promote maritime businesses and address environmental issues.	DCP	N/A	N/A	N/A	N/A	N/A	2.4, 2.5, 2.6	High
F.P.6	Infrastructure Project	**Croton Falls pump station rehabilitation:** Provide additional redundancy for water supply operations by allowing DEP to move water between the Croton and Catskill/Delaware systems to supplement the local distribution system. Upgrade pump stations to provide 87 million additional gallons per day into distribution if there is an emergency service disruption in the Catskill or Delaware system.	DEP	N/A	2017	$41 million	Capital budget	No change	2.1, 2.7, 2.8	Medium

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F.P.7	Infrastructure Project	**Bergen Basin and Tallman Island Wastewater Treatment Plant drainage upgrades:** Reconfigure and expand sewer system capacity in Bergen Basin and Tallman Island Wastewater Treatment Plant drainage areas to capture more stormwater, reduce combined sewer overflows into surrounding water bodies, and prevent sewer backups and street flooding.	DEP	N/A	2023	$106 million	Capital budget	No change	2.1, 2.7, 2.8	Medium
F.P.8	Emergency Services	**Server capacity improvements:** Enhance agency servers housing necessary data. Agency servers crashed due to flooding. Additional servers outside of flood zones are necessary to ensure safety of customer data and reimbursement of partners.	DFTA	DoITT, HRA	2 years	$636,700	DFTA, TBD	N/A	1.1, 2.3, 2.10	High
F.P.9	Property Protection	**DHS electrical improvements:** Relocate electrical closets from the lower floors/basements to higher levels at the 26 DHS sites.	DHS	N/A	Ongoing	$13,500,000	TBD	Scope reduced to 26 DHS sites from 29 DHS sites	1.1, 2.1, 2.2	Medium

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F.P.10	Property Protection	**Borden Avenue facility:** Dig an exterior trench around foundation to divert water to Newtown Creek, waterproof foundation, and elevate first floor level.	DHS	DEP, DOB	Ongoing	$16,000,000	HMPG	N/A	1.1, 1.5, 2.1	Medium
F.P.11	Emergency Services	**Data system upgrade:** Computerize data system to assist in post-storm inspections.	DOB	N/A	Latest revision expected to be passed by City Council in fall 2013 and go into effect by fall 2014	TBD	Staff time	Ongoing	2.3, 2.5	High
F.P.12	Infrastructure Project	**Rikers Island roadway regrading:** Redesign and elevate roadways on Rikers Island to alleviate flooding conditions.	DOC	N/A	TBD	$4.6 million	Capital	No change	1.1, 2.1, 2.7	Medium

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F.P.13	Property Protection	**Water infiltration prevention:** Do thermal imaging of roofs and building facades of all DOHMH facilities to determine areas and extent of existing water infiltration.	DOH MH	N/A	6-12 months	$80,000	Grant funds	N/A	1.1, 2.1, 5.2	Medium
F.P.14	Property Protection	**Flood-proofing 125 Worth Street vault:** Seal the existing window with masonry, move the HVAC system to the building's roof, install large-capacity sump pumps in the floor to pump any water out, and install a new FM-200 fire suppression system that does not use water.	DOH MH	DCAS	6-18 months	$463,275	N/A	N/A	2.1, 2.2, 2.7	Medium
F.P.15	Infrastructure Project	**Permeable pavement:** Expand use of permeable pavement in roadways, plazas, and (where appropriate) sidewalks to capture and detain stormwater to mitigate localized flooding of streets, reduce flooding of structures, make streets passable to emergency vehicles more quickly, and reduce loads on sewage treatment plants and consequent combined sewer overflows.	DOT	DDC	5 years (design, construction)	$30,000,000	HMGP, DEP G.I. funding (within Priority CSO areas), state GIGP grants, TEP/TAP grants, City	Incorporates several 2009 projects (2009 Indices: MH.P.37, F.E.15, F.E.36, F.P.8)	2.1, 2.7, 2.8, 2.9	High

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							Capital Budget			
F.P.16	Emergency Services	**Protection for the Manhattan 1,2,5 facility:** Do new design planning for the Manhattan 1,2,5 facility under construction to provide for automated flood protection gates built into the sidewalks.	DSNY	N/A	Implemented as needed--immediately	Unknown	Capital budget	N/A	2.1, 2.7, 2.8	Medium
F.P.17	Prevention & Policy	**Stapleton waterfront flood mitigation:** Construct a new tidal wetlands area at the Stapleton waterfront, between Canal and Water Streets, and a pilot stormwater management system in an adjacent public open space to capture stormwater before it reaches the bay.	EDC	N/A	24 months	$12,500,000	HMGP	Currently pending grant review	2.7, 4.3, 4.4	Medium

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F.P.18	Property Protection	**Brooklyn Army Terminal passive flood barrier system:** Install 550 linear feet of passive flood barriers at Building A to prevent future flood damage.	EDC	N/A	24 months	$1,243,533	HMGP	Currently pending grant review	2.1, 2.7	High
F.P.19	Property Protection	**EDC operations centers flood mitigation:** Raise the emergency generator at the Brooklyn Emergency Operations Center, and upgrade emergency backup systems related to MIS equipment at Brooklyn Emergency Operations Center and Manhattan Asset Management Emergency Operations Center.	EDC	N/A	24 months	$1,200,000	HMGP	Currently pending grant review	2.1, 2.2, 2.3, 2.7	High
F.P.20	Property Protection	**Flood effects reduction program:** Install electronic check valves at the street level to prevent sewer and stormwater backflow at firehouses and other locations prone to flooding and damage associated with storms.	FDNY	DDC	TBD	TBD	TBD	N/A	2.1, 2.10	Medium

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F.P.21	Emergency Services	**Dewatering pumps at FDNY facilities:** Purchase and install dewatering pumps at FDNY facilities in the revised FEMA flood zones, and acquire portable dewatering pumps for field units.	FDNY	DHS	TBD	TBD	TBD	N/A	2.1	Medium
F.P.22	Property Protection	**New construction flood mitigation:** Raise newly built and in-construction structures (e.g., firehouses and EMS stations) several feet in the designated flood zone(s) according to FEMA standards.	FDNY	DDC	TBD	TBD	TBD	N/A	1.1, 2.1, 2.2	Medium
F.P.23	Property Protection	**Coney Island Hospital flood-proofing:** Install flood-proofing in Coney Island Hospital basement as part of the Phase II modernization.	HHC	TBD	7 years	$13,293,000	General obligation bonds	No change	1.1, 2.1, 2.7, 2.8	Medium

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F.P.24	Property Protection	**Coney Island Hospital emergency department mitigation:** Relocate and elevate the Emergency Department and its critical systems (imaging and generators) above the base flood elevation.	HHC	TBD	3-4 years	$60 million additional (some parts damaged/ covered)	FEMA 406, HMGP, CDBG, general obligation bonds	N/A	1.1, 2.1, 2.8	Medium
F.P.25	Property Protection	**Coney Island Hospital/critical system protection:** Elevate or harden electrical gear.	HHC	TBD	1 year	$42 million (included in plans for new structure)	FEMA HMGP, general obligation bonds	N/A	1.1, 2.1, 2.2, 2.7, 2.8	Medium
F.P.26	Property Protection	**Metropolitan Hospital:** Install flood barriers.	HHC	TBD	1-2 years	$60 million additional (some parts damaged/ covered)	HMGP, general obligation bonds	N/A	1.1, 2.1, 2.7, 2.8	Medium

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F.P.27	Property Protection	**Metropolitan Hospital:** Relocate and elevate Emergency Department and its critical systems (imaging and generators) above the base flood elevation.	HHC	TBD	2 years	$7 million	HMGP, CDBG, general obligation bonds	N/A	1.1, 2.1, 2.8	Medium
F.P.28	Property Protection	**Coler Hospital:** Protect electrical equipment.	HHC	TBD	1 year	$40 million	HMGP, general obligation bonds	N/A	1.1, 2.1, 2.7, 2.8	Medium
F.P.29	Property Protection	**Coler Hospital**: Install emergency fuel tanks and pumps.	HHC	TBD	1 year	$12 million	HMGP, general obligation bonds	N/A	1.1, 2.1, 2.7, 2.8	Medium

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F.P.30	Property Protection	**Building flood protection**: Supply buildings susceptible to flooding with sandbags and/or request that landlord do so.	HRA	N/A	Plan semi in place	TBD	Expense budget	N/A	1.1, 2.1, 2.6, 2.7	Medium
F.P.31	Property Protection	**Portable generators:** Maintain an inventory of portable generators for facility staff to use to operate tradesman tools.	HRA	N/A	Generators now in storage	$6,000	Agency capital budget	N/A	1.1, 2.1, 2.3	Medium
F.P.32	Infrastructure Project	**Substation mitigation:** Raise replacement equipment in Sandy-flooded substations to protect against another storm of similar magnitude.	LIPA		November 2013 start, TBD completion	$ 28,500,000 (Far Rockaway, Arverne, Rockaway Beach, and Neponsit)	Insurance, FEMA 406, NYS CDBG fund, LIPA	N/A	2.1, 2.2, 3.3	Medium

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F.P.33	Emergency Services	**Water-balance study:** Study flood-prone areas to determine ways to prevent water from entering system. This study will involve analyzing inflow and outflow capacity, storage, etc.; identify funding. Implement drainage master plan, if recommended by study.	MTA (NYCT - Subway)	DEP	5 years (study)	TBD	FEMA, NYCT	No change	2.1, 2.7	Medium
F.P.34	Infrastructure Project	**Double Track Main Line, Phase 2.** Complete second track on the Main Line between Farmingdale and Ronkonkoma to allow LIRR to operate increased off-peak service on the Main Line. -This added service is critical should a catastrophic event halt LIRR service on Long Island's South Shore, impacting southeast Queens stations.	MTA (LIRR)	N/A	TBD	$300 million	Potential FTA Local Priority Resiliency funds	N/A	2.1, 2.3	Medium
F.P.35	Infrastructure Project	**Ventilation grate improvements**: Make improvements in Atlantic Avenue tunnels.	MTA (LIRR)	N/A	TBD	$4 million	Potential FTA Local Priority Resiliency Funds	N/A	2.1, 2.7	Medium

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F.P.36	Property Protection	**Long Island City Yard protection:** Determine perimeter protection measures for the Yard.	MTA (LIRR)	N/A	TBD	TBD	TBD	N/A	2.1, 2.7	Medium
F.P.37	Property Protection	**Safeguarding of basement/cellar equipment**: Install duplex sump pumps for dewatering and additional floor drains; raise switchgear where possible; use watertight seals on electrical panels subject to flooding; and install elevated platforms for vital equipment. Avoid using cellars for public use (meeting rooms, centers, etc.).	NYCHA	TBD	Estimated time of completion 2016	$7,700,000	Insurance, FEMA	To be incorporated with Hurricane Sandy development re-design efforts	2.2, 2.7, 2.8	Medium
F.P.38	Property Protection	**New NYCHA building or development:** Construct a building/development adding a number of units to the NYCHA portfolio equal to the number of first-floor apartments in Evacuation zones 1, 2, and 3 to be vacated and used for other purposes.	NYCHA	TBD	TBD	TBD	TBD	N/A	1.1, 2.2	Low

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F.P.39	Property Protection	**NYCHA floodgates and barriers:** Install floodgates and barrier mechanisms to control the rate of water infiltration into building areas prone to flooding.	NYCHA	TBD	Estimated time of completion 2016	TBD	Insurance, FEMA	N/A	2.1, 2.7, 2.8	Medium
F.P.40	Property Protection	**NYCHA boiler rooms and electrical equipment:** Relocate low-lying boiler rooms and electrical switchgear/panels submerged during Hurricane Sandy to areas within existing structures, new extensions, or stand-alone facilities at higher elevations.	NYCHA	TBD	Estimated time of completion 2016	TBD	Insurance, FEMA	N/A	1.1, 2.1, 2.2	Medium
F.P.41	Property Protection	**Sump pump protection:** Upgrade sump pumps in facilities located within 100-year floodplain.	NYPD	N/A	TBD	TBD	TBD	N/A	2.1, 2.7, 2.8	Medium

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F.P.42	Property Protection	**Building electrical protection**: Relocate existing electrical distribution within Police Department buildings to areas or floors above the 100-year flood level.	NYPD	N/A	TBD	TBD	TBD	N/A	2.1, 2.2, 2.7, 2.8	Medium
F.P.43	Property Protection	**Boiler protection**: Raise boilers in buildings to locations above 100-year flood level.	NYPD	N/A	TBD	TBD	TBD	N/A	2.1, 2.2, 2.7, 2.8	Medium
F.P.44	Property Protection	**Short-term flood mitigation of OCME emergency management storage facility at 18th Street and FDR Drive:** Relocate all equipment to a leased warehouse in a centralized area not prone to flooding.	OCME		Unknown	$4,400,000	Capital	N/A	2.1, 2.2, 2.7, 2.9	Medium

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F.P.45	Property Protection	**Flood mitigation measures for New York City's backup Emergency Operations Center**: Implement flood mitigation measures, including sump-pumps, wet flood-proofing, and drainage improvements.	OEM	DCAS, FEMA	2–3 years	$10,000,000	HMGP, PDM-C, SRL, RFC	No change	2.1, 2.7	Medium
F.P.46	Emergency Services	**HAZUS-MH modeling:** Evaluate various building design enhancements using HAZUS-MH to identify opportunities to reduce flooding.	OEM	DOB	3 months	Staff time	Agency operating budget	No change	2.5, 5.1, 5.2	Medium
F.P.47	Prevention & Policy	**National Flood Insurance Program (NFIP) Community Rating System:** Enroll in NFIP Community Rating System. By implementing floodplain management initiatives and reducing the city's flood risk, residents can receive discounted flood insurance.	OEM	OLTPS, DCP, DOB	5 years	TBD	Agency operating budget	No change	2.4, 2.7	Medium

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F.P.48	Education & Awareness	**Public information and guidance:** Disseminate mitigation information and help provide technical assistance to property owners affected by flood events.	OEM	DEP, FEMA, NYS OEM	TBD	TBD	HMGP, PDM-C, SRL, RFC	No change	2.6, 5.1, 5.2, 5.3	High
F.P.49	Education & Awareness	**Outreach and education for owners of Severe Repetitive Loss properties:** Compile and map SRL properties throughout the city. Determine SRL funding eligibility and target these properties for outreach.	OEM	DEP, FEMA, NYS OEM	TBD	TBD	HMGP, PDM-C, SRL, RFC	Assessment still pending	2.9, 5.1, 5.2, 5.3	Medium
F.P.50	Infrastructure Project	**Local storm surge barrier for Gowanus Canal:** Call on and work with the USACE to develop an implementation plan and preliminary designs for a surge barrier.	OLTPS	N/A	TBD	$2 million	Funding not yet secured	N/A	4.3, 4.4	High
F.P.51	Infrastructure Project	**Plan for flood protection along the Williamsburg, Greenpoint, and Long Island City coastlines**: Create an implementation plan for comprehensive improvements on public and private property.	OLTPS	DCP, DOT, Parks	TBD	$1 million	Funding not yet secured	N/A	4.3, 4.4	High

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F.P.52	Infrastructure Project	**Floodgate repairs at Oakwood Beach, Staten Island:** Continue to work with the USACE to complete emergency floodgate repairs at Oakwood Beach.	OLTPS	N/A	TBD	$1 million	USACE	N/A	4.3, 4.4	Medium
F.P.53	Infrastructure Project	**Primary and secondary dune systems in Rockaway Peninsula**: Call on and work with the USACE to study and install dunes in vulnerable neighborhoods (such as Breezy Point).	OLTPS	Parks	TBD	$20.5 million	Funding not yet secured	N/A	1.1, 4.3, 4.4	High
F.P.54	Infrastructure Project	**Offshore breakwaters adjacent to and south of Great Kills Harbor:** Call on and work with the USACE to study and install offshore breakwaters.	OLTPS	N/A	TBD	$250 million	Funding not yet secured	N/A	4.3, 4.4	High
F.P.55	Infrastructure Project	**Flood protection in Hunts Point:** Install an integrated flood protection system.	OLTPS	N/A	TBD	$171 million	Funding not yet secured	N/A	2.1, 4.3, 4.4	Medium
F.P.56	Infrastructure Project	**Flood protection in East Harlem:** Install an integrated flood protection system.	OLTPS	N/A	TBD	$189 million	Funding not yet secured	N/A	1.1, 2.1, 4.3, 4.4	Medium
F.P.57	Infrastructure Project	**Lower Manhattan flood protection:** Install an integrated flood protection system in Lower Manhattan, including the Lower East Side.	OLTPS	N/A	TBD	$315 million	Funding not yet secured	N/A	1.1, 2.1, 4.3, 4.4	Medium

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F.P.58	Infrastructure Project	**Integrated Flood Protection System for Red Hook:** Design and construct a flexible, integrated flood protection system for Red Hook that is composed of elements such as terraced berms; benches, park walls, flood-proofed buildings, or bridge abutments; drainage improvements; and temporary features such as deployable floodwalls, which can be erected in advance of an extreme weather event.	OLTPS	N/A	TBD	$315 million	Funding not yet secured	N/A	1.1, 2.1, 2.7	Medium
F.P.59	Infrastructure Project	**Protection of Farragut substation:** Continue to work with Con Ed to protect the substation.	OLTPS	N/A	TBD	$0	Ratepayers	N/A	2.1, 2.7, 3.3	High
F.P.60	Infrastructure Project	**Newtown Creek flood protection:** Call on and work with the USACE to study and install local storm surge barriers at Newtown Creek.	OLTPS	N/A	TBD	$1 billion	Funding not yet secured	N/A	1.1, 2.1, 4.3, 4.4	High
F.P.61	Prevention & Policy	**Flood protection research:** Evaluate soft infrastructure as flood protection and study innovative coastal protection techniques.	OLTPS	N/A	TBD	$4 million	Funding not yet secured	N/A	4.3, 4.4	High
F.P.62	Prevention & Policy	**Prevention of drainage pipe flooding**: Evaluate the city's vulnerability to drainage pipe flooding and identify appropriate	OLTPS	N/A	TBD	$13 million	Funding not yet secured	N/A	2.1, 4.3, 5.2	High

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		solutions to minimize those risks.								
F.P.63	Infrastructure Project	**Floodgate at Mill Creek:** Call on and work with the USACE to study the construction of a floodgate at Mill Creek.	OLTPS	N/A	TBD	$0	N/A	N/A	4.3, 4.4	High
F.P.64	Prevention & Policy	**Community Rating System:** Study approaches for New York City to join FEMA's Community Rating System program.	OLTPS	DOB, DCP	TBD	$0.5 million	CDBG	N/A	1.6, 5.1	High
F.P.65	Infrastructure Project	**Coney Island Creek wetlands and tidal barrier**: Develop an implementation plan and preliminary designs for new Coney Island Creek wetlands and tidal barrier.	OLTPS	N/A	TBD	$1 million	Funding not yet secured	N/A	4.3, 4.4	High
F.P.66	Prevention & Policy	**Integrated flood protection for southern Manhattan:** Create an implementation plan and design for an integrated flood protection system for remaining southern Manhattan areas.	OLTPS	N/A	TBD	$1 million	Funding not yet secured	N/A	2.1, 4.4	High
F.P.67	Property Protection	**Flood protection of vital infrastructure at LaGuardia Airport:** Construct a floodwall around the West Field Lighting Vault; protect West End Substation by installing dikes and re-grading; construct a new East Field Lighting Vault Building.	PANYNJ (Aviation)	FAA	4 years	$21,800,000	Capital budget, HMGP	N/A	2.1, 2.7	Medium

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F.P.68	Property Protection	**Flood protection of vital infrastructure at Kennedy Airport**: Restore capacity to handle stormwater runoff captured in catch basins and conveyed into outfalls 1 and 2 through storm drainage system.	PANYNJ (Aviation)	FAA	4 years	$5,000,000	Capital budget, HMGP	N/A	2.1, 2.7	Medium
F.P.69	Property Protection	**Drainage improvements at Kennedy Airport**: Install tide gates/drainage check valves to manage drainage outfalls in low-lying areas vulnerable to reverse flow through the drainage system.	PANYNJ (Aviat.)	DEP, NYS DEC	4 years	$60,000,000	Capital budget, HMGP	N/A	2.1, 2.7	Medium
F.P.70	Infrastructure Project	**Protection of Kennedy Airport fuel farm tanks:** Redesign "moat" system that surrounds each fuel farm tank to prevent flooding.	PANYNJ (Aviation)	PANYNJ	4 years	$7,000,000	Capital budget, HMGP	No change	2.1, 2.7, 4.1	Medium
F.P.71	Infrastructure Project	**LaGuardia Airport dike wall:** Reinforce dike wall along Bowery Bay and runways 13-31.	PANYNJ (Aviation)	FAA	4 years	$5,000,000	Capital budget, HMGP, 406	No change	2.1, 2.7	Medium

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F.P.72	Property Protection	**Kennedy Airport sanitary lift station:** Redesign and upgrade sanitary lift station in central terminal area to prevent facility flooding.	PANY NJ (Aviation)	PANYNJ	5 years	$8,000,000	Capital budget, HMGP	No change	2.1, 2.7	Medium
F.P.73	Property Protection	**Kennedy Airport runway upgrade:** Redesign and retrofit runways 4R and 22L including raising the grade, modifying existing drainage, and installing new lighting and concrete pavement.	PANY NJ (Aviation)	FAA	4 years	$40,000,000	Capital budget	No change	2.1, 2.7	Medium
F.P.74	Property Protection	**Kennedy Airport runway upgrade:** Redesign and retrofit runways 4L and 22R including raising the grade, modifying existing drainage, and installing new lighting and concrete pavement.	PANY NJ (Aviation)	FAA	4 years	$47,997,000	Capital budget	No change	2.1, 2.7	Medium
F.P.75	Property Protection	**Improvements to George Washington Bridge anchorage drainage system:** Install new passive drainage system and rehabilitate the New Jersey anchorage sump pump room to mitigate the effects of heavy rainfall on the structural components in the anchoring of the bridge.	PANY NJ (TBT)	NJ DEP, NYS DEC	4 years	$9,200,000	Capital budget, HMGP	N/A	2.1, 2.7	Medium

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F.P.76	Property Protection	**Flood-proofing at Olmsted site:** Implement flood-proofing (including possible elevation and creation of additional drainage capacity) at the Olmsted Center, Parks' capital division headquarters, which suffers repetitive flooding.	Parks	N/A	5 years	$10,000,000	TBD	No change	2.1, 2.2, 2.7	Low
F.P.77	Emergency Services	**Tidegate upgrade in Flushing Meadow Corona Park:** Update and upgrade tidegates in the floodwater flow control structure under the north fascia of the Purpose Bridge. Install automated system that can be opened and closed based on tides, replacing the current gate system which is manually controlled and difficult to operate.	Parks	DEP	TBD	$5,000,000	HMGP, other funding	N/A	2.1, 2.3, 2.7	High
INFRASTRUCTURE FAILURES										
IF.P.1	Emergency Services	**Expansion of cogeneration:** Explore the feasibility of expanding cogeneration and other energy-related reliability measures to other wastewater treatment plants in the city besides North River, including the Wards Island WWTP. These measures—which could include energy efficiency, increased generation, and use of renewable energy supplies such as methane	DEP	N/A	2014	$0.5million	Operating budget	N/A	2.1, 2.3, 2.7, 4.3	High

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		gas and solar energy, and cogeneration—would improve the ability of wastewater treatment plants to operate reliably during electrical disruptions.								
IF.P.2	Infrastructure Project	**Repair of the Delaware Aqueduct leak:** Implement planned repairs to the Delaware Aqueduct—which conveys, on average, 50% of the city's water from upstate sources—by constructing a bypass tunnel and repairing sections of the tunnel.	DEP	N/A	Project to be completed in 2022	$760 million	Capital budget	N/A	2.1, 2.7, 2.8	High
IF.P.3	Property Protection	**Utilities on Buono Bridge:** Build redundancy, including additional water and gas mains and upgraded generators, to protect against bridge collapse.	DOC	DOT	TBD	$211 million	Capital	No change	1.1, 2.1, 2.3	Low

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IF.P.4	Infrastructure Project	**Facility electrical power and data infrastructure upgrade:** Provide necessary upgrades for building services during emergency situation.	DOH MH	DDC	12-36 months	$5,000,000	Capital budget	N/A	2.1, 2.3	High
IF.P.5	Emergency Services	**DOHMH generators and retrofits:** Equip facilities with generators for continuity of building services during power outages, including making any necessary structural improvements to support generators.	DOH MH	DDC	12 to 24 months	$500,000	Capital budget	N/A	1.1, 2.3	High
IF.P.6	Infrastructure Project	**Session Initiation Protocol (SIP):** Implement SIP for voice communication between 311 and the carrier's public network, enabling the City to be less reliant on one carrier central office and have the ability to fail over to alternate locations.	DoITT	N/A	TBD	$3.5 million	TBD	N/A	1.2, 2.1, 2.3, 2.10	High

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IF.P.7	Emergency Services	**Citywide IVR for employee announcements:** Expand the City's in-house audio conferencing solution to support 500 simultaneous calls, with overflow of another 1,000 calls to be handled in the cloud.	DoITT	OEM	TBD	$1.05 million	TBD	N/A	1.2, 2.1, 2.3, 2.10	High
IF.P.8	Infrastructure Project	**Telecommunications Planning and Resiliency Office:** Create new unit in DoITT to study telecommunications risks and formulate and advocate for solutions.	DoITT	N/A	Federal grant for 2-year period; long-term funding TBD	$1.2 million	Federal block grant approved	N/A	2.1, 2.3, 2.10, 3.3	High
IF.P.9	Infrastructure Project	**IP routing network:** Harden the network, providing the City with required advanced bandwidth management devices to regulate appropriate use of ISP links during emergencies.	DoITT	N/A	TBD	$2.9 million	TBD	N/A	1.2, 2.1, 2.2, 2.10	High

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IF.P.10	Property Protection	**Purchase of mobile substation:** Mitigate substation outage by developing specifications and purchasing mobile substation equipment suitable for NYC applicability due to loss of key substation equipment.	LIPA	N/A	February 2013 start, September 2014 completion	$ 2,900,000 (two units)	FEMA 406, NYS CDBG fund, LIPA	N/A	2.1, 2.3, 3.3	High
IF.P.11	Property Protection	**Purchase of mobile switchgear:** Mitigate substation outage by developing specifications and purchasing mobile switchgear for use in event of switchgear disruption in or near substation.	LIPA	N/A	February 2013 start December 2013 completion	$ 2,000,000 (two units)	FEMA 406, NYS CDBG fund, LIPA	N/A	2.1, 2.3, 3.3	High
IF.P.12	Emergency Services	**Emergency generators in NYCHA properties:** Install natural gas-powered, emergency generators throughout NYCHA properties to ensure building corridors and stairwells remain lit and provide power for vital domestic water pumps (high-rise buildings) and boilers for hot water and heating during utility outages.	NYCHA	TBD	Estimated time of completion 2016	$ 120,000,000	CDBG	N/A	1.1, 2.1, 2.3	Medium

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IF.P.13	Prevention & Policy	**Stand-alone power generation in NYCHA developments:** Re-engineer and re-configure all 334 NYCHA developments for enhanced stand-alone power generation. Consider all latest technologies including Microgrid, COGEN, and CHP.	NYCHA	TBD	TBD	TBD	TBD	N/A	1.1, 2.1, 2.3	Medium
IF.P.14	Emergency Services	**Backup generators for Police Department facilities:** Procure and install backup generators and automatic transfer switches.	NYPD	N/A	TBD	TBD	TBD	N/A	2.1, 2.7, 2.8	Medium
IF.P.15	Infrastructure Project	**Flood mitigation of 520 First Ave. (Manhattan Morgue) and Forensic biology building:** Purchase approximately 100,000 square feet of space due to history of flooding in these structures. Relocate records, evidence, samples, back up OCME training lab, special operations equipment/ vehicles, and records to a temperature-controlled, secured, CCTV-monitored warehouse under the control of OCME.	OCME	N/A	Unknown	$50,000,000	Capital	N/A	2.1, 2.2, 2.7, 2.9	Medium

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IF.P.16	Emergency Services	**Kings and Queens facilities:** Acquire backup generators and storage for generators.	OCME	N/A	Unknown	Unknown	Capital	N/A	2.1, 2.3	Medium
IF.P.17	Emergency Services	**Generator assessment and installation of quick- connects for critical infrastructure:** Expand the Prime Power Assessment Program citywide to include a generator quick-connect and/or generator installation in addition to the survey.	OEM	USACE, FEMA, DCAS, City agencies	Immediate	$50,000,000	Capital budget	No change	2.1, 2.3, 2.7	Medium
IF.P.18	Emergency Services	**Backup generators for gas stations and terminals:** Ensure that a subset of gas stations and terminals have access to backup generators in case of widespread power outages.	OEM	N/A	1 year	TBD	Agency operating budget	N/A	2.1, 2.3	Medium
IF.P.19	Prevention & Policy	**Protection from utility service interruptions:** Amend the Construction Codes and develop best practices to protect against service interruptions.	OLTPS	N/A	TBD	$1 million	Funding not yet secured	N/A	1.3, 2.5, 5.2	High
IF.P.20	Prevention & Policy	**Distributed generation (DG) and micro-grids:** Work with public and private partners to scale up DG and micro-grids.	OLTPS	N/A	TBD	$5 million	HMGP, CDBG	N/A	2.1, 2.3	High
MULTI-HAZARD										

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MH.P.1	Prevention & Policy	**Overhead electric system improvements:** Fortify the overhead system from wind and tree damage by reducing circuits into smaller segments, isolating open wire spurs from feeder main runs, improving auto-loop reliability, and selective undergrounding of overhead infrastructure.	Con Ed	N/A	4 years	Approximately $250 million	Agency operating budget	N/A	2.7, 3.3	Medium
MH.P.2	Prevention & Policy	**Underground electric system improvements:** Fortify the underground system by installing submersible equipment in flood-prone areas and applying sectionalizing strategies to minimize number of customers impacted by flooding.	Con Ed	N/A	4 years	Approximately $200 million	Agency operating budget	N/A	2.7, 3.3	Medium
MH.P.3	Prevention & Policy	**Gas system Improvements:** Fortify the gas system by installing special valves to prevent water infiltration and replacing cast-iron and bare-steel mains in flood zones.	Con Ed	N/A	2 years	Approximately $100 million	Agency operating budget	N/A	2.7, 3.3	Medium
MH.P.4	Prevention & Policy	**Storm-hardening of critical facilities:** Install new and modify existing flood protection to improve storm-hardening at critical facilities to new flood protection levels. Modify equipment housing and penetrations to minimize water intrusion.	Con Ed	N/A	3 years	Approximately $400 million	Agency operating budget	N/A	2.2, 2.7, 3.3	Medium

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MH.P.5	Property Protection	**Window upgrades:** Replace windows at 100 Centre Street, 1 Centre Street, 2 Lafayette Street, 125 Worth Street, and 80 Centre Street.	DCAS	DDC	10 years	$15,000,000	Capital budget	No change	2.1, 2.2	Medium
MH.P.6	Prevention & Policy	**Retail resiliency study:** Examine commercial corridors in the flood zone to better understand resiliency options.	DCP	N/A	2013	N/A	N/A	N/A	3.3	Medium
MH.P.7	Prevention & Policy	**Building Identification Numbers (BINs):** Assign BIN numbers to buildings that currently don't have them and to structures (such as bridges, tunnels, subway stations, monuments, and temporary structures) to allow the FDNY to better inspect these buildings and structures as part of its Risk Based Inspection System (RBIS).	DCP	N/A	N/A	N/A	N/A	N/A	2.1, 2.5, 5.2	Medium
MH.P.8	Prevention & Policy	**BIN Working Group recommendations:** Implement recommendations made as result of the seven-month analysis of BIN usage.	DCP	N/A	N/A	N/A	N/A	N/A	2.1, 2.5, 5.2	Medium

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MH.P.9	Property Protection	**Inspection and upgrade program for DEP facilities:** Implement programmatic inspection and upgrade program to ensure all critical DEP facilities maintain continuity of operations during flood, hurricane, or earthquake events. This program will include flood-proofing and structural retrofits of DEP offices, field locations, and other critical facilities.	DEP	N/A	Ongoing	Included in regular agency capital/operating budget	Capital/expense budget	No change	2.1, 2.3, 2.7, 2.8	Medium
MH.P.10	Infrastructure Project	**Groundwater development:** Construct treatment facilities throughout the southeast Queens groundwater system to provide up to 55 million gallons per day of additional water treated to meet EPA Safe Drinking Water Act standards.	DEP	N/A	TBD	TBD	TBD	No change	1.5, 2.1, 2.7	Medium
MH.P.11	Infrastructure Project	**Groundwater treatment plant:** Construct a treatment facility in southeast Queens with four existing groundwater wells to provide an additional 12 million gallons of water supply for the city. Remove and treat groundwater to meet EPA Safe Drinking Water Act standards.	DEP	N/A	2021	$40 million	Capital budget	No change	1.5, 2.1, 2.7, 2.8	Medium

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MH.P.12	Emergency Services	**Laptops for DFTA essential staff:** Purchase additional laptops for essential personnel to continue operations in the event of flooding at DFTA offices.	DFTA	HRA, DoITT	2 years	$10,000	TBD	N/A	1.1, 2.3	High
MH.P.13	Emergency Services	**Generator for neighborhood hub:** Purchase generator for one senior center hub in each borough.	DFTA	CBOs	3 years	TBD	TBD	N/A	1.1, 2.3	Medium
MH.P.14	Emergency Services	**Headlamps for home-delivered meals deliverers:** Purchase headlamps to deliver meals safely to homebound individuals during power outages.	DFTA	CMOW	2 years	$10,000	TBD	N/A	1.1, 1.6, 2.3	Medium

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MH.P.15	Property Protection	**Upgrades to DHS buildings:** Add exterior reinforcements and energy performance enhancements to 29 DHS-owned buildings, exceeding the requirements of the New York City Building Code.	DHS	N/A	Ongoing	TBD	TBD	No change	1.1, 2.1, 2.4, 2.5	Medium
MH.P.16	Property Protection	**DHS building roof improvements:** Add ballast to flat roofs of 21 DHS-owned facilities to protect against high winds, heavy rain, and flying debris, exceeding the requirements of the City's Building Code.	DHS	N/A	Ongoing	$2,000,000	TBD	No change	1.1, 2.1, 2.4, 2.5	High
MH.P.17	Property Protection	**Window upgrade in DHS buildings:** Retrofit windows in 29 DHS-owned facilities by glazing to withstand effects of coastal storms, windstorms, and tornadoes, exceeding the requirements of the City's Building Code.	DHS	N/A	Ongoing	$18,000,000	TBD	No change	1.1, 2.1, 2.4, 2.5	Medium
MH.P.18	Emergency Services	**Power redundancy at DHS buildings:** Install redundant power supply at all DHS-owned facilities.	DHS	N/A	Ongoing	$6,500,000	TBD	Scope expanded to include purchase of emergency generators to provide redundant power supplies for critical operations at the remaining 26 DHS-owned buildings.	1.1, 2.3	Medium

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MH.P.19	Prevention & Policy	**DHS shelter protection:** Obtain restrictive covenants on six DHS shelters to replace with non-residential structures in areas within the flood and SLOSH zone.	DHS	N/A	Ongoing	TBD	TBD	No change	1.1, 1.5, 2.1, 2.2	Medium
MH.P.20	Property Protection	**Bellevue shelter facility improvements:** Elevate mechanical systems, create independent heating system, purchase emergency generator, and improve windows and roofing.	DHS	N/A	Ongoing	$42,825,000	HMGP	N/A	1.1, 1.5, 2.1, 2.4, 2.5	Medium
MH.P.21	Property Protection	**LIFE Family Residence facility improvements:** Elevate mechanical systems and purchase emergency generator.	DHS	N/A	Ongoing	$17,000,000	HMGP	N/A	1.1, 1.5, 2.1, 2.2, 2.3	Medium
MH.P.22	Emergency Services	**Mobile command stations:** Procure three permanently available mobile command stations for flood zones in Brooklyn, Queens, and Staten Island.	DOB	N/A	TBD	$150,000	TBD	N/A	2.3	Medium
MH.P.23	Emergency Services	**DOB backup generators:** Procure backup generators for 280 Broadway to sufficiently meet the needs of DOB to operate the EOC and power the central servers, which house data for all five boroughs, among other core functions.	DOB	N/A	TBD	TBD	TBD	N/A	2.3	Low

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MH.P.24	Emergency Services	**DOB radios:** Procure 80 communication radios to effectively carry out inspections and communicate with command posts during disasters when cell phone services are typically down or unreliable.	DOB	N/A	TBD	$120,000	TBD	N/A	2.3	Medium
MH.P.25	Emergency Services	**DOB vehicles:** Procure 25 SUVs and 75 hybrid vehicles outfitted with "emergency packages" for disaster use to expedite inspector response and guarantee service levels, and to address the addition of nearly 40 inspectors.	DOB	N/A	TBD	$2,750,000	TBD	N/A	2.3	Medium
MH.P.26	Infrastructure Project	**Stormwater management:** Upgrade steam tunnel pumps to remove water that may enter during a coastal storm or flooding event.	DOC	DEP	TBD	$15 million	TBD	No change	1.1, 2.1, 2.7	Medium
MH.P.27	Infrastructure Project	**Rikers Island ferry dock**: Add new docking facility to provide additional access to Rikers Island for inmate transport and supplies such as food and medicines.	DOC	DOT	TBD	$25 million	Capital/FTA	N/A	1.1, 2.1, 2.7	Medium
MH.P.28	Property Protection	**Roof and façade improvements:** Upgrade roofs and facades to withstand extreme weather events.	DOC	N/A	TBD	$78 million	Capital	N/A	1.1, 2.1, 2.7	Medium

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MH.P.29	Property Protection	**Emergency Operations Center improvements**: Upgrade Emergency Operations Center building infrastructure and communications.	DOC	N/A	TBD	TBD	Capital	N/A	1.1, 1.2, 2.1	Medium
MH.P.30	Emergency Services	**Off-island satellite Emergency Operations Center (EOC) for Rikers Island:** Procure an off-island satellite EOC to allow for continuity of operations. Currently Rikers Island Bridge is the only means of egress, and should the bridge become impaired due to high winds or collapse, operation of the existing EOC would be comprised.	DOC	N/A	TBD	TBD	Capital	N/A	1.1, 1.2, 2.1, 2.3	Medium
MH.P.31	Emergency Services	**MDC cellar/backup emergency system:** Provide second emergency generator for 100% capacity.	DOC	N/A	TBD	$3 million	Capital	N/A	2.1, 2.3	Medium
MH.P.32	Emergency Services	**Provision of power redundancy:** Acquire portable generators, pumping station, lighting systems, radios, and other essential equipment to create redundancy for critical networks.	DOE	N/A	TBD	$1,000,000	FEMA	No change	1.1, 2.1, 2.3	Medium

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MH.P.33	Property Protection	**Protection of DOE facilities from electrical system damage from trees:** Implement program to prune or remove old and overgrown trees near DOE facilities to prevent damage to the electrical distribution grid and nearby structures during tornadoes, windstorms, and coastal storms.	DOE	DOE, SCA	TBD	TBD	TBD	No change	1.1, 2.1, 2.7	Medium
MH.P.34	Property Protection	**DOE green roof installation:** Install updated building management systems that include green roof structures for DOE facilities to reduce the volume of stormwater runoff.	DOE	DOE, SCA	TBD	TBD	TBD	No change	1.1, 2.1, 2.7, 4.4	Medium
MH.P.35	Emergency Services	**Surge protection for DOE critical electrical systems:** Install surge suppression protection to minimize impacts from severe weather.	DOE	DOE, SCA	TBD	TBD	TBD	No change	1.1, 2.1, 2.7	Medium
MH.P.36	Emergency Services	**Emergency power at DOE facilities:** Install emergency power-generation systems at existing facilities.	DOE	DOE, SCA	TBD	$1,250,000	FEMA	Not started	1.1, 2.1, 2.3	Medium

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MH.P.37	Prevention & Policy	**Emergency preparedness plans and training for DOE custodian engineers and building managers**: Develop site-specific plans for 72 buildings, and engage consultants to do training.	DOE	DOE	1 year	$150,000	TBD	N/A	1.1, 1.4, 2.1	High
MH.P.38	Education & Awareness	**Psychological First Aid (PFA)**: Train New York City responders in PFA, an evidence-informed modular approach to help children, adolescents, adults, and families in the immediate aftermath of disaster to reduce the initial distress caused by traumatic events and foster short- and long-term adaptive functioning and coping.	DOH MH	OEM	Immediate and ongoing	$20,000	TBD	N/A	1.4, 1.6, 1.5	High
MH.P.39	Education & Awareness	**"Mental Health First Aid" public education program**: Conduct a "Mental Health First Aid" public education program to introduce non-mental health professionals to risk factors and warning signs of mental health problems and build understanding of their impact, and provide an overview of common treatments to increase individual and community resilience.	DOH MH	N/A	Immediate and ongoing	$150,000	TBD	N/A	1.6	Medium

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MH.P.40	Emergency Services	**Mental health system IT improvement:** Convert paper records to electronic formats (including off-site backup capacity) to prevent damage and loss in the event of a disaster and to facilitate remote accessibility of client records.	DOH MH	N/A	One year to implement	$6,000,000	One-time expense and capital combined	N/A	2.3	Medium
MH.P.41	Emergency Services	**Mental health system power backup:** Purchase generators and needed equipment for community-based providers. Include gasoline reserves.	DOH MH	N/A	Immediate and ongoing	$1,500,000	Capital	N/A	1.1., 2.3	Medium
MH.P.42	Education & Awareness	**Mental health system support network:** Establish a network of community-based mental health organizations (different types of programs located in various zones) that may develop a COOP plan to share resources and collaboratively ensure consumer safety and provide services during and following an emergency.	DOH MH	N/A	One year to implement and ongoing	$500,000	One-time expense	N/A	1.1, 1.6, 2.3, 5.3	High
MH.P.43	Education & Awareness	**Mental health volunteer preparedness and response**: Promote involvement of mental health consumers in volunteer preparedness and response activities. Peer volunteers would receive training on emergency preparedness and be linked to a	DOH MH	N/A	One year to implement and ongoing	$250,000	Expense	N/A	1.1, 1.4, 1.5, 1.6	High

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		network of programs that mobilize volunteers to respond to an emergency such as Community Emergency Response Teams, American Red Cross, City Serve, and NYC Cares.								
MH.P.44	Infrastructure Project	**DOHMH IT systems protection:** Safeguard crucial DOHMH applications and systems through the creation of a mirror system or DR Data Center (cloud). The current DOHMH Data Center at 22 Cortlandt Street in downtown Manhattan, in a flood zone, competes for power resources and priorities with the city's financial institutions.	DOHMH	N/A	18 months to implement; yearly contracting	$ 1,500,000 up front and $1,000,000 per year	N/A	N/A	2.1, 2.3	High
MH.P.45	Property Protection	**DOHMH primary data center availability:** Increase DOHMH's network infrastructure capacity and redundancy to improve preparedness and response during a major system failure.	DOHMH	N/A	1 year to implement	$6,000,000 one-time investment	N/A	N/A	2.3	Medium

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MH.P.46	Property Protection	**Riverside clinic upgrade:** Equip the new back-up DEOC with the appropriate infrastructure and technology to support DOHMH public health response to a citywide emergency.	DOHMH	DDC, DCAS	Estimated implementation by February 2014	$447,000	Capital and CDC Public Health Emergency Preparedness (PHEP) grant funds	N/A	2.3	Medium
MH.P.47	Infrastructure Project	**DOHMH warehouse and print shop capacity:** Develop and install a new inventory tracking system for the DOHMH warehouse (520 Kingsland Ave.) destroyed by Hurricane Sandy. Purchase critical equipment for the DOHMH print shop to produce secure documents that can only be issued by DOHMH.	DOHMH	N/A	6- 12 months	$550,000	Operating and IT development staff	N/A	2.1, 2.3	High
MH.P.48	Emergency Services	**Health data and provider portal:** Create a centralized provider directory and associated reporting portal to communicate with providers as well as gather information from providers. Data can be analyzed and used to generate reports during emergencies.	DOHMH	NYS DOH	Potentially 2 years	$2.6 million	SSBG is being pursued	N/A	1.2, 1.5, 5.2	High

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MH.P.49	Emergency Services	**Enhanced emergency response communication operations at DOHMH headquarters:** Equip 2 Gotham with enhanced Motorola 800Mhz radio capacity to allow DOHMH response operations and communication to continue even if IT and phone networks are down.	DOH MH	OEM, NYS DOH	Potentially 2 years	$1.046 million	CDC PHEP	N/A	1.2, 2.3	High
MH.P.50	Property Protection	**Generators for healthcare facilities:** Ensure that the 53 nursing homes and 26 ACFs located in hurricane evacuation zones 2-4 have backup power capacity by purchasing portable generators and installing quick-connects**.**	DOH MH	OEM, NYS DOH	Potentially 3 years	$34.9 million	HMGP	N/A	1.1, 1.5, 2.3	Medium
MH.P.51	Prevention & Policy	**Small grants program to support community-based social cohesion:** Support 10 longstanding community-based organizations, schools, or faith-based organizations that serve diverse vulnerable populations (e.g. children, undocumented immigrants, precariously un-domiciled and homeless, and the elderly). Funding will be will be in two increments of $25,000 each for a total award of $50,000 per site.	DOH MH	Possibly DOE	12-24 months	$500,000	N/A	N/A	1.5, 1.6, 5.1, 5.3	Medium

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MH.P.52	Prevention & Policy	**"Hub the Hood" program:** Develop a grant program in which neighborhood associations compete for seed money to become a "Hub" for their neighborhood by connecting block associations, buildings, and social service providers for a more socially cohesive neighborhood.	DOH MH	DOB/HPD	Potentially 2 years	TBD	TBD	N/A	1.6, 5.1, 5.3	Medium
MH.P.53	Property Protection	**DOHMH facility repair and upgrade:** Restore and strengthen DOHMH buildings, including DOHMH clinics and the Public Health Laboratory (PHL). Repair building facades, walls, parking lots, water infiltration and drainage systems, and install sump pumps and generators.	DOH MH	DDC, EDC, DCAS	Existing: 12-24 months; potential: 24 – 60 months	$15,000,000	Capital or grant funds	N/A	1.1, 1.5, 2.1	Medium
MH.P.54	Emergency Services	**Notification system for City employees:** Develop an enhanced system for contacting City employees using a variety of communications media to notify, alert, and/or instruct City employees prior to and during emergencies.	DoITT	OEM	Ongoing	TBD	TBD	No change	1.2, 2.1, 2.3	Medium
MH.P.55	Infrastructure Project	**Hardening of NYCWiN network:** Install fixed generators at 126 NYCWiN sites to protect and enhance the reliability and resiliency of communications	DoITT	N/A	18 months	$11.2 million	FEMA Grant	N/A	2.1, 2.3, 2.10	Medium

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		infrastructure.								
MH.P.56	Infrastructure Project	**Data Center Site B:** Provide consolidated Site B capability and capacity for applications not already hosted at DoITT's 2 MTC Data Center.	DoITT	N/A	12-18 months	$50 million	TBD	N/A	2.1, 2.2, 2.10	Medium
MH.P.57	Property Protection	**Secure HAZMAT at DOT facilities**: Prevent release, in the event of hazard event, of herbicides at Arterials yards; combustible materials at sites such as Webster Fleet Services Shop; fuel from above-ground tanks at sites such as Conner Street Yard.	DOT	DDC, DCAS	TBD	TBD	TBD	N/A	2.1, 2.2	Medium
MH.P.58	Emergency Services	**Redundant power for all mission-critical DOT sites:** Provide and/or upgrade generators at fleet fueling stations.	DOT	DCAS, OEM	TBD	TBD	TBD	N/A	2.1, 2.3	Medium
MH.P.59	Emergency Services	**Continuity of Operations sites:** Prepare sites within each borough to support operations and permitting immediately following an event. Fit out sites with redundant power and infrastructure.	DOT	DDC, DCAS	TBD	TBD	TBD	N/A	2.1, 2.3	Medium

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MH.P.60	Emergency Services	**Information tracking:** Follow formalized response to natural hazard-based incidents to identify repetitive loss locations or hazards. Use this information to inform the creation and implementation of future mitigation actions.	DOT	OEM	2 years	$150,000	Expense and capital budgets	No change	2.1, 5.2	High
MH.P.61	Infrastructure Project	**High-reflectivity pavements:** Explore and incorporate high-reflectivity/high-albedo paving (e.g. lighter-colored roadways) into street resurfacing and reconstruction to reduce the urban heat island effect. Explore and test material sourcing (e.g. for asphalt aggregate) and new approaches (e.g. whitetopping). Feasible and cost-effective options will ultimately be added to DDC and DOT's standard specifications.	DOT	DEP	Ongoing	$5,000,000 for study plus testing	TBD	No change	2.1, 2.7, 2.8, 2.9, 5.2	Medium
MH.P.62	Emergency Services	**Critical facility loss estimation:** Conduct a detailed natural and non-natural hazard loss estimation on critical facilities (including bridges) using increased positional accuracy-building attribute databases and available hazard maps.	DOT	DOB, OEM	TBD	$500,000	Expense	No change	5.2	Medium
MH.P.63	Infrastructure Project	**Staten Island Ferry fleet upgrade:** Purchase new vessels to replace the Barberi class vessels, thereby improving the capability of the	DOT	N/A	6 years	$300,000,000	FTA ER	N/A	2.1, 2.7	Medium

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		fleet.								
MH.P.64	Infrastructure Project	**Staten Island Ferry vessel improvement**: Install high-lift rudders on vessels.	DOT	N/A	TBD	$5,000,000	FEMA HMGP, FTA ER	N/A	2.1, 2.7	Medium
MH.P.65	Emergency Services	**COOP trailer compound:** Purchase COOP trailer compound (minimum 7 trailers) to operate daily district operations while affected permanent facilities are being repaired.	DSNY	N/A	Action would take approximately 24 hours to re-locate trailer or trailers to staging area	Approximately $400,000	Capital budget	N/A	2.1, 2.3	Medium
MH.P.66	Property Protection	**Industrial property upgrades:** Implement planned upgrades to vulnerable City-owned industrial properties.	EDC, BNYDC	N/A	60 months	$10,000,000	HMGP	EDC: $300,000 for study	2.7, 4.3	Medium
MH.P.67	Property Protection	**Hardening Staten Island Ferry and private ferry terminals from climate change-related threats:** Construct physical improvements to the floating infrastructure, loading gangways, pilings, and piers, as well as develop a stock of spare parts to be stored in a secure upland location.	EDC	DOT	60 months	$15,000,000	FTA	Ongoing	1.2, 2.1, 2.3, 4.4	Medium

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MH.P.68	Infrastructure Project	**Construction of new ferry landings to support private ferry services:** Expand the network of ferry landings available for both regular and emergency use. Design and procure two new ferry landing barges that are outfitted with the required equipment for providing basic ferry service, including self-contained generators.	EDC	DOT	60 Months	$15,000,000	FTA	N/A	1.1, 2.1	Medium
MH.P.69	Prevention & Policy	**Waterfront fueling facilities:** Retrofit one or two waterfront fueling facilities to accommodate large commercial vessels, including ferry boats and other government vessels.	EDC	N/A	24 months	$5,000,000	TBD	N/A	2.1, 2.3	Medium
MH.P.70	Prevention & Policy	**Mobile/portable ferry ticketing machines**: Procure up to 15 mobile ticketing machines to provide a flexible ticketing solution that can be moved to ferry landings experiencing high-volume ridership in post-storm periods to reduce wait times and enable a more efficient flow of passengers to final destinations.	EDC	DOT	TBD	Approximately $50,000 per machine.	Capital budget	N/A	2.3	Medium

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MH.P.71	Infrastructure Project	**Use of the Staten Island Ferry's Austen Class vessels for East River Ferry service during weather-related storm disruptions:** Supplement East River Ferry capacity during transit service disruptions that cause large numbers of commuters to use ferry services by retrofitting existing ferry landings to accommodate the Austen Class vessels.	EDC, DOT	N/A	24 months	Cost included in MH.P. 69	EDC	N/A	2.1, 2.7	Medium
MH.P.72	Property Protection	**Storm shutters project:** Install storm shutters at FDNY facilities in flood-prone areas subject to punishing winds, flying debris, and horizontal, driving rain during storms.	FDNY	N/A	TBD	TBD	TBD	N/A	2.1, 2.7	High
MH.P.73	Emergency Services	**Backup communications carrier:** Research the feasibility of using a commercial carrier to back up NYCWiN until NYCWiN can be hardened and made more resilient.	FDNY	DoITT	TBD	TBD	TBD	N/A	2.1, 2.3, 2.10	Medium
MH.P.74	Emergency Services	**Voice-over IP architecture:** Explore feasibility of switching to more resilient voice-over IP architecture.	FDNY	N/A	TBD	TBD	TBD	N/A	1.1, 2.1, 2.3, 2.10	Medium
MH.P.75	Emergency Services	**Next-generation satellite phones:** Purchase "smart" satellite phones for critical staff.	FDNY	N/A	TBD	TBD	TBD	N/A	2.1, 2.3, 2.10	Medium

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MH.P.76	Infrastructure Project	**FDNY facilities survey:** Conduct a survey of FDNY facilities and facility components (e.g., roofs, doors, windows) in the revised FEMA flood zones, and schedule upgrades.	FDNY	N/A	TBD	TBD	TBD	N/A	2.1, 2.7	Medium
MH.P.77	Emergency Services	**FCOC cell phone coverage:** Improve cell phone coverage of FCOC, which FDNY staffs with additional personnel during major events, taxing the already overcrowded and sometimes unavailable cell network.	FDNY	N/A	TBD	TBD	TBD	N/A	2.1, 2.10	Low
MH.P.78	Emergency Services	**FDNY cable network:** Upgrade FDNY's cable network, which connects dispatch centers with firehouses to relay 911 calls, to fiber to improve resiliency and reduce outages.	FDNY	N/A	TBD	TBD	TBD	N/A	1.1, 2.1, 2.3, 2.10	High
MH.P.79	Emergency Services	**Spare radios:** Acquire additional portable radios to facilitate more widespread use of FDNY trunking system during cell carrier outages.	FDNY	N/A	TBD	TBD	TBD	N/A	1.1, 2.1, 2.10	Medium
MH.P.80	Prevention & Policy	**Home-work plans:** Explore feasibility of telecommuting options for non-emergency personnel who support critical operations during disasters.	FDNY	N/A	TBD	TBD	TBD	N/A	2.1, 2.10	Medium

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MH.P.81	Emergency Services	**Gas vendors:** Negotiate with vendors to ensure they maintain spare fuel supply in the event of shortages.	FDNY	N/A	TBD	TBD	TBD	N/A	2.1	Medium
MH.P.82	Emergency Services	**Cache of vaccinations:** Ensure a sufficient supply of vaccines to inoculate all first responders.	FDNY	DOHMH	TBD	TBD	TBD	N/A	2.1	Medium
MH.P.83	Emergency Services	**Urban search and rescue team:** Increase the number of trained officers and firefighters in New York Task Force 1 to meet the growing demands of a professional, trained, and proven search and rescue team.	FDNY	US DHS	TBD	TBD	TBD	N/A	1.1, 2.1	Medium
MH.P.84	Prevention & Policy	**Coney Island Hospital HVAC**: Protect hospital's HVAC system.	HHC	TBD	2 years	$30 million	HMGP, general obligation bonds	N/A	1.1, 2.1, 2.8	Medium
MH.P.85	Emergency Services	**Coney Island Hospital power pre-connections:** Install pre-connections on the perimeter wall of the existing building above the 500-year BFE for connection to rollup generators, chillers, and high-pressure steam boilers. This will enable the facility to rent portable, roll-up equipment and quickly restore critical services should facility equipment be subject to damage during a flood.	HHC	TBD	1 year	$7 million	HMGP, general obligation bonds	N/A	1.1, 2.1, 2.7, 2.8	Medium

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MH.P.86	Prevention & Policy	**Metropolitan Hospital HVAC:** Protect the HVAC system.	HHC	TBD	2 years	$30 million	HMGP, CDBG, general obligation bonds	N/A	1.1, 2.1, 2.7, 2.8	High
MH.P.87	Emergency Services	**Metropolitan Hospital pre-connections**: Install pre-connections for critical systems.	HHC	TBD	1 year	$42 million (included in plans for new structure)	HMGP, general obligation bonds	N/A	1.1, 2.1, 2.7, 2.8	High
MH.P.88	Prevention & Policy	**Bellevue Hospital:** Protect HVAC system.	HHC	TBD	1 year	$35 million	HMGP, CDBG, general obligation bonds	N/A	1.1, 2.1, 2.7, 2.8	High
MH.P.89	Emergency Services	**Bellevue Hospital power pre-connections:** Install pre-connections for critical systems.	HHC	TBD	1 year	$5 million	HMGP, CDBG, general obligation bonds	N/A	1.1, 2.1, 2.7, 2.8	High
MH.P.90	Emergency Services	**Central Office Emergency Command Center (ECC) and alternate ECC:** Designate and equip a new central office command center, as well as an alternate central office command center.	HHC	TBD	3 months	$300,000	HMGP, CDBG, general obligation bonds	N/A	1.1, 2.1, 2.3	Medium

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MH.P.91	Emergency Services	**Henry J. Carter Hospital improvements:** Purchase backup generator and make associated structural improvements.	HHC	TBD	2 months	$920,000	HMGP, CDBG, general obligation bonds	N/A	1.1, 2.1, 2.3, 2.7, 2.8	High
MH.P.92	Education & Awareness	**Outreach to residential building owners:** Develop a methodology and technology solution to provide pre- and post-disaster outreach and information to residential building owners. This may include the creation of a new online emergency notification contact system.	HPD	N/A	2 years	$1,500,000 plus ongoing maintenance costs	Grants	N/A	1.2, 1.6, 2.6, 5.1	Medium
MH.P.93	Education & Awareness	**Flood protection for critical facilities:** Evaluate flood-protection measures in long-term-lease buildings in or near flood zones and Coastal Storm Evacuation zones 1 and 2. Make recommendations to building owners.	HRA	N/A	5 years	TBD	Lease budget, Administrative Other-Than-Personal-Services (AOTPS) Budget	Equipped key buildings that are most vulnerable with sandbags. Maintaining an inventory of portable generators.	1.1, 2.1, 2.6, 2.7	High

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MH.P.94	Property Protection	**Overhead electric infrastructure**: Raise/relocate the overhead electric infrastructure to mitigate proximity violations as a result of homes being raised to comply with FEMA guidelines.	LIPA	N/A	Ongoing and as required	$500,000	Insurance, FEMA, NYS CDBG, LIPA	N/A	1.1, 2.1, 2.2, 3.3	Low
MH.P.95	Infrastructure Project	**Storm damage mitigation:** Place overhead distribution lines underground in high-risk areas with extreme exposure to falling trees, and replace existing lines with aerial spacer cable construction in areas of moderate risk. Install automated sectionaling switches to isolate flood zones.	LIPA	N/A	March 2014 start, June 2015 completion	$3,500,000	FEMA 406, LIPA	N/A	2.1, 2.2, 2.7, 3.3	Low
MH.P.96	Education & Awareness	**Exploration of loss-reduction actions for landmarked properties:** Assist owners of locally designated landmarked structures in flood hazard areas to identify appropriate resiliency measures.	LPC	DOB, DOT, DCP, DEP	As needed	TBD	Expense budget	Studying need	2.6, 2.9	High

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MH.P.97	Education & Awareness	**Public education and outreach for landmarked buildings:** Provide information on site and building preservation issues for locally designated landmarked structures in flood hazard areas.	LPC	DCP	Unknown	TBD	Expense budget	Studying need	2.6, 2.9, 5.1, 5.3	High
MH.P.98	Prevention & Policy	**Marine Parkway/Cross Bay Bridge mitigation master plan:** Compare various long-term capital investment strategies to rehabilitate/reconstruct the crossings while building resiliency and robustness into the structures.	MTA (Bridges and Tunnels)	N/A	3 years	$10 million	Applying for funding from FEMA HMGP	Procurement for study has commenced	2.1, 2.7, 2.8, 2.9	High
MH.P.99	Prevention & Policy	**Engineering flood studies at non-tunnel facilities:** Determine vulnerabilities and prepare conceptual designs for mitigation work.	MTA (Bridges and Tunnels)	N/A	2 years	$6 million	Capital budget. May apply for funding from HMGP	Contracts have been awarded for studies several bridges and one facility.	2.1, 2.7, 2.8, 2.9	Medium

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MH.P.100	Infrastructure Project	**Far Rockaway depot green roof:** Design and install green roof to reduce the volume of stormwater runoff and help reduce the urban heat island effect.	MTA (Buses)	NYSDE, DEP, FTA	2 years	$4,703,730	Capital improvement budget	No change	2.1, 2.7	Medium
MH.P.101	Prevention & Policy	**Hazards/threats planning:** Develop comprehensive planning guidance and contingency/response plans for all hazards/threats.	MTA (MNR)	N/A	Indefinite/12 months	$500,000	Staff time	N/A	2.1, 5.2	High
MH.P.102	Prevention & Policy	**Fueling capabilities/backup for emergency response:** Conduct an assessment for providing emergency fueling capabilities to MNR's rubber tire fleet.	MTA (MNR)	N/A	12 months	$500,000	Staff time	N/A	2.1, 2.3	High

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MH.P.103	Infrastructure Project	**Penn Station access:** Provide Metro-North and the region with resiliency to the Metro-North system to enable the New Haven Line service to access Manhattan in the case of a catastrophic event. There are three single points of failure for Metro-North Service into Manhattan – Mott Haven Junction, the Harlem River Lift Bridge and GCT and its viaduct and tunnel approaches. Each individually or collectively requires resiliency to protect service into midtown Manhattan. Without the resiliency inherent in these improvements, a catastrophic event at any of the three points would cut off Metro-North service to midtown Manhattan affecting over 700 trains and over 220,000 commuters daily. In addition, there is a risk of terrorist attack, a ship or large construction barge with a crane hitting the bridge, or fire.	MTA (MNR)	Amtrak, LIRR	Design completion 3-4 years	$40 million	Sandy Emergency Relief Program Resiliency	N/A	2.1, 2.2, 2.8	High

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MH.P.104	Infrastructure Project	**Harlem-125 Street Station improvements:** Make improvements to the Harlem-125 Street Station to allow Metro-North to maintain service to and from Manhattan should a catastrophic event disrupt service at Grand Central Terminal.	MTA (MNR)	N/A	TBD	TBD	TBD	N/A	2.1, 2.2, 2.8	High
MH.P.105	Property Protection	**Emergency management equipment:** Purchase mobile vehicle fueling equipment, install East End fueling station, make communication upgrades to trucks and mobile command center, purchase mobile trailer mounted substations and emergency generators.	MTA (LIRR)	N/A	November 2013 - November 2014	$20 million	Potential FTA Local Priority Resiliency Funds	N/A	2.1, 2.3, 2.7, 2.10	High
MH.P.106	Property Protection	**NYCHA grounds, pavements, and drainage improvements:** Install planting for soil stabilization and to create buffer zones. Strengthen anchorage/footings for play equipment and pole lighting in nine developments (91 buildings).	NYCHA	TBD	TBD	$9,390,708	Capital improvement budget	Ongoing	2.1, 2.7	High

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MH.P.107	Property Protection	**Category 4 distributed power-generation feasibility studies:** Assess NYCHA developments severely damaged by Hurricane Sandy in an effort to combine/centrally locate utility systems where feasible. Combine developments to continue operations during utility outages and include within future NYCHA distributed power-generation systems (CHP, COGEN, micrgrid, etc.). Current developments include RedHook East and West, Ocean Bay (Bayside), Coney Island Site 8, O'Dwyer Gardens, and Surfside, but may include others if deemed appropriate by future feasibility studies.	NYCHA	TBD	Estimated time of completion 2016	TBD	TBD	N/A	2.1, 2.2, 2.3	Medium
MH.P.108	Property Protection	Morrisania Air Rights: Repair/re-support building.	NYCHA	TBD	TBD	TBD	TBD	N/A	2.1, 2.7	Low

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MH.P.109	Prevention & Policy	**NYCHA AC improvements:** Outfit all 334 NYCHA developments with central AC systems. AC central chiller plants can increase COGEN/CHP efficiencies during summer months, provide cool air to building residents during extreme heat events, and keep buildings pressurized, thereby preventing airborne hazardous waste from entering buildings.	NYCHA	TBD	TBD	TBD	TBD	N/A	1.1, 2.1	Medium
MH.P.110	Property Protection	**NYPD precinct facility protection:** Enhance design of the 40th, 66th, 70th, 110th, 120th, 121st, and Central Park precinct facilities to withstand severe wind, rain, and flooding events.	NYPD	TBD	TBD	TBD	TBD	No change	2.1, 2.7, 2.8	Medium
MH.P.111	Property Protection	**NYPD facility protection:** Enhance facility design of Public Safety Answering Center I, Public Safety Answering Center II, and Joint Operations Center to withstand severe wind, rain, and flooding events.	NYPD	TBD	TBD	TBD	TBD	No change	2.1, 2.7, 2.8	Medium

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MH.P.112	Property Protection	**NYPD critical facilities protection:** Promote hardening of existing and future critical facilities from the primary and secondary effects of natural hazards.	NYPD	N/A	TBD	TBD	TBD	No change	2.1, 2.7, 2.8	Medium
MH.P.113	Emergency Services	**OCME unified agency command center**: Relocate all critical communications function into one unified workspace on emergency generator power.	OCME	DDC	Unknown	$2,267,710	Capital budget	N/A	2.1, 2.10	High
MH.P.114	Education & Awareness	**Educational outreach to private sector:** Coordinate and provide educational outreach on mitigation strategies the private sector can use to reduce or eliminate the impact of hazards on private-sector services and infrastructure. Opportunities to educate OEM's private-sector partners include conferences, OEM website, and presentations.	OEM	N/A	TBD	TBD	TBD	OEM's website hosts information on hazard mitigation.	3.1, 3.3, 3.4, 3.5	Medium

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MH.P.115	Property Protection	**OEM facilities protection:** Conduct or update natural-hazard vulnerability assessments for all OEM facilities, and harden facilities to prevent or minimize damage from natural hazard events.	OEM	DCAS, FEMA, NYS OEM	TBD	TBD	HMGP, PDM-C	Assessments still pending	2.1, 2.7, 2.8	Medium
MH.P.116	Emergency Services	**HAZUS-MH software:** Update software to optimize of HAZUS-MH modeling for New York City's unique urban environment. The software update will allow New York City to generate more accurate loss estimates for various hazards.	OEM	FEMA, NYS OEM	1 year	TBD	HMGP, PDM-C	No change	2.5, 5.1, 5.2	High
MH.P.117	Education & Awareness	**Community Emergency Response Team (CERT) Curriculum:** Adapt CERT curriculum to educate team members on strategies that mitigate the impact of natural hazards on the city, including protecting utility services, redundant communication, continuity of business services (for corporate CERTs), and property protection.	OEM	NYPD, FDNY	Ongoing	$200,000	US Department of Homeland Security Initiative, grants	No change	3.2, 3.4, 3.5, 5.3	High

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MH.P.118	Emergency Services	**Infrastructure systems modeling:** Coordinate the development of a multi-hazard infrastructure vulnerability model.	OEM	FEMA, NYS OEM, academic institutions	3 years	TBD	HMGP	No change	5.1, 5.2	Medium
MH.P.119	Emergency Services	**Loss estimation**: Assist agencies in determining loss estimates using HAZUS-MH.	OEM	MPC	5 years	TBD	HMGP, PDM-C, FEMA	No change	5.1, 5.2	Medium
MH.P.120	Emergency Services	**Natural hazard event database:** Create a natural hazard event database to capture description, severity, location, impact, and potential loss/damage estimates from an event. Use data to update the hazard analysis and mitigation actions for New York City.	OEM	FEMA, NYS OEM	5 years	TBD	Agency operating budget	No change	5.1, 5.2	Medium

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MH.P.121	Education & Awareness	**CERT collaboration with community groups:** Partner the CERT program with local community organizations—including civic, faith-based, and tenant associations—to promote mitigation strategies.	OEM	NYPD, FDNY	Ongoing	$200,000	U.S. Department of Homeland Security Urban Area Security Initiative, grants	No change	3.1, 3.3, 3.4, 3.5, 5.3	High
MH.P.122	Education & Awareness	**Ready New York update:** Expand guide for seniors and people with disabilities.	OEM	DFTA, MOPD	1 year	TBD	OEM	Ready New York: My Emergency Plan, created especially for seniors and people with special needs, launched in October 2011.	1.1, 1.6, 5.3	High
MH.P.123	Education & Awareness	**Public/private mitigation initiatives:** Support the resiliency of New York City's private sector through information sharing, partnership building, and education on mitigation principles and the City's HMP.	OEM	N/A	Ongoing	TBD	TBD	No change	3.1, 3.3, 3.4, 3.5	High

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MH.P.124	Emergency Services	**Regional critical infrastructure mapping:** Map critical infrastructure for the New York City region to better understand the interrelationships among components of the region's infrastructure and to support the HMP's Risk Assessment section.	OEM	DHS, NYSOH, NYSOH, PANYNJ	12 months	TBD	TBD	No change	5.1, 5.2	Medium
MH.P.125	Emergency Services	**Subway depths mapping:** Collaborate with NYCT to assign depth below-street-level and absolute-depth-below-sea-level elevations for subway stations and tunnels to support planning for flooding and secondary impacts from other natural hazards.	OEM	NYCT	12 months	TBD	TBD	No change	5.1, 5.2	Medium
MH.P.126	Prevention & Policy	**Vegetation data:** Develop vegetation data for New York City for use in HAZUS-MH and other hazard-impact models to allow for better debris estimates and to identify areas more susceptible to the urban heat island effect.	OEM	Parks	6 months	TBD	TBD	No change	5.1, 5.2	Medium

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MH.P.127	Prevention & Policy	**Zoning for hazard-prone areas:** Correlate natural hazard-vulnerable areas with existing zoning districts to identify areas where mitigation actions would be necessary to maintain responsible and sustainable development.	OEM	DCP	12 months	TBD		No change	2.4, 2.5, 5.1, 5.2	Medium
MH.P.128	Education & Awareness	**Mitigation public outreach:** Develop a mitigation guide and online training course for homeowners and property managers on risk reduction before and after a hazard event, and work with community-based organizations and non-governmental organizations to engage the community in advance of an emergency.	OEM	N/A	3 years	$1 million	HMGP	No change	1.6, 2.6, 2.9, 5.1, 5.3	High
MH.P.129	Emergency Services	**Emergency Operations Center (EOC):** Create and build out a new backup EOC to include room and capability for all citywide operations (e.g., EOC, Logistics Center [LC], Unified Operations and Resource Center [UORC], Commodity Distribution Point Command Center [CCC], Healthcare Evacuation Center [HEC], and other Continuity of Operations [COOP]	OEM	DCAS, FEMA	2-3 years	$100,000,000	Capital budget, HMGP	Real estate search underway—250,000 square feet of space has been scoped out	2.1, 2.2, 2.3, 2.7	Medium

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		working needs).								
MH.P.130	Emergency Services	**OEM Warehouse:** Identify a new warehouse space or build out a new OEM warehouse (the current warehouse is not large enough to accommodate the existing stockpile of supplies to support NYC for an emergency). Include adequate spacing for all citywide operational needs, storage, and functioning.	OEM	DCAS	2-3 years	$25,000,000	Capital budget	N/A	2.1, 2.2	High
MH.P.131	Education & Awareness	**New York City mitigation guide and education:** Educate New Yorkers about hazard mitigation techniques that they can use to reduce long-term risks from natural hazards. Include a mitigation guide for homeowners and property managers; online training; flood-risk information; and CBO/NGO outreach—all to be incorporated into OEM's website.	OEM	OLTPS, DEP, DOB, DOHM, DOF, DOT, NYC Service/ Citizen Corps Council member	1 year	$1,000,000	HMGP (5%)	Citizen Corps Sponsored a hazard mitigation presentation to Citizen Corps members on September 17, 2013 and followed up with outreach on information on hazard mitigation on OEM's website.	1.6, 2.6, 2.9, 5.1, 5.3	High

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				agencies/other City agencies						
MH.P.132	Education & Awareness	**Building community capacity**: Launch pilot program to identify and address gaps in community capacity.	OEM	N/A	Ongoing	$1 million	CDBG	N/A	1.6, 5.1, 5.3	Medium
MH.P.133	Prevention & Policy	**Urban Post-Disaster Housing site identification in New York City:** Prepare communities and agencies for deployment of post-disaster housing units by identifying potential sites and evaluating feasibility for use in terms of constructability and livability.	OEM	FEMA, USACE, DOB, DEP, DOT, MTA	1 year	$100,000	FEMA, city tax levy, U.S. Department of Homeland Security Regional Catastrophic Preparedness	N/A	1.1, 2.1, 2.5	

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							Grant Program			
MH.P.134	Prevention & Policy	**Executive decision-making guide for deployable post-disaster housing**: Provide executives with information needed to evaluate deployable post-disaster housing option, with the goal of preventing population loss and creating quality interim housing.	OEM	DDC, DOB, USACE, FEMA, HUD, EDC, NYCHA, CAU	2014	$25,000	FEMA, city tax levy, U.S. Dept. of Homeland Security Regional Catastrophic Preparedness Grant Program	N/A	1.1, 2.5, 2.9	

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MH.P.135	Prevention & Policy	**Request for Proposal for Urban Post-Disaster Housing:** Prepare RFP to procure deployable housing to help people soon after a disaster. This is a time-of-event document for the USACE to select housing manufacturers who can meet the City's criteria for urban deployable housing.	OEM	DDC, USACE, FEMA, HUD	6 months	$10,000	FEMA, City Tax Levy, U.S. Department of Homeland Security Regional Catastrophic Preparedness Grant Program	N/A	1.1, 2.5, 2.9	
MH.P.136	Property Protection	**Storm shutter protection at OEM headquarters:** Install storm shutters at OEM headquarters to protect windows from flying debris.	OEM	N/A	3–5 years	$800,000	HMGP, PDM-C	No change	2.1, 2.7	High

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MH.P.137	Property Protection	**NYC Brownfield Incentive Grant (BIG) program**: Seek more funding to facilitate financial assistance to property owners seeking to investigate and clean up contaminated properties, as well as to community groups, for public outreach, planning, and technical assistance.	OER	OMB, NYSEDC, EDC, USEPA	3 months pending funding	$2.5 million per year	OMB budget allocation, NYS Regional Economic Development Council grants, USEPA grants	N/A	1.5, 2.1, 2.4, 2.6, 2.10	High
MH.P.138	Emergency Services	**Fuel advance warning system:** Implement advance-warning system for emergency fuel shutoff during a natural disaster.	PANYNJ (Aviation)	PANYNJ	3 years	$500,000	Capital budget	No change	1.1, 1.2, 4.1	High
MH.P.139	Emergency Services	**Kennedy Airport electrical system resiliency:** Rehabilitate Bergen substation to enhance the airport's ability to withstand extreme events that disrupt power transmission.	PANYNJ (Aviation)	FAA	5 years	$39,820,000	Capital budget, HMGP	N/A	2.1, 2.7, 2.10	Medium

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MH.P.140	Emergency Services	**LaGuardia Airport central electric substation: R**ehabilitate the supervisory controls and data acquisition of the Central Electric and West End substation SCADA system to enhance the airport's ability to manage and recover from emergencies.	PANYNJ (Aviation)	PANYNJ	4 years	$1,500,000	Capital budget, HMGP	N/A	2.1, 2.7, 2.10	High
MH.P.141	Emergency Services	**LaGuardia Airport electrical system enhancement:** Enhance old generator equipment to provide upgraded and enhanced capacity. Currently outdated backup power sources cannot provide reliable power during critical periods.	PANYNJ (Aviation)	PANYNJ	2 years	$31,000,000	Capital budget, HMGP	N/A	2.1, 2.3	Medium
MH.P.142	Emergency Services	**LaGuardia Airport power system redundancy:** Install a secondary power supply for the airport.	PANYNJ (Aviation)	Con Ed	5 years	$25,100,000	Capital budget, HMGP	N/A	2.1, 2.3	Medium

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MH.P.143	Emergency Services	**Kennedy Airport power system redundancy:** Install a secondary power supply for the airport.	PANYNJ (Aviation)	Con Ed	4 years	$50,000,000	Capital budget, HMGP	N/A	2.1, 2.3	Medium
MH.P.144	Emergency Services	**Stewart Airport standby emergency generator:** Provide power redundancy to allow for safe evacuation of the airport and limited operations to continue during extreme weather events.	PANYNJ (Aviation)	PANYNJ	2 years	$2,500,000	Capital budget, HMGP	N/A	2.1, 2.3	High
MH.P.145	Emergency Services	**Stewart Airport power system redundancy:** Install a secondary power supply for the airport.	PANYNJ (Aviation)	Con Ed	4 years	$10,000,000	Capital budget, HMGP	N/A	2.1, 2.3	High

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MH.P.146	Infrastructure Project	**Kennedy Airport fuel storage:** Elevate storage tank and pumping station a structural platform.	PANYNJ (Aviation)	PANYNJ	4 years	$2,000,000	Capital budget, HMGP	N/A	2.1, 2.3	High
MH.P.147	Emergency Services	**Intelligent Transportation System (ITS) program at Kennedy and Newark Airports:** Enhance intra-agency visibility and regional situation awareness—critical to manage traffic during emergencies—by investing in a comprehensive multi-facility Intelligent Transportation System (ITS) program.	PANYNJ (Aviation)	New York DOT, New Jersey DOT	5 years	$69,300,000	Capital budget, HMGP	N/A	2.1, 2.10	Medium
MH.P.148	Emergency Services	**Emergency generator capacity for Red Hook and Howland Hook container terminals:** Add backup power to improve the resiliency of the terminals and mitigate the effects of power loss from a flooding or other weather event.	PANYNJ (Ports)	PANYNJ	2 years	$1,500,000	Capital budget, HMGP	N/A	2.1, 2.3	High

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MH.P.149	Emergency Services	**Lincoln Tunnel electrical and power system improvements:** Upgrade the electrical and power system to avert the loss of power to pumps and ventilation systems, which can cause flooding and disruption in tunnel use.	PANYNJ (TBT)	PANYNJ	3 years	$14,000,000	Capital budget, HMGP	N/A	2.1, 2.7, 2.10	Medium
MH.P.150	Emergency Services	**George Washington Bridge (GWB) electrical and power system improvements:** Upgrade GWB's emergency power feed and low-voltage power distribution, and rehabilitate high-tension switchgear.	PANYNJ (TBT)	PSE&G, Con Ed	4 years	$40,600,000	Capital budget, HMGP	N/A	2.1, 2.7	Medium
MH.P.151	Emergency Services	**GWB tower transformers**: Replace the GWB tower transformers to provide a reliable source of power for tower lighting, communications systems, tower elevators, and security system.	PANYNJ (TBT)	PANYNJ	3 years	$3,200,000	Capital budget, HMGP	N/A	2.1, 2.7	High

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MH.P.152	Emergency Services	**Multi-facility real-time traffic information software:** Develop Enterprise Transportation Management Center software to process data collected from sensors in the field and present up-to-minute information to operators.	PANYNJ(TBT)	New York DOT, New Jersey DOT	5 years	$18,500,000	Capital budget, HMGP	N/A	2.1, 2.10	Medium
MH.P.153	Emergency Services	**Intelligent Transportation System (ITS) program:** Develop a comprehensive multi-facility ITS program to provide a cost-effective system to unify multiple facilities within PANYNJ and connect with other regional transportation agencies to provide real-time traffic information for emergencies.	PANYNJ (TBT)	New York DOT, New Jersey DOT	5 years	$146,000,000	Capital budget, FHA, HMGP	N/A	2.1, 2.10	Medium
MH.P.154	Property Protection	**Green roofs on Parks buildings:** Install green roofs on select Parks facilities to reduce stormwater runoff and help reduce the urban heat island effect. Estimated cost is $25 per square foot.	Parks	DOE, SCA	2 years	$30,000 to $50,000 per site	HMGP, other grants	No change	2.7, 2.8, 4.3, 4.4	High

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MH.P.155	Coastal/Natural Resource Protection	**Green Streets:** Transform selected traffic medians from concrete to areas densely planted with trees and horticulture to reduce stormwater runoff and help reduce the urban heat island effect.	Parks	DOT	2 years	$50,000 per site	HMGP, other grants	No change	2.7, 2.8, 4.3, 4.4	High
MH.P.156	Property Protection	**Wetlands and other land in a natural state:** Leave purchased or donated land and wetlands in a natural state to absorb floodwaters, mitigate storm surge impacts, reduce heat impacts, and prevent construction in flood zones.	Parks	N/A	5 years	$1,000,000 per acre	HMGP	No change	2.2, 2.5, 2.7, 4.3	Medium
MH.P.157	Infrastructure Project	**Seawall, pier, and marina structural repairs:** Restore docks and other seawall structures at the 79th Street Boat Basin in Manhattan. Seawalls help mitigate erosion and prevent flooding.	Parks	N/A	5 years	$1,500,000 ($10 per square foot for piers and $20 per linear foot for bulkheads)	HMGP	Emergency repairs to Shore Road seawall in Brooklyn completed	2.1, 2.7	High

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MH.P.158	Property Protection	**Upgrades to Parks buildings' systems:** Protect vulnerable Parks buildings from flooding and other hazards by hardening or elevating electrical and mechanical systems.	Parks	DOB, DOHMH	TBD	$12,000,000	HMGP	N/A	2.1, 2.2, 2.7	Medium
MH.P.159	Education & Awareness	**SBS outreach**: Update SBS website with information on emergency preparedness and mitigation best practices, and email-blast business and neighborhood organization customers to inform them of mitigation best practices and how to prepare for upcoming hazard.	SBS	TBD	TBD	TBD	TBD	N/A	3.3, 3.4, 5.1, 5.3	Medium
MH.P.160	Emergency Services	**Toolkit and training materials for city volunteer groups**: Create toolkit and training materials to enable volunteer groups to help businesses. Materials may include training videos, best practices documentation, and checklists. Volunteers will communicate available services to business owners in the field as well as gather critical data that would allow SBS to connect business owners to necessary recovery services.	SBS	OEM and other City partners as necessary	TBD	TBD	TBD	N/A	3.2, 3.3, 3.4, 3.5, 5.1	Medium

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MH.P.16 1	Education & Awareness	**Small business outreach:** Partner with OEM to hold a series of workshops for small businesses in areas vulnerable to coastal storms and flooding. Workshops will cover disaster preparedness and recovery planning, marketing, social media, and financing.	SBS	OEM	TBD	TBD	TBD	N/A	3.2, 3.3, 3.4, 3.5, 5.1	Medium
MH.P.16 2	Education & Awareness	**Hazard mitigation education for businesses:** Work with OEM to create hazard mitigation planning materials/resources to be distributed/presented during business services (launches, courses, and financing assistances) to encourage businesses to include hazard mitigation planning in their business plans, thereby increasing the likelihood of businesses surviving a hazard.	SBS	OEM	TBD	TBD	TBD	N/A	3.1, 3.2, 3.3, 3.4, 3.5	Medium
MH.P.16 3	Education & Awareness	**Ready New York materials**: Work with OEM to update/create Ready New York materials geared towards businesses with information on mitigation actions.	SBS	OEM	TBD	TBD	TBD	N/A	3.2, 3.3, 3.4, 5.3	Medium

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MH.P.164	Education & Awareness	**Toolkit and training materials for BIDs and LDCs on mitigation best practices**: Partner with OEM to create toolkit and training materials to train BIDs and LDCs on mitigation best practices. BID representatives and AvenueNYC contract managers will partner with OEM to present on mitigation best practices at meetings in the field.	SBS	OEM	TBD	TBD	TBD	N/A	3.1, 3.2, 3.3, 3.4, 3.5	Medium
MH.P.165	Education & Awareness	**Hazardous mitigation seminar for BIDs and LDCs**: Partner with OEM to hold annual seminar on hazardous mitigation best practices.	SBS	OEM	TBD	TBD	n/a	N/A	3.1, 3.2, 3.3, 3.4, 3.5	Medium
MH.P.166	Education & Awareness	**Dissemination of hazard information:** Distribute personal preparedness materials created by OEM on an occasional basis to 200,000+ jobseekers in SBS database. Help New Yorkers be better prepared for or more aware of potential hazards by getting information out about impending hazards (like a hurricane or tornado warning) or how to react in the wake of a hazard.	SBS	OEM	TBD	TBD	n/a	N/A	3.1, 3.2, 3.3, 3.4, 3.5, 5.1, 5.3	Medium

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MH.P.167	Coastal/Natural Resource Protection	**Rockaway Reformulation Study**: Complete Rockaway Reformulation Study with sea level rise considerations for future long-term coastal protection recommendations, design, and construction.	USACE,NYSDEC	Parks	3 years	TBD	USACE, NYC, RCPT	N/A	4.1, 4.3, 4.4	High
MH.P.168	Coastal/Natural Resource Protection	**T-groins at Coney Island**: Construct T-groins at Coney Island to protect coastline.	USACE,NYSDEC	NYSDE, Parks	1 year	TBD	USACE, NYC, RCPT	N/A	2.7, 4.3	High
SEVERE WEATHER										
SW.P.1	Property Protection	**Protection of NYCDOT facilities from high winds:** Focus on locations including trailer yards and roofs.	DOT	DDC, DCAS	TBD	TBD	TBD	N/A	2.1, 2.7	Medium
SW.P.2	Emergency Services	**Sign inspection program:** Develop enhanced inspection program of key street, parking, and life-protecting signs throughout the city to ensure these do not become potentially hazardous debris during high-wind events.	DOT	N/A	3 years	$3,250,000	Consolidated Highway Improvement Program	N/A	2.1, 2.7	High

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
SW.P.3	Property Protection	**Rooftop equipment protection at HRA facilities:** Secure rooftop equipment to withstand high-wind events.	HRA	OEM, DEP, DDC, DCAS, FEMA	5 years	$5,000,000	Agency capital budget	Recommendations were made to landlord	1.1, 2.1, 2.7	Medium
SW.P.4	Property Protection	**Increased line clearance tree trim program:** Expand line clearance tree trim program to shorten tree trim cycle and increase removal of hazardous trees outside normal trim zones.	LIPA	N/A	January 2014 start, December 2014 completion	$500,000	NYS (CDBG fund), LIPA	N/A	2.1, 2.7, 3.3	Medium
SW.P.5	Infrastructure Project	**Bridge reinforcement:** Study and design to construct bridge features that mitigate the effects of high-wind events.	MTA (Bridges and Tunnels)	N/A				Incorporated into facility "State-of-Good Repair" projects	2.1, 2.7, 2.8, 2.9	Medium
WINTER STORMS										
WS.P.1	Infrastructure Project	**Improved snow and ice melt:** Research and, if appropriate, test and monitor the effectiveness of permeable pavement and other paving techniques to speed snowmelt and icemelt on streets. The goal is to clear them more quickly, thereby reducing vehicular crashes and improving emergency access post-snowstorm.	DOT	N/A	1 year (consultant study)	$250,000	HMGP, city capital budget, city expense budget	No change	2.1, 2.7, 2.8, 2.9, 5.2	Medium

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Index	Action Type	Mitigation Action Description	Lead	Support	Timeline	Cost Estimate	Possible Funding Sources	2009 Progress Status	Goals and Objectives	Prioritization
WS.P.2	Education & Awareness	**Outreach to property owners on impacts of snow loads:** Partner with DOB to educate property owners about the impacts of snow load, snow drift loads, and sliding snow loads.	OEM	DOB	1 year	TBD	Agency operating budget	No change	2.6, 3.4, 5.3	High

Table 6: New York City Hazard Mitigation Action (Potential)/Implementation Table

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v. Private Institutions and Non-Profit Organizations—Potential Mitigation Actions

Like other groups in New York City, private institutions and non-profit organizations are vulnerable to hazards and interested in formulating mitigation strategies. The City works closely with private institutions and non-profits before, during, and after emergencies. This partnership is critical to strengthen resiliency and preparedness throughout the entire city. The private and non-profit world in New York City encompasses hundreds of entities that can be categorized according to five primary sectors:

- Human services–special needs
- Healthcare
- Cultural institutions
- Education
- Emergency services

For each sector, there are corresponding mitigation actions.

Human Services–Special Needs

The human services sector includes organizations that aim to improve quality-of-life issues for the local community, addressing the human element in response and recovery operations. This sector includes organizations that provide services and advocacy to special needs populations and thus make the City's plans and operations all-inclusive, reaching as diverse a population as possible to ensure that no group is left behind. The sector also encompasses organizations responsible for mass-care operations including sheltering, feeding, and volunteer and donation coordination and management. Also included in this sector are affordable housing providers, nursing homes, and assisted living complexes.

Organizations within the human services sector may implement a variety of mitigation actions to help reduce or eliminate long-term risk. For instance, they may take property protection actions to prevent flooding at an affordable housing complex and, in addition, install backup generators to ensure continuity in a power outage.

Public messaging is a key component of ensuring inclusive human services efforts.

Healthcare

The organizations in this sector include private hospitals and other healthcare facilities, such as nursing homes, adult care facilities, senior centers, and dialysis centers. In New York City, many hospitals belong to a larger umbrella organization called Greater New York Hospitals Association (GNYHA), a trade association comprising nearly 250 hospitals and continuing care facilities, both voluntary and public, in the metropolitan New York area and throughout New York State, as well as New Jersey, Connecticut, and Rhode Island. After Hurricane Sandy, New

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York City hospitals reviewed general building codes and healthcare regulations to determine recommendations for existing buildings and new construction standards.

In particular, NYU Langone Medical Center and Memorial Sloan-Kettering Cancer Center have been identified several mitigation projects focusing on property protection and emergency services. Such mitigation actions within this sector can include floodgate installation and equipment elevation to ensure that critical hospital functions and research programs continue to uninterrupted under hazardous conditions. Additional emergency power distribution is vital to mitigate power outages, which rendered all hospital functions at these facilities inoperable during Sandy.

Cultural Institutions

Museums, cultural facilities, libraries, historic places, and conservation societies are all included in the cultural institutions sector. Many of these organizations make up the Alliance for Response NYC, an initiative of the non-profit organization Heritage Perseveration, which brings cultural institutions and the first responder community together to prepare and respond for emergencies. These organizations may propose actions to mitigate flooding, such as designing drainage systems, constructing seawalls, and installing leak-detection equipment. Property protection mitigation actions may include elevating generator equipment or moving historic collections from the basements of buildings to higher floors.

Education

The education sector includes high schools, private colleges, universities, and other educational institutions. Many of the mitigation actions proposed by these entities address emergency services (for instance, promoting backup power generation to ensure continuity in the event of a power outage); others address property protection (facilities in low-lying areas may consider elevating electrical equipment or installing drainage systems to protect buildings from flooding). It is critical to maintain power and ensure that physical structures are resilient in the face of hazardous environments.

Emergency Services

Organizations that provide ambulatory services and/or alert notification systems are part of the emergency services sector. These organizations may propose backup power mitigation actions to prevent the loss of communication services due to power outages during an emergency.

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B. Analysis

The Planning Team and Steering Committee analyzed potential mitigation actions using the FEMA STAPLEE (social, technical, administrative, political, legal, economic, and environmental) review method. This analysis helped determine whether actions achieved one or more of the five hazard mitigation goals and 28 objectives of the HMP. The analysis also established the opportunities and constraints of implementing each potential mitigation action.

i. STAPLEE Analysis

The STAPLEE review method is an evaluation process developed by FEMA that is a systematic method to help identify the benefits and constraints of a particular mitigation action. Figure 1, below, provides a summary of the STAPLEE criteria.

Social **T**echnical **A**dministrative **P**olitical **L**egal **E**conomic **E**nvironmental

Social: The public must support the overall implementation and specific mitigation actions.

Will the proposed action adversely affect one segment of the population?
Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?
Is the action compatible with present and future community values?

How effective is the action in avoiding or reducing future losses?
Will it create more problems than it solves?
Does it solve the problem or only the symptom?

Technical: It is important to determine if the proposed action is technically feasible and will help reduce losses in the long term.

Administrative: Determine if the city has the staff and capabilities necessary to implement the action.

Does the jurisdiction have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained?
Can the community provide the necessary maintenance?
Can it be accomplished in a timely manner?

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Is there Political support to implement and maintain the action? Is there a local champion willing to see the action to completion? Is there enough public support to ensure the success of the action?	**Political:** Understanding how the community and political leadership feel about issues related to the environment, economic development, safety and emergency management.
Legal: Without appropriate legal authority, the action cannot lawfully be undertaken.	Are the proper laws, ordinances, and resolutions in place to implement the action? Are there potential legal consequences? Will the community be liable for the actions or support of actions, or lack of action? Is the action likely to be challenged by stakeholders who may be negatively affected?
Are there currently sources of funds that can be used to implement the action? What benefits will the action provide? Does the cost seem reasonable for the size of the problem and likely benefits? What burden will be place on the tax base to implement the action? Does the action contribute to the community economic goals, such as capital improvements or economic development?	**Economic:** Economic considerations must include the present economic base and projected growth.
Environment: Impact on the environment is an important consideration because of public desire for sustainable and environmentally healthy communities.	How will this action affect the environment (land, water, endangered species)? Will this action comply with local, state, and federal environmental laws or regulations? Is the action consistent with community environmental goals?

Figure 1: STAPLEE Summary Table

The Planning Team used the seven STAPLEE evaluation criteria to assign values to the actions. A score of plus (1) was assigned if the proposed action is favorable, a minus (-1) if the action is unfavorable, or a Not Applicable (0) if the evaluation criteria does not apply to the mitigation action.

			Social		Technical			Administrative			Political		Legal			Economic			Environment	
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CBRN																				
CB.P.1	Construction Code revision	DOB	1	1	1	1	0	0	0	0	1	1	1	1	0	1	1	1	0	1
CB.P.2	Harlem River lift bridge	MNR	1	0	1	1	1	1	0	0	1	1	0	1	1	1	1	0	0	0
CB.P.3	NYCHA fresh water supply	NYCHA	1	1	1	1	0	1	0	-1	1	1	1	1	0	1	0	0	0	1
CB.P.4	Brownfield cleanup in the 100-year floodplain	OER	1	1	1	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1
CB.P.5	Environmental research	OER	1	0	1	1	0	0	0	-1	1	0	1	1	1	1	1	1	1	1
CB.P.6	BrownfieldWORKS!	OER	1	-1	1	1	-1	1	0	0	1	1	1	1	-1	1	1	-1	1	1
CB.P.7	Environmental Project Information Center (EPIC)	OER	1	0	1	1	0	0	0	-1	1	1	1	1	1	1	1	-1	1	1
Coastal Erosion																				
CE.P.1	Protection of Rikers Island east, west, and south shorelines	DOC	1	1	1	1	0	0	0	0	1	0	1	1	1	1	0	1	0	0
CE.P.2	Beach restoration	Parks	1	1	1	-1	-1	0	0	-1	1	1	1	1	0	1	0	0	0	0

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CE.P.3	Renourishment of Orchard Beach, Bronx	USACE/NYC P&R	1	0	1	-1	-1	1	0	-1	1	1	1	1	-1	1	1	1	-1	0
Coastal Storms																				
CS.P.1	Resilient neighborhoods planning studies	DCP	1	1	1	0	1	0	0	0	1	1	1	1	1	1	0	0	0	1
CS.P.2	DCP planning support and technical assistance for Sandy disaster recovery	DCP	1	1	1	0	1	0	0	0	1	1	1	1	1	1	0	0	0	1
CS.P.3	Emergency contracts	DDC	1	0	1	0	0	0	0	0	1	1	1	1	-1	1	0	0	0	1
CS.P.4	Hardening pumping stations	DEP	1	1	0	1	-1	-1	0	-1	1	1	1	1	0	1	-1	-1	0	0
CS.P.5	Hardening wastewater treatment plants	DEP	1	0	1	1	1	1	1	1	1	1	1	1	1	1	-1	1	1	1
CS.P.6	Alternatives for Rockaway Wastewater Treatment Plant	DEP	1	0	1	-1	-1	0	0	0	0	0	1	1	0	1	-1	1	0	0
CS.P.7	VCBC mooring system and site access improvement	DOC	1	0	1	1	0	0	0	0	1	1	1	1	0	1	0	1	0	1
CS.P.8	Division I, II and III	DOC	1	0	1	0	0	0	-1	-1	1	0	1	1	0	1	0	1	0	1

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	storehouse																			
CS.P.9	FDNY storehouse improvement	FDNY	1	0	1	1	0	0	0	-1	1	1	1	1	0	1	0	0	0	1
CS.P.10	EMS Battalion	FDNY	1	1	0	1	-1	0	0	0	1	1	1	1	1	1	0	0	0	1
CS.P.11	EMS fallback sites	FDNY	1	1	1	0	1	0	0	0	1	1	1	1	1	1	0	0	0	1
CS.P.12	FDNY emergency services	FDNY	1	1	0	1	0	1	0	-1	1	1	1	1	1	1	0	0	0	1
CS.P.13	Outreach to residential building owners	HPD	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	-1	0	1
CS.P.14	Resilient home design competition	HPD	1	1	1	0	0	1	0	0	1	1	1	1	1	1	1	1	0	1
CS.P.15	Bridge and tunnel improvements and study	MTA (Bridges and Tunnels)	1	1	0	0	-1	-1	0	-1	1	1	1	1	0	1	0	0	0	0
CS.P.16	Flood-hardening of vital communications, substations, transformers, mechanical equipment, revenue equipment, and other electronic systems at	MTA (Bridges and Tunnels)	1	1	0	0	-1	-1	0	-1	1	1	1	1	0	1	0	-1	0	0

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	all MTA B&T facilities																			
CS.P.17	Raising Governors Island seawall for Hugh L. Carey Tunnel	MTA (Bridges and Tunnels)	1	0	1	1	1	0	0	-1	1	1	1	1	0	1	-1	1	0	1
CS.P.18	Water-level monitoring/alarm systems/CCTV	MTA (MNR)	1	1	1	1	0	0	0	-1	1	1	1	1	0	1	0	-1	0	1
CS.P.19	Power and communications/signal infrastructure mitigation	MTA (MNR)	1	0	0	1	0	0	0	1	1	1	1	1	0	1	0	-1	0	1
CS.P.20	Hardening of vulnerable healthcare facilities	NYS DOH	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	-1	0	1
CS.P.21	Protection of hurricane shelter windows	OEM	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	0	0	1
CS.P.22	Hazards U.S. Multi-Hazard (HAZUS-MH) modeling	OEM	1	0	0	0	0	1	0	1	1	1	1	1	1	1	0	-1	0	1

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CS.P.23	Backup power for evacuation centers	OEM	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	0	-1	-1	0
CS.P.24	Storm shutters for the Emergency Operations Center	OEM	1	1	1	1	0	0	0	-1	1	1	1	1	0	1	1	0	0	1
CS.P.25	Storm surge/tidal gauge real-time monitoring system	OEM	1	1	0	1	0	-1	0	-1	1	1	1	1	0	1	0	-1	0	1
CS.P.26	Evacuation center/ hurricane shelter ADA retrofit program for DOE facilities	OEM	1	1	-1	1	0	-1	0	-1	1	1		1	-1	1	0	-1	0	1
CS.P.27	Updates to Urban Post-Disaster Interim Neighborhood Design Guidelines	OEM	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	-1	0	1
CS.P.28	Cleanup standards for waterfront brownfields	OER	1	1	1	0	1	0	0	0	1	1	1	1	0	1	1	1	1	1
CS.P.29	Building Code update for wind resiliency in new buildings	OLTPS	1	1	0	1	0	0	0	0	1	1	1	1	0	1	1	-1	0	1

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CS.P.30	Building Code update for wind resiliency in existing buildings	OLTPS	1	1	0	1	0	0	0	0	1	1	1	1	0	1	1	-1	0	1
CS.P.31	Power exercises	USACE/NYCOEM/RCPT	1	1	1	0	0	0	0	0	1	1	1	1	0	1	0	1	0	1
Cyber Threats																				
CY.P.1	Supplement IT Security	HRA	1	1	1	1	0	1	-1	-1	1	1	1	1	1	1	-1	-1	0	0
CY.P.2	Cyber-Security Strategy	MTA (MNR)	0	0	1	1	0	0	1	-1	1	0	1	1	0	1	-1	1	0	0
Disease Outbreaks																				
DO.P.1	Pandemic Planning	MTA (MNR)	1	1	1	-1	1	1	0	0	1	1	1	1	1	1	0	0	0	0
Drought																				
D.P.1	Maximizing capacity for water delivery from the Catskill/Delaware system	DEP	1	0	1	1	0	-1	1	-1	1	0	1	1	-1	1	-1	0	0	1
D.P.2	Catskill Aqueduct capacity	DEP	1	0	1	1	0	-1	1	-1	1	0	1	1	-1	1	-1	0	0	1
D.P.3	Construction Code revision	DOB	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
D.P.4	Drought effects monitoring	FDNY	1	-1	1	1	-1	-1	1	-1	1	1	1	1	1	1	0	0	1	1

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Earthquakes																				
EQ.P.1	Mechanical equipment seismic upgrade	DCAS	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0
EQ.P.2	Seismic protection for sewers	DEP	1	1	1	1	0	1	1	-1	1	1	1	1	1	1	0	0	1	1
EQ.P.3	Seismic inspection and retrofit for drinking water distribution system	DEP	1	1	1	0	0	1	1	0	1	1	1	1	1	1	0	0	1	1
EQ.P.4	Seismic study and retrofit for tall buildings	DOE	1	1	1	1	1	0	1	-1	1	1	1	1	1	1	0	1	0	0
EQ.P.5	Building upgrades to seismic codes	HHC	1	1	1	1	1	0	-1	-1	1	1	1	1	1	1	-1	-1	0	0
EQ.P.6	HPD facility improvement	HPD	1	1	1	1	1	-1	-1	0	1	1	1	1	1	1	-1	-1	0	0
EQ.P.7	UPACA (Site 6)	NYCHA	1	1	1	1	-1	-1	0	-1	1	1	1	1	1	1	0	0	0	0
EQ.P.8	HAZUS-MH modeling	OEM	0	1	1	1	0	1	-1	1	1	1	0	0	1	1	-1	1	0	0
Extreme Temperatures																				
ET.P.1	Power redundancy in City-owned buildings	DCAS	1	1	1	0	-1	0	0	-1	1	1	1	1	1	1	0	1	0	0
ET.P.2	AC upgrade for senior	DFTA	1	1	1	0	0	0	0	-1	1	1	1	1	1	1	0	0	0	0

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	centers																			
ET.P.3	AC availability and affordability	DOHMH	1	1	1	1	-1	0	-1	0	1	1	-1	0	0	1	-1	-1	-1	-1
ET.P.4	Urban heat island effect mitigation	DOHMH	1	1	1	1	1	-1	0	0	1	1	0	1	0	1	0	-1	1	1
ET.P.5	Cooling centers	NYCHA	1	1	1	0	-1	0	0	-1	1	1	1	1	1	1	0	0	-1	-1
Flooding																				
F.P.1	Flooding Prevention	DCAS	0	1	1	1	-1	0	0	1	-1	-1	0	0	0	1	0	0	0	0
F.P.2	Infrastructure flood protection	DCAS	0	1	1	1	0	0	-1	0	0	0	0	1	0	1	-1	0	1	1
F.P.3	Flood Resilient Building Design Manual	DCP	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1
F.P.4	Zoning for flood-resistant construction, Phase I and II:	DCP	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1
F.P.5	Ecologically sensitive industrial area planning	DCP	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1
F.P.6	Croton Falls pump station rehabilitation	DEP	1	1	1	1	0	0	-1	-1	1	1	-1	1	0	1	-1	0	1	1

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F.P.7	Bergen Basin and Tallman Island Wastewater Treatment Plant drainage upgrades	DEP	1	1	1	1	0	0	-1	-1	1	1	-1	1	0	1	-1	0	1	1
F.P.8	Server capacity improvements	DFTA	1	1	1	1	0	0	-1	1	1	1	0	1	0	1	-1	0	0	0
F.P.9	DHS electrical improvements	DHS	1	1	1	1	0	0	-1	1	1	1	0	1	0	1	-1	0	0	0
F.P.10	Borden Avenue facility	DHS	1	1	1	1	0	0	-1	1	1	0	0	1	0	1	-1	0	-1	-1
F.P.11	Data system upgrade	DOB	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	-1	0	1
F.P.12	Rikers Island roadway regrading	DOC	1	1	1	1	0	0	-1	1	1	0	0	1	0	1	-1	0	0	0
F.P.13	Water infiltration prevention	DOHMH	0	0	1	1	0	0	-1	1	0	0	0	1	0	1	-1	0	0	0
F.P.14	Flood-proofing 125 Worth Street vault	DOHMH	1	1	1	1	0	0	-1	0	1	1	0	1	0	1	-1	-1	0	1
F.P.15	Permeable pavement	DOT	1	0	1	1	1	1	-1	-1	1	0	1	1	1	1	1	-1	1	1
F.P.16	Protection for the Manhattan 1,2, and 5 facility	DSNY	1	1	1	1	-1	0	0	-1	0	1	0	1	0	1	-1	0	1	1
F.P.17	Stapleton waterfront	EDC	1	1	1	1	1	0	0	0	1	1	0	1	0	1	-1	0	1	1

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	flood mitigation																			
F.P.18	Brooklyn Army Terminal passive flood barrier system	EDC	1	1	1	1	-1	0	0	-1	0	1	0	1	0	1	-1	0	1	1
F.P.19	EDC operations centers flood mitigation	EDC	1	1	1	1	-1	0	0	-1	0	1	0	1	0	1	-1	0	1	1
F.P.20	Flood effects reduction program	FDNY	1	1	1	1	-1	0	0	-1	0	1	0	1	0	1	-1	0	1	1
F.P.21	Dewatering pumps at FDNY facilities	FDNY	1	1	1	1	-1	0	0	-1	0	1	0	1	0	1	-1	0	1	1
F.P.22	New construction flood mitigation	FDNY	1	0	1	1	0	-1	-1	1	1	1	1	1	0	1	0	-1	0	1
F.P.23	Coney Island Hospital flood-proofing	HHC	1	1	1	1	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.24	Coney Island Hospital emergency department mitigation	HHC	1	1	1	1	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.25	Coney Island Hospital/critical system protection	HHC	1	1	1	1	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0

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F.P.26	Metropolitan Hospital	HHC	1	1	1	1	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.27	Metropolitan Hospital	HHC	1	1	1	1	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.28	Coler Hospital	HHC	1	1	1	1	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.29	Coler Hospital	HHC	1	1	1	1	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.30	Building flood protection	HRA	1	1	1	0	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.31	Portable generators	HRA	1	1	1	0	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.32	Substation mitigation	LIPA	1	1	1	1	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.33	Water-balance study	MTA (NYCT-Subway)	1	1	1	0	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.34	Double Track Main Line, Phase 2	MTA/LIRR	1	1	1	1	1	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.35	Ventilation grate improvements	MTA/LIRR	1	1	1	0	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.36	Long Island City Yard protection	MTA/LIRR	1	1	1	1	0	0	0	-1	0	1	0	1	0	1	-1	0	0	0
F.P.37	Safeguarding of basement/cellar equipment	NYCHA	1	1	1	1	0	0	0	-1	1	1	0	1	0	1	-1	0	0	0
F.P.38	New NYCHA building or development	NYCHA	-1	-1	1	1	-1	0	-1	-1	0	-1	-1	1	-1	1	-1	-1	-1	0

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F.P.39	NYCHA floodgates and barriers	NYCHA	1	1	1	1	0	0	0	-1	1	1	0	1	0	1	-1	0	0	0
F.P.40	NYCHA boiler rooms and electrical equipment	NYCHA	1	1	1	1	0	0	0	-1	1	1	0	1	0	1	-1	0	0	0
F.P.41	Sump pump protection	NYPD	1	1	1	1	0	0	0	-1	1	1	0	1	0	1	-1	0	0	0
F.P.42	Building electrical protection	NYPD	1	1	1	1	0	0	0	-1	1	1	0	1	0	1	-1	0	0	0
F.P.43	Boiler protection	NYPD	1	1	1	1	0	0	0	-1	1	1	0	1	0	1	-1	0	0	0
F.P.44	Short-term flood mitigation of OCME emergency management storage facility at 18th Street and FDR Drive	OCME	1	1	1	0	0	0	0	-1	1	1	0	1	0	1	-1	0	0	0
F.P.45	Flood mitigation measures for New York City's backup Emergency Operations Center	OEM	1	1	1	1	0	0	0	-1	1	1	0	1	0	1	-1	0	0	0
F.P.46	HAZUS-MH modeling	OEM	0	0	1	1	0	-1	0	-1	1	1	0	1	0	1	-1	0	0	0

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F.P.47	National Flood Insurance Program (NFIP) Community Rating System	OEM	1	1	1	1	1	0	0	0	1	1	0	1	0	1	-1	0	0	0
F.P.48	Public information and guidance	OEM	1	1	1	1	1	0	0	0	1	1	0	1	0	1	1	0	0	0
F.P.49	Outreach and education for owners of Severe Repetitive Loss properties	OEM	1	1	1	1	-1	0	0	0	1	1	0	1	-1	1	0	0	0	0
F.P.50	Local storm surge barrier for Gowanus Canal	OLTPS	1	1	1	1	1	0	0	0	1	1	0	1	0	1	0	-1	1	0
F.P.51	Plan for flood protection along the Williamsburg, Greenpoint, and Long Island City coastlines	OLTPS	1	1	1	1	1	0	-1	0	1	1	0	1	0	1	1	0	1	1
F.P.52	Floodgate repairs at Oakwood Beach, Staten Island	OLTPS	1	1	1	1	1	0	-1	-1	1	1	0	1	0	1	-1	-1	0	0
F.P.53	Primary and secondary dune systems in	OLTPS	1	1	1	1	1	0	1	0	1	1	0	1	0	1	0	0	1	1

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	Rockaway Peninsula																			
F.P.54	Offshore breakwaters adjacent to and south of Great Kills Harbor	OLTPS	1	1	1	1	1	0	1	0	1	1	0	1	0	1	0	0	1	1
F.P.55	Flood protection in Hunts Point	OLTPS	1	1	1	1	0	0	-1	0	1	1	0	1	0	1	-1	-1	1	1
F.P.56	Flood protection in East Harlem	OLTPS	1	1	1	1	0	0	-1	0	1	1	0	1	0	1	-1	-1	1	1
F.P.57	Lower Manhattan flood protection	OLTPS	1	1	1	1	0	0	-1	0	1	1	0	1	0	1	-1	-1	1	1
F.P.58	Integrated Flood Protection System for Red Hook	OLTPS	1	1	1	1	1	0	-1	0	1	1	0	1	0	1	1	0	1	1
F.P.59	Protection of Farragut substation	OLTPS	1	1	1	1	1	0	0	0	1	1	0	1	0	1	0	0	1	1
F.P.60	Newtown Creek flood protection	OLTPS	1	1	1	1	1	0	1	0	1	1	0	1	0	1	0	0	1	1
F.P.61	Flood protection research	OLTPS	1	1	1	1	1	0	0	0	1	1	0	1	0	1	0	0	1	1
F.P.62	Prevention of drainage pipe flooding	OLTPS	1	1	1	1	1	0	0	0	1	1	0	1	0	1	0	0	1	1
F.P.63	Floodgate at Mill Creek	OLTPS	1	1	1	1	1	0	1	0	1	1	0	1	0	1	0	0	1	1

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F.P.64	Community Rating System	OLTPS	1	1	1	1	1	0	0	0	1	1	0	1	0	1	0	0	1	1
F.P.65	Coney Island Creek wetlands and tidal barrier	OLTPS	1	1	1	1	1	0	-1	0	1	1	0	1	0	1	1	0	1	1
F.P.66	Integrated flood protection for southern Manhattan	OLTPS	1	1	1	1	1	0	0	0	1	1	0	1	0	1	0	0	1	1
F.P.67	Flood protection of vital infrastructure at LaGuardia Airport	PANYNJ (Aviat.)	0	0	1	1	1	0	-1	-1	1	1	1	-1	0	1	-1	-1	1	0
F.P.68	Flood protection of vital infrastructure at Kennedy Airport	PANYNJ (Aviat.)	0	0	1	1	1	0	-1	-1	1	1	1	-1	0	1	-1	-1	1	0
F.P.69	Drainage improvements at Kennedy Airport	PANYNJ (Aviat.)	0	0	1	1	1	0	-1	-1	1	1	1	-1	0	1	-1	-1	1	0
F.P.70	Protection of Kennedy Airport fuel farm tanks	PANYNJ (Aviation)	0	0	1	1	1	0	-1	-1	1	1	1	-1	0	1	-1	-1	1	0
F.P.71	LaGuardia Airport dike wall	PANYNJ (Aviation)	0	0	1	1	1	0	-1	-1	1	1	1	-1	0	1	-1	-1	1	0
F.P.72	Kennedy Airport sanitary lift station	PANYNJ (Aviation)	0	0	1	1	1	0	-1	-1	1	1	1	-1	0	1	-1	-1	1	0

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F.P.73	Kennedy Airport runway upgrade	PANYNJ (Aviation)	0	0	1	1	1	0	-1	-1	1	1	1	-1	0	1	-1	-1	1	0
F.P.74	Kennedy Airport runway upgrade	PANYNJ (Aviation)	0	0	1	1	1	0	-1	-1	1	1	1	-1	0	1	-1	-1	1	0
F.P.75	Improvements to George Washington Bridge anchorage drainage system	PANYNJ(TBT)	0	0	1	1	1	0	-1	-1	1	1	1	-1	0	1	-1	-1	1	0
F.P.76	Flood-proofing at Olmsted site	Parks	0	0	1	1	0	0	0	0	0	0	0	-1	0	1	-1	0	0	0
F.P.77	Tidegate upgrade in Flushing Meadow Corona Park	Parks	1	1	1	1	0	1	1	-1	1	1	1	1	1	1	1	-1	1	1
Infrastructure Failures																				
IF.P.1	Expansion of cogeneration	DEP	1	1	1	1	0	-1	1	0	1	1	0	0	1	1	1	1	1	1
IF.P.2	Repair of the Delaware Aqueduct leak	DEP	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
IF.P.3	Utilities on Buono Bridge	DOC	-1	1	1	1	0	1	-1	-1	-1	-1	0	1	1	1	-1	1	0	0
IF.P.4	Facility electrical power and data	DOHMH	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0

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	infrastructure upgrade																			
IF.P.5	DOHMH generators and retrofits	DOHMH	1	1	1	-1	0	1	1	1	1	1	0	1	1	1	1	1	0	0
IF.P.6	Session Initiation Protocol (SIP)	DoITT	1	1	1	1	0	1	1	0	1	1	0	1	1	1	1	0	0	0
IF.P.7	Citywide IVR for employee announcements	DoITT	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	0	0	0
IF.P.8	Telecommunications Planning and Resiliency Office	DoITT	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0
IF.P.9	IP routing network	DoITT	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0
IF.P.10	Purchase of mobile substation	LIPA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	0	0
IF.P.11	Purchase of mobile switchgear	LIPA	1	1	1	1	1	1	1	-1	1	1	0	1	1	1	1	-1	0	0
IF.P.12	Emergency generators in NYCHA properties	NYCHA	1	1	1	-1	0	1	-1	-1	1	1	0	1	1	1	0	0	0	0
IF.P.13	Stand-alone power generation in NYCHA developments	NYCHA	1	1	1	1	-1	1	-1	-1	1	1	1	1	1	1	-1	-1	0	0

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IF.P.14	Backup generators for Police Department facilities	NYPD	1	1	1	-1	0	1	1	1	1	1	0	1	1	1	0	0	0	0
IF.P.15	Flood mitigation of 520 First Ave. (Manhattan Morgue) and Forensic biology building	OCME	1	1	1	1	-1	0	1	1	1	1	0	1	1	1	-1	1	0	0
IF.P.16	Kings and Queens facilities	OCME	0	0	1	-1	1	1	1	1	1	1	0	1	1	1	0	-1	0	0
IF.P.17	Generator assessment and installation of quick- connects for critical infrastructure	OEM	1	1	1	-1	0	-1	1	-1	1	1	1	1	1	1	0	-1	0	0
IF.P.18	Backup generators for gas stations and terminals	OEM	1	1	1	-1	1	-1	1	-1	1	1	1	1	1	1	0	-1	0	0
IF.P.19	Protection from utility service interruptions	OLTPS	1	1	1	1	1	1	-1	0	1	1	1	1	1	1	0	0	1	1
IF.P.20	Distributed generation (DG) and micro-grids	OLTPS	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	0
Multi-Hazards																				
MH.P.1	Overhead electric	Con Ed	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	-1	1	0	1

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	system improvements																			
MH.P.2	Underground electric system improvements	Con Ed	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	-1	1	0	0
MH.P.3	Gas system Improvements	Con Ed	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	-1	0	0	0
MH.P.4	Storm-hardening of critical facilities	Con Ed	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	-1	0	0	1
MH.P.5	Window upgrades	DCAS	1	0	1	1	0	0	0	-1	1	1	1	1	1	1	0	1	0	1
MH.P.6	Retail resiliency study	DCP	1	1	1	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0
MH.P.7	Building Identification Numbers (BINs)	DCP	1	0	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0	1
MH.P.8	BIN Working Group recommendations	DCP	1	1	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	1
MH.P.9	Inspection and upgrade program for DEP facilities	DEP	0	0	0	1	0	0	0	-1	1	1	1	1	0	1	0	0	0	1
MH.P.10	Groundwater development	DEP	0	0	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1
MH.P.11	Groundwater treatment plant	DEP	0	1	0	0	1	0	0	-1	1	1	1	1	-1	1	0	1	1	1
MH.P.12	Laptops for DFTA essential staff	DFTA	1	1	1	0	0	1	0	-1	1	1	1	1	0	1	1	0	0	1

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MH.P.13	Generator for neighborhood hub	DFTA	1	1	0	0	-1	0	0	-1	1	1	1	1	0	1	0	0	-1	0
MH.P.14	Headlamps for home-delivered meals deliverers	DFTA	1	1	1	0	0	0	0	0	1	1	1	1	0	1	1	0	0	1
MH.P.15	Upgrades to DHS buildings	DHS	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	0	0	0	1
MH.P.16	DHS building roof improvements	DHS	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	1	0	0	1
MH.P.17	Window upgrade in DHS buildings	DHS	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	0	0	0	1
MH.P.18	Power redundancy at DHS buildings	DHS	1	1	0	1	0	0	0	0	1	1	1	1	0	1	1	0	0	0
MH.P.19	DHS shelter protection	DHS	0	0	0	1	-1	0	0	0	0	-1	0	0	-1	1	0	0	0	1
MH.P.20	Bellevue shelter facility improvements	DHS	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	0	-1	-1	0
MH.P.21	LIFE Family Residence facility improvements	DHS	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	0	-1	-1	0
MH.P.22	Mobile command stations	DOB	1	0	1	0	0	0	0	0	0	0	0	0	-1	1	1	0	0	1
MH.P.23	DOB backup generators	DOB	1	0	1	0	0	0	0	-1	1	0	1	1	0	1	0	0	-1	0

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MH.P.24	DOB radios	DOB	1	0	1	1	0	0	0	0	1	0	1	1	0	1	-1	0	0	1
MH.P.25	DOB vehicles	DOB	1	0	1	1	-1	0	0	-1	1	0	0	0	0	1	1	0	-1	0
MH.P.26	Stormwater management	DOC	1	1	0	0	1	0	0	0	1	0	1	1	0	1	0	0	0	1
MH.P.27	Rikers Island ferry dock	DOC	1	0	0	0	0	0	0	-1	1	0	1	1	0	1	0	0	0	1
MH.P.28	Roof and façade improvements	DOC	1	1	0	1	0	0	0	-1	1	0	1	1	0	1	0	1	0	1
MH.P.29	Emergency Operations Center improvements	DOC	1	1	0	1	0	0	0	0	1	0	1	1	0	1	0	1	0	1
MH.P.30	Off-island satellite Emergency Operations Center (EOC) for Rikers Island	DOC	1	0	0	1	0	0	0	-1	1	0	1	1	0	1	0	1	0	1
MH.P.31	MDC cellar/backup emergency system	DOC	1	0	1	1	-1	0	0	-1	1	1	1	1	0	1	1	1	-1	0
MH.P.32	Provision of power redundancy	DOE	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	1	0	0	0
MH.P.33	Protection of DOE facilities from electrical system	DOE	1	1	1	0	0	0	0	-1	1	0	1	1	0	1	0	0	0	0

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	damage from trees																			
MH.P.34	DOE green roof installation	DOE	1	1	1	1	1	0	0	-1	1	1	1	1	0	1	0	0	1	1
MH.P.35	Surge protection for DOE critical electrical systems	DOE	1	1	0	1	0	0	0	0	1	1	1	1	0	1	0	0	0	1
MH.P.36	Emergency power at DOE facilities	DOE	1	0	1	1	0	0	0	-1	1	0	1	1	0	1	1	0	-1	0
MH.P.37	Emergency preparedness plans and training for DOE custodian engineers and building managers	DOE	1	0	1	0	0	0	0	0	1	0	1	1	0	1	1	0	0	1
MH.P.38	Psychological First Aid (PFA)	DOHMH	1	1	1	1	0	-1	0	1	1	1	1	1	0	1	1	1	0	1
MH.P.39	"Mental Health First Aid" public education program	DOHMH	1	1	1	0	0	0	0	1	1	1	1	1	0	1	1	1	0	1
MH.P.40	Mental health system IT improvement	DOHMH	1	1	0	1	0	0	0	0	1	1	1	1	0	1	1	1	0	1
MH.P.41	Mental health system power backup	DOHMH	1	1	0	0	-1	0	0	-1	1	1	1	1	0	1	1	1	-1	0

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MH.P.42	Mental health system support network	DOHMH	1	1	1	0	0	0	0	0	1	1	1	1	0	1	1	0	0	1
MH.P.43	Mental health volunteer preparedness and response	DOHMH	1	1	1	0	0	0	0	0	1	1	1	1	0	1	1	1	0	1
MH.P.44	DOHMH IT systems protection	DOHMH	1	0	0	1	0	0	0	-1	1	1	1	1	0	1	1	0	0	1
MH.P.45	DOHMH primary data center availability	DOHMH	1	0	0	1	0	0	0	0	1	1	1	1	0	1	1	0	0	1
MH.P.46	Riverside clinic upgrade	DOHMH	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	1	0	0	1
MH.P.47	DOHMH warehouse and print shop capacity	DOHMH	1	0	0	1	0	0	0	0	1	1	1	1	0	1	1	1	0	1
MH.P.48	Health data and provider portal	DOHMH	1	1	0	1	0	0	0	-1	1	1	1	1	0	1	1	0	0	1
MH.P.49	Enhanced emergency response communication operations at DOHMH headquarters	DOHMH	1	0	1	1	0	0	0	0	1	0	1	1	0	1	1	-1	0	1
MH.P.5	Generators for	DOHMH	1	1	1	0	0	0	0	-1	1	1	1	1	0	1	0	-1	-1	0

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0	healthcare facilities																			
MH.P.5 1	Small grants program to support community-based social cohesion	DOHMH	1	1	1	1	1	0	-1	0	1	1	0	-1	-1	1	0	0	0	0
MH.P.5 2	"Hub the Hood" program	DOHMH	1	1	1	1	1	0	0	0	1	1	0	-1	-1	1	0	0	0	0
MH.P.5 3	DOHMH facility repair and upgrade	DOHMH	1	1	1	1	1	-1	-1	-1	1	1	0	-1	-1	1	-1	-1	0	0
MH.P.5 4	Notification system for City employees	DoITT	1	1	1	1	0	0	-1	-1	1	1	1	1	1	1	-1	0	0	0
MH.P.5 5	Hardening of NYCWiN network	DoITT	1	1	1	1	0	0	-1	-1	1	1	1	1	1	1	-1	0	0	0
MH.P.5 6	Data Center Site B	DoITT	1	1	1	1	0	0	-1	-1	1	1	1	1	1	1	-1	0	0	0
MH.P.5 7	Secure HAZMAT at DOT facilities	DOT	1	1	1	1	0	-1	0	0	1	1	1	1	1	1	0	0	1	1
MH.P.5 8	Redundant power for all mission-critical DOT sites	DOT	0	0	1	1	1	1	-1	1	1	0	1	1	1	1	1	-1	0	0
MH.P.5 9	Continuity of Operations sites	DOT	1	1	1	1	1	-1	-1	-1	1	1	0	0	-1	1	-1	-1	0	0
MH.P.6 0	Information tracking	DOT	0	0	1	1	1	1	0	-1	1	0	1	1	1	1	1	0	0	0

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MH.P.6 1	High-reflectivity pavements	DOT	1	1	1	1	1	-1	-1	-1	1	1	0	0	-1	1	-1	0	0	0
MH.P.6 2	Critical facility loss estimation	DOT	1	0	1	1	1	0	-1	0	1	-1	0	0	-1	1	0	0	0	1
MH.P.6 3	Staten Island Ferry fleet upgrade	DOT	1	1	1	1	1	0	-1	0	1	1	0	0	0	1	-1	-1	0	0
MH.P.6 4	Staten Island Ferry vessel improvement	DOT	1	0	1	1	1	0	-1	0	1	1	0	-1	-1	1	-1	0	0	0
MH.P.6 5	COOP trailer compound	DSNY	1	1	1	1	1	-1	-1	-1	1	1	0	0	0	1	-1	0	0	0
MH.P.6 6	Industrial property upgrades	EDC/BNYDC	1	1	1	1	1	1	-1	-1	1	1	1	1	1	1	1	-1	1	1
MH.P.6 7	Hardening Staten Island Ferry and private ferry terminals from climate change-related threats	EDC	1	1	1	1	1	-1	-1	-1	1	-1	0	0	-1	1	-1	-1	1	1
MH.P.6 8	Construction of new ferry landings to support private ferry services	EDC	1	0	1	1	1	-1	-1	-1	1	1	0	0	-1	1	-1	-1	0	0
MH.P.6 9	Waterfront fueling facilities	EDC	1	0	1	1	1	-1	-1	-1	1	1	0	0	-1	1	-1	-1	0	0

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MH.P.70	Mobile/portable ferry ticketing machines	EDC	1	1	1	1	1	0	-1	-1	1	1	0	0	0	1	-1	-1	0	0
MH.P.71	Use of the Staten Island Ferry's Austen Class vessels for East River Ferry service during weather-related storm disruptions	EDC/DOT	1	1	1	1	1	-1	0	-1	1	1	0	0	-1	1	-1	-1	0	1
MH.P.72	Storm shutters project	FDNY	1	0	1	1	0	1	-1	1	1	1	1	1	0	1	0	-1	0	1
MH.P.73	Backup communications carrier	FDNY	1	0	1	1	1	1	-1	-1	1	1	1	1	0	1	-1	-1	0	0
MH.P.74	Voice-over IP architecture	FDNY	1	0	1	1	1	0	-1	0	1	1	0	-1	-1	1	-1	0	0	0
MH.P.75	Next-generation satellite phones	FDNY	1	1	1	1	1	0	-1	-1	1	1	0	1	1	1	-1	-1	0	0
MH.P.76	FDNY facilities survey	FDNY	1	1	1	1	1	-1	0	0	1	1	0	0	0	1	-1	0	0	1
MH.P.77	DCOC cell phone coverage	FDNY	1	-1	1	1	1	0	-1	0	0	0	0	-1	-1	1	0	0	0	0
MH.P.7	FDNY cable network	FDNY	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	-1	0	0

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8																				
MH.P.79	Spare radios	FDNY	1	1	1	1	1	1	0	-1	1	1	1	1	0	1	-1	0	0	0
MH.P.80	Home-work plans	FDNY	1	1	1	1	1	1	0	1	-1	-1	-1	-1	-1	1	0	0	0	0
MH.P.81	Gas vendors	FDNY	1	1	1	1	-1	0	0	0	1	1	0	0	-1	1	0	0	0	0
MH.P.82	Cache of vaccinations	FDNY	1	0	1	1	1	1	1	1	1	1	0	-1	-1	1	-1	-1	0	0
MH.P.83	Urban search and rescue team	FDNY	1	1	1	1	1	-1	0	0	1	1	0	-1	0	1	1	0	0	0
MH.P.84	Coney Island Hospital HVAC	HHC	1	1	1	1	1	0	-1	-1	1	1	0	0	0	1	-1	-1	0	0
MH.P.85	Coney Island Hospital power pre-connections	HHC	1	1	1	1	1	0	-1	-1	1		0	0	0	1	-1	-1	0	0
MH.P.86	Metropolitan Hospital HVAC	HHC	1	1	1	1	1	0	0	-1	1	1	1	1	0	1	-1	0	0	0
MH.P.87	Metropolitan Hospital pre -connections	HHC	1	1	1	1	1	0	0	-1	1	1	1	1	0	1	-1	0	0	0
MH.P.88	Bellevue Hospital	HHC	1	1	1	1	1	0	0	-1	1	1	1	1	0	1	-1	0	0	0

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MH.P.89	Bellevue Hospital power pre-connections	HHC	1	1	1	1	1	0	0	-1	1	1	1	1	0	1	-1	0	0	0
MH.P.90	Central Office Emergency Command Center (ECC) and alternate ECC	HHC	1	1	1	1	1	0	0	-1	1	1	1	1	0	1	-1	-1	0	0
MH.P.91	Henry J. Carter Hospital improvements	HHC	1	1	1	1	1	0	-1	-1	1	1	1	1	0	1	-1	0	0	0
MH.P.92	Outreach to residential building owners	HPD	1	1	1	1	1	-1	-1	-1	1	1	0	0	-1	1	-1	0	0	0
MH.P.93	Flood protection for critical facilities.	HRA	1	1	1	1	1	-1	1	1	1	1	0	1	0	1	0	1	1	0
MH.P.94	Overhead electric infrastructure	LIPA	-1	-1	1	-1	-1	0	0	0	0	-1	0	-1	-1	0	-1	-1	0	0
MH.P.95	Storm damage mitigation	LIPA	-1	0	1	0	0	0	-1	-1	-1	-1	0	0	-1	0	-1	0	-1	0
MH.P.96	Exploration of loss-reduction actions for landmarked properties	LPC	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0
MH.P.97	Public education and outreach for	LPC	1	1	1	1	0	1	1	-1	1	1	0	1	1	1	0	1	0	0

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	landmarked buildings																			
MH.P.98	Marine Parkway/Cross Bay Bridge mitigation master plan	MTA (Bridges and Tunnels)	1	1	1	1	1	-1	0	0	1	1	1	1	0	1	0	0	0	0
MH.P.99	Engineering flood studies at non-tunnel facilities	MTA (Bridges and Tunnels)	1	0	1	1	1	0	-1	0	1	1	-1	-1	-1	1	-1	0	0	0
MH.P.100	Far Rockaway depot green roof	MTA (Buses)	1	1	1	1	1	1	1	-1	1	1	0	1	1	1	1	1	1	1
MH.P.101	Hazards/threats planning	MTA (MNR)	1	1	1	1	1	-1	0	0	1	1	1	1	0	1	0	0	0	0
MH.P.102	Fueling capabilities/backup for emergency response	MTA (MNR)	1	1	1	1	1	-1	0	0	1	1	1	1	0	1	0	0	0	0
MH.P.103	Penn Station access	MTA (MNR)	1	1	1	1	-1	1	1	-1	1	1	0	1	1	1	-1	1	0	0
MH.P.104	Harlem-125 Street Station improvements	MTA (MNR)	1	1	1	1	-1	1	1	-1	1	1	1	1	1	1	0	0	0	0
MH.P.105	Emergency management equipment	MTA/LIRR	1	0	1	1	0	1	1	1	1	1	1	1	0	1	-1	-1	-1	1

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MH.P.106	NYCHA grounds, pavements, and drainage improvements	NYCHA	1	1	1	1	1	-1	1	-1	1	1	0	1	1	1	1	1	1	1
MH.P.107	Category 4 distributed power-generation feasibility studies	NYCHA	1	1	1	1	1	-1	0	0	1	1	0	1	1	1	-1	-1	0	0
MH.P.108	Morrisania Air Rights	NYCHA	-1	-1	1	1	-1	-1	0	-1	-1	-1	1	1	1	1	-1	-1	0	0
MH.P.109	NYCHA AC improvements	NYCHA	1	1	1	0	-1	-1	1	-1	1	1	0	1	1	1	0	0	-1	0
MH.P.110	NYPD precinct facility protection	NYPD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	-1	0	0
MH.P.111	NYPD facility protection	NYPD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	-1	0	0
MH.P.112	NYPD critical facilities protection	NYPD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	-1	0	0
MH.P.113	OCME unified agency command enter	OCME	1	0	1	-1	1	1	1	1	1	1	0	1	1	1	1	1	0	0
MH.P.114	Educational outreach to private sector	OEM	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	0	-1	0	0
MH.P.115	OEM facilities protection	OEM	1	0	1	1	1	1	-1	-1	1	1	0	1	1	1	0	-1	0	0

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MH.P.116	HAZUS-MH software	OEM	1	0	1	1	1	1	1	1	1	1	0	1	1	1	-1	-1	1	0
MH.P.117	Community Emergency Response Team (CERT) Curriculum	OEM	1	1	1	1	0	1	1	-1	1	1	0	1	1	1	1	1	0	0
MH.P.118	Infrastructure systems modeling	OEM	1	1	1	-1	1	1	1	1	1	1	1	1	-1	1	0	-1	-1	1
MH.P.119	Loss estimation	OEM	1	0	1	-1	0	1	-1	1	1	1	0	1	1	1	0	-1	0	0
MH.P.120	Natural hazard event database	OEM	1	0	1	-1	0	1	1	1	1	1	0	1	1	1	0	1	0	0
MH.P.121	CERT collaboration with community groups	OEM	1	-1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0
MH.P.122	Ready New York update	OEM	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0
MH.P.123	Public/private mitigation initiatives	OEM	1	0	1	1	1	1	-1	-1	1	1	0	1	1	1	0	-1	1	0
MH.P.124	Regional critical infrastructure mapping	OEM	1	0	1	-1	0	1	-1	-1	1	1	0	1	1	1	0	-1	0	0
MH.P.125	Subway depths mapping:	OEM	-1	0	1	-1	0	1	-1	1	1	1	0	1	-1	1	0	-1	0	0

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MH.P.126	Vegetation data	OEM	-1	0	1	-1	0	1	-1	1	1	1	0	1	-1	1	0	-1	0	0
MH.P.127	Zoning for hazard-prone areas	OEM	1	1	1	1	1	1	-1	-1	1	1	0	1	-1	1	0	-1	1	1
MH.P.128	Mitigation public outreach	OEM	1	1	1	1	1	-1	-1	-1	1	1	1	1	1	1	0	-1	1	1
MH.P.129	Emergency Operations Center (EOC)	OEM	1	0	1	1	1	1	-1	-1	1	1	0	1	1	1	-1	-1	0	0
MH.P.130	OEM Warehouse	OEM	1	1	1	1	1	1	1	-1	1	1	0	1	1	1	1	1	0	0
MH.P.131	New York City mitigation guide and education	OEM	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	-1	1	1
MH.P.132	Building community capacity	OEM	1	1	1	-1	0	-1	-1	-1	1	1	0	1	1	1	1	0	0	0
MH.P.133	Urban Post-Disaster Housing site identification in New York City	OEM	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1
MH.P.134	Executive decision-making guide for deployable post-disaster housing	OEM	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1

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			Social		Technical			Administrative			Political		Legal			Economic			Environment	
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MH.P.135	Request for Proposal for Urban Post-Disaster Housing	OEM	1	1	1	1	1	1	1	0	1	1	0	1	0	1	1	-1	0	1
MH.P.136	Storm shutter protection at OEM headquarters	OEM	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	1	-1	0	1
MH.P.137	NYC Brownfield Incentive Grant (BIG) program	OER	1	1	1	1	1	-1	-1	1	1	1	1	1	1	1	1	-1	1	1
MH.P.138	Fuel advance warning system	PANYNJ (Aviation)	1	0	1	-1	0	1	1	1	1	1	1	1	1	1	1	1	0	0
MH.P.139	Kennedy Airport electrical system resiliency	PANYNJ(Aviat.)	1	1	1	1	1	1	1	-1	1	1	1	1	1	1	0	-1	0	0
MH.P.140	LaGuardia Airport central electric substation	PANYNJ(Aviat.)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	0	0
MH.P.141	LaGuardia Airport electrical system enhancement	PANYNJ(Aviat.)	1	1	1	-1	1	1	1	-1	1	1	1	1	1	1	-1	-1	0	0
MH.P.142	LaGuardia Airport power system redundancy	PANYNJ(Aviat.)	1	1	1	-1	1	1	1	-1	1	1	1	1	1	1	-1	-1	0	0

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MH.P.143	Kennedy Airport power system redundancy	PANYNJ(Aviat.)	1	1	1	-1	1	1	1	-1	1	1	1	1	1	1	-1	-1	0	0
MH.P.144	Stewart Airport standby emergency generator	PANYNJ(Aviat.)	1	1	1	-1	1	1	1	-1	1	1	1	1	1	1	1	-1	0	0
MH.P.145	Stewart Airport power system redundancy	PANYNJ(Aviat.)	1	1	1	-1	1	1	1	-1	1	1	1	1	1	1	1	-1	0	0
MH.P.146	Kennedy Airport fuel storage	PANYNJ(Aviat.)	1	1	1	1	-1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1
MH.P.147	Intelligent Transportation System (ITS) program at Kennedy and Newark Airports	PANYNJ(Aviat.)	1	1	1	-1	1	1	1	1	1	1	1	1	1	1	-1	-1	0	0
MH.P.148	Emergency generator capacity for Red Hook and Howland Hook container terminals	PANYNJ(Ports)	1	1	1	-1	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1
MH.P.149	Lincoln Tunnel electrical and power system improvements	PANYNJ(TBT)	1	1	1	1	1	1	1	-1	1	1	1	1	1	1	-1	-1	0	0

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MH.P.150	George Washington Bridge (GWB) electrical and power system improvements	PANYNJ(TBT)	-1	1	1	1	-1	1	1	-1	1	1	1	1	1	1	-1	-1	-1	0
MH.P.151	GWB tower transformers	PANYNJ(TBT)	1	1	1	1	1	1	1	-1	1	1	1	1	1	1	1	-1	0	0
MH.P.152	Multi-facility real-time traffic information software	PANYNJ(TBT)	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	0	0
MH.P.153	Intelligent Transportation System (ITS) program	PANYNJ(TBT)	0	0	1	1	1	1	-1	0	1	1	1	1	1	1	-1	-1	0	0
MH.P.154	Green roofs on Parks buildings	Parks	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	1	-1	1	1
MH.P.155	Green Streets	Parks	1	1	1	1	1	1	1	-1	1	1	0	1	1	1	1	1	1	1
MH.P.156	Wetlands and other land in a natural state	Parks	1	1	1	1	1	1	-1	-1	1	1	0	0	-1	1	-1	-1	1	1
MH.P.157	Seawall, pier, and marina structural repairs	Parks	1	1	1	1	1	1	1	-1	0	0	-1	-1	1	1	1	1	-1	0
MH.P.158	Upgrades to Parks buildings' systems	Parks	1	1	1	1	0	1	-1	-1	1	1	1	1	1	1	0	0	1	1

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MH.P.159	SBS outreach.	SBS	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	0	0	0	0
MH.P.160	Toolkit and training materials for city volunteer groups	SBS	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	0	0	0	0
MH.P.161	Small business outreach	SBS	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	0	0	0	0
MH.P.162	Hazard mitigation education for businesses	SBS	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	0	0	0	0
MH.P.163	Ready New York materials	SBS	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	0	0	0	0
MH.P.164	Toolkit and training materials for BIDs and LDCs on mitigation best practices	SBS	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	0	0	0	0
MH.P.165	Hazardous mitigation seminar for BIDs and LDCs	SBS	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	0	0	0	0
MH.P.166	Dissemination of hazard information	SBS	1	1	1	1	1	1	-1	-1	1	1	0	1	1	1	0	0	0	0
MH.P.167	Rockaway Reformulation Study	USACE/NYSDEC	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	-1	1	1

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MH.P.168	T-groins at Coney Island	USACE/NYSDEC	1	1	1	1	1	1	1	-1	1	1	1	1	1	1	0	-1	1	1
Severe Weather																				
SW.P.1	Protection of NYCDOT facilities from high winds	DOT	1	1	1	1	1	0	0	-1	1	1	-1	-1	-1	1	0	0	0	0
SW.P.2	Sign inspection program	DOT	0	0	1	1	1	1	-1	1	1	0	1	1	1	1	1	-1	0	0
SW.P.3	Rooftop equipment protection at HRA facilities	HRA	1	1	1	1	0	-1	0	-1	1	1	-1	-1	1	1	0	0	0	0
SW.P.4	Increased line clearance tree trim program	LIPA	-1	-1	1	1	0	-1	0	-1	1	1	1	1	1	1	0	0	1	1
SW.P.5	Bridge reinforcement	MTA (Bridges and Tunnels)	1	1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	-1	1	0	0
Winter Weather																				
WS.P.1	Improved Snow & Ice Melt	DOT	-1	0	1	1	-1	0	-1	-1	1	-1	1	1	-1	1	-1	-1	1	1
WS.P.2	Public Outreach	OEM	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1

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ii. Previous Mitigation Projects

Below is a narrative overview of select mitigation actions. This provides additional information beyond the STAPLEE analysis and explains the many considerations that are applied to each project identified in the HMP.

1. **Prevention and Policy** - **The Flood Resilience Zoning Text Amendment** (Capability Assessment and FP.4)

- **Original Problem**
  - Coastal storms and flooding events have repetitively damaged buildings along the coastline of New York City. In 2012, Hurricane Sandy flooded an area that included approximately 88,700 buildings; of these, according to Department of Buildings (DOB) inspections, 82,000 were identified as having some form of damage. Since owners are required to comply with flood-resistant construction standards when they rebuild if their properties are more than 50% damaged, many of the zoning regulations made it difficult for owners to rebuild after Sandy.
- **Project Description**
  - The Flood Resilience Zoning Text Amendment encourages flood-resilient building construction throughout designated flood zones. The amendment removes regulatory barriers that would hinder or prevent the reconstruction of storm-damaged properties. It also enables new and existing buildings to comply with new, higher flood elevations issued by FEMA in addition to new requirements in the New York City Building Code. The text amendment became effective after a vote by City Council on October 9, 2013.
  - Project Cost - Staff time at the Department of City Planning (DCP)
- **Social, political, and environmental considerations**
  - *Social*
    - There is public support for the text amendment by homeowners so that they are permitted to rebuild homes to be flood-resistant.
    - Constraints: New York City's dense urban environment may make it difficult to implement flood-proofing strategies in denser neighborhoods.
  - *Political*
    - The text amendment was a recommendation identified in *A Stronger, More Resilient New York*, which is a City document with mayoral support.
    - Mayor Bloomberg issued a temporary executive order to allow property owners rebuilding after Sandy to meet updated Federal Emergency Management Agency (FEMA) flood standards.
  - *Environment*
    - The amendment facilitates adaptation to a changing environment.

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        - The amendment facilitates the replacement of existing buildings at slightly higher elevations, with few new environmental impacts.

2. **Property Protection** – **Building Code Update** (FE.14)
   - **Original Problem**
     - Buildings in New York City are often damaged during coastal storms and flooding events. For example, many of the buildings damaged by Sandy were built prior to 1983 and thus were constructed to codes and standards that did not incorporate flood resistance.
     -
   - **Project Description**
     - On January 31, 2013, the New York City Building Code was updated to match New York State standards for flood protection. The update will help protect newly constructed buildings because it incorporates the latest flood-resistant building requirements and references the Flood Insurance Rate Maps that are based on most recent data.
     - The update requires new and substantially improved buildings in the 100-year floodplain to protect to a level one or two feet higher than the FEMA-designated flood elevation, depending on building type. Single- and two- family homes are now required to provide two feet of extra protection above flood elevation, and most other buildings are required to provide a foot of freeboard.
     - Project Cost - Staff time at DOB
   - **Social, political, and environmental considerations**
     - *Social*
       - The Building Code update will help New Yorkers limit the cost of future federal flood insurance premiums by ensuring flood zone compliance, better protect properties in flood-prone areas from risk and damage, and reduce the likelihood of housing displacement in the future.
     - *Political*
       - The Building Code update ensures homeowners are in compliance with FEMA flood-resistant construction standards and allows New York City to continue to be eligible to participate in the National Flood Insurance Program.
     - *Environmental*
       - The building code update facilitates adaptation to a changing environment.

3. **Infrastructure Projects – Expansion of the Bluebelt Program** (MH.E.13)

   - **Original Problem**

- Periods of heavy rainfall can lead to excess stormwater causing flood-related damage to property.

- **Project Description**
  - The Bluebelt Program, which was launched in Staten Island in the early 1990s, makes use of natural drainage corridors including streams, ponds, and other wetland areas to manage stormwater. More specifically, Bluebelt systems perform the function of conveying, storing, and filtering stormwater. This system has saved millions of dollars by relying on sustainable solutions and reducing the need to build traditional sewer systems.
  - Since the program's inception, the City has acquired 325 acres of wetland property. Furthermore, it has provided effective stormwater management for more than 14,000 acres of Staten Island. While the City continues to build out the Bluebelt in Staten Island, it is also applying the Bluebelt concept in other parts of the city. For instance, in July 2011, the City expanded the bluebelt program to Oakland Lake Park in Queens. In 2012, the City completed construction of the first bluebelt in the Bronx at the New York Botanical Garden.
  - *Project Cost:* Millions of dollars have been spent in Staten Island and continue to be spent as the City extends the system both in Staten Island and to other boroughs.
- **Social, political, and environmental considerations**
  - *Social*
    - Bluebelt systems help reduce street flooding, raise property values, improve water quality for recreation, and provide attractive open spaces for the community.
  - Political
    - Bluebelt systems decrease the financial impacts on the local tax base by relying on natural systems instead of costly "grey" infrastructure (traditional sewer systems).
    - Expanding the Bluebelt Program is a strategy identified in *PlaNYC*, *Vision 2020: New York City Comprehensive Waterfront Plan*, and *A Stronger, More Resilient New York*—all City documents with mayoral support.
  - Environment
    - Bluebelt systems enhance the environment by protecting natural eco-systems, restoring natural habitats, and maintaining natural floodplains. The Bluebelt Program is a sustainable system that allows for adaptation to climate change.

4. Emergency Services – Notify NYC (part of MH.E.98)

- **Original Problem**

- Communicating emergency information to New York City residents is an essential component in emergency management. But prior to Notify NYC, the City lacked a central system for communicating localized emergency information to city residents. Emergency information was distributed through press releases and/or press conferences or directly by emergency personnel on the street. Several incidents that occurred in 2007—such as tornadoes, a steam pipe explosion, a major fire, and crane collapses—prompted the City to look for ways to quickly provide New Yorkers emergency information.

- **Project Description:**
  - In May 2009, New York City created a dedicated emergency notification program, Notify NYC, operating out of the Office of Emergency Management (OEM). Notify NYC staff work in OEM Watch Command, where they constantly monitor emergency activity in New York City and the larger metropolitan area. Notify NYC communicates localized emergency information quickly to city residents. This alert system includes the following types of notifications: emergency alerts, significant event notifications, public heath notifications, Public School Closing/Delay Advisories, unscheduled parking rules suspensions, and combined sewer overflow notifications.
  - Since its inception, Notify NYC has sent out thousands of notifications about local emergencies. In addition, more than 180,000 people receive information directly.
- **Social, political, and environmental considerations**
  - *Social*
    - The Notify NYC service is available to the general public by signing up via the OEM website.
  - *Political*
    - There is political acceptance for disseminating emergency information to the public.
  - *Environmental*
    - There is no significant adverse effect on the environment.

5. **Coastal/Natural Resource Protection** – **Wetlands Restoration and Creation** (FE.5)

- **Original Problem**
  - Although much of New York City's original waterfront consisted of wetlands, over the past century many of the wetlands have been overtaken by development or degraded due to human modifications to natural systems, industrial pollution, and changes to water and sediment quality.

- **Project Description**

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- To protect existing wetlands, which improve water quality and aid in the retention of stormwater, the City has designated three Special Natural Waterfront Areas (SNWAs): Northwestern Staten Island, Jamaica Bay, and the East River-Long Island Sound area. The Waterfront Revitalization Program helps protect and restore the SNWAs by prioritizing both public and private actions.
- Over the past 20 years, the City has completed or planned restoration projects on 69 acres of salt marsh and 18 acres of freshwater marsh. Some of these projects are in connection with the construction of recent CSO detention facilities. For example, at Alley Pond Park in Queens, the city recently completed 16 acres of restoration to revive the local ecosystem and improve water quality.
- The City's work with state and federal partners has resulted in over 175 acres of restored or enhanced wetlands since 2002.
- *Project cost:* Working with state and federal partners, the city has invested over $74 million to restore wetlands since 2002.

- **Social, political, and environmental considerations**:
  - *Social*
    - Restoring and creating wetlands offers a variety of social benefits, including improving water quality for recreation, protecting properties from storm surge, and creating attractive environments for community use.
  - *Political*
    - Restoring and creating wetlands is a strategy identified in *PlaNYC* and aligns with strategies put forth in *Vision 2020: New York City Comprehensive Waterfront Plan* and *A Stronger, More Resilient New York*—all City documents with mayoral support.
  - *Environment*
    - Preserving and enhancing the city's valuable wetlands improves the city's natural environment, provides habitats for diverse wildlife, and aids in reducing the impacts of coastal erosion.

6. Education and Awareness - Ready New York Campaign (MH.E.103)

- **Original Problem**
  - If New Yorkers are not aware of hazards and prepared for hazard events, they may be at greater personal risk.

- **Project Description**

  - The Ready New York campaign, launched in 2003 and expanded every year, encourages New Yorkers to be ready for all types of emergencies. Geared to

both the public and private sectors, it provides instruction on how to develop a disaster plan, how to gather emergency supplies, and how to keep informed about the hazards that may occur in New York City. In 2013 the program participated in over 1,000 events, providing a variety of presentations and maintaining a presence at a range of resource fairs across the city. Ready New York also publishes a dozen guides and workbooks and has produced several informational DVDs.

- *Project cost*: The budget is $2 million per year for staff, guide development, translation, printing, and related costs.

- **Social, political, and environmental considerations**
  - *Social*
    - Government agencies (NYS and NYC), community boards, houses of worship, schools (elementary through senior high), senior centers, social service agencies, private non-profits, grassroots organizations, large and small businesses, organized labor, and many other groups request OEM to do Ready New York presentations.
    - The campaign makes a strong effort to reach all populations, including seniors, youth (and their households), people with special needs, immigrant populations and communities with limited English proficiency, low-income New Yorkers, and university/college students. Brochures and materials are available in as many as 23 languages for 2013.

  - *Political*
    - There is local, state, and federal support for emergency preparedness education.

      1. The Ready New York campaign facilitated National Preparedness Month in New York City during September 2013. OEM Commissioner Joseph Bruno and FEMA Administrator Craig Fugate hosted the kickoff event at the Staten Island Children's Museum.
  - *Environment*
    - This campaign has no adverse impact on the environment.

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4. Prioritization

The Planning Team developed a methodology for prioritizing the potential mitigation actions using the STAPLEE criteria and implementation critera presented above. By assigning a numerical value to each action based on a set of 10 criteria, the Planning Team was able to give each action a high, medium, and low ranking. (The Planning Team did not prioritize existing mitigation actions because they have already secured funding and have been scheduled for implementation.)

A. Methodology

The Planning Team established 10 criteria: The first seven criteria are based on the STAPLEE analysis; the remaining three are based on: (1) number of objectives the action meets, (2) projected costs, and (3) projected timeline. Each criterion was assigned a value of -1, 0, or 1. These values represent whether the criterion is unfavorable or negative (-1); neutral, not applicable, or moderate (0); or favorable or positive (1).

1. Project Timeline	2. Project Cost	3. Number of objectives the action meets
-1 = ≥ 10 yrs 0 = TBD, ongoing, ≥ 5 yrs to < 10 yrs 1 = ≤ 5 yrs	-1 = > $100 million 0 = TBD, > $10 million to < $100 million 1 = < $10 million	-1 = 1 objective 0 = 2 to 3 objectives 1= 4+ objectives

i) STAPLEE Criteria

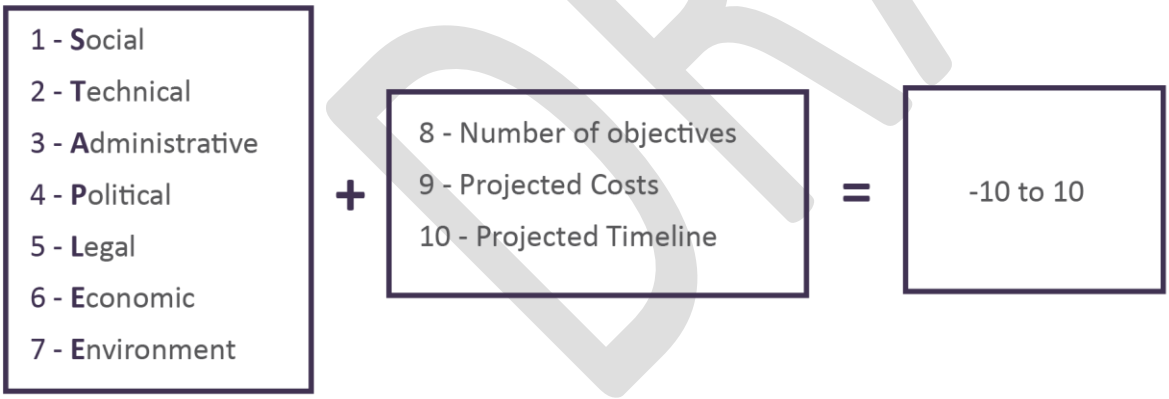
To determine the value of the seven STAPLEE criteria, the Planning Team assessed each of the 18 measures addressed in the STAPLEE analysis. For each criteria (social, technological, administrative, political, legal, economic, and environmental), two to three measures are taken into consideration. Table 7 shows how the planning team determined the criteria's overall value based on the number of –1s, 1s, or 0s assigned to the measures. For example, the administrative criterion has three measures: staffing, funding allocation, and maintenance/operations. If these three measures are given a value of 1, 1, and -1, the administrative criterion's overall value is a 1.

	Administrative (Measures)			Score
Mitigation Action	Staffing	Funding Allocation	Maintenance/ Operations	Final Score
Construction Code	1	1	0	1
Property Protection	-1	-1	1	-1
Public Outreach	0	1	-1	0

Table 7: Applying STAPLEE Criteria to Prioritization

ii) Implementation Criteria

For the three remaining criteria (number of objectives met, projected cost, and projected timeframe), the Planning Team evaluated the distribution of each criteria's values. Using this information, the Planning Team established quantifiable ranges for each criterion that met the parameters of the -1, 0, or 1 values.



Adding up the values of the 10 criteria was the next step in prioritizing the mitigation actions. The 161 potential mitigation actions received a cumulative value ranging from –10 to 10. These values were sorted in ascending order. Based on the overall value distribution, the Planning Team assigned a final prioritization value of "low" to actions with a final score of zero or lower because these actions have as many or more negative attributes as positive attributes. Actions with a final score of 1–5 were prioritized as "medium," while actions with a final score of 6–10 were prioritized as "high" because they have many positive attributes and few, if any, negative attributes. Table 8 presents the distribution of actions by final prioritization value. Clearly, these final prioritization values are determined from very general criteria, and additional information or data not included in this analysis could affect the prioritization results.

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Hazard	Priority Ranking			
	Low	Medium	High	Total
CBRN releases	0	3	4	***7***
Coastal erosion	0	3	0	***3***
Coastal storms	0	19	11	***31***
Cyber threats	0	2	0	***2***
Disease outbreaks	0	1	0	***1***
Drought	0	3	1	***4***
Earthquakes	0	3	5	***8***
Extreme temperatures	0	4	1	***5***
Flood	2	53	22	***78***
Infrastructure failures	1	7	12	***20***
Severe weather	0	4	1	***5***
Winter storms	0	1	1	***2***
Multi-Hazards*	5	109	51	***168***
Total	***8***	***212***	***111***	***334***

***** Although wildfires are not individually addressed by any actions, they are addressed by the multi-hazard actions.

Table 8: Summary of Mitigation Action Prioritization

B. Benefit-Cost Analysis for Specific Projects

A benefit-cost analysis (BCA) is a method for determining the potential positive effects of a specific mitigation action and comparing them to the cost of the action. To assess and demonstrate the cost-effectiveness of mitigation actions, FEMA has developed a suite of BCA software, including hazard-specific modules. Agencies seeking funding from one of FEMA's mitigation grant programs must perform a detailed BCA using this software for the submission of the grant application. OEM will assist agencies with this effort.

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Prioritization

Section IV: Mitigation Strategy

HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
CBRN														
CB.P.1	Construction Code revision	DOB	1	1	0	1	1	1	1	1	0	0	7	High
CB.P.2	Harlem River lift bridge	MNR	1	1	0	1	1	1	0	-1	0	0	4	Medium
CB.P.3	NYCHA fresh water supply	NYCHA	1	1	0	1	1	0	1	0	0	0	5	Medium
CB.P.4	Brownfield cleanup in the 100-year floodplain	OER	1	1	0	1	1	1	1	1	1	0	8	High
CB.P.5	Environmental research	OER	1	1	0	1	1	1	1	1	1	0	8	High
CB.P.6	BrownfieldWORKS!	OER	0	0	0	1	0	0	1	1	1	0	4	Medium
CB.P.7	Environmental Project Information Center (EPIC)	OER	1	1	0	1	1	0	1	1	1	0	7	High
Coastal Erosion														
CE.P.1	Protection of Rikers Island east, west, and south shorelines	DOC	1	1	0	1	1	1	0	0	0	0	5	Medium
CE.P.2	Beach restoration	Parks	1	0	0	1	1	0	0	0	0	0	3	Medium
CE.P.3	Renourishment of Orchard Beach, Bronx	USACE/NYC P&R	1	0	0	1	0	1	-1	1	1	0	4	Medium
Coastal Storms														
CS.P.1	Resilient	DCP	1	1	0	1	1	0	1	0	0	1	6	High

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	neighborhoods planning studies													
CS.P.2	DCP planning support and technical assistance for Sandy disaster recovery	DCP	1	1	0	1	1	0	1	0	0	0	5	Medium
CS.P.3	Emergency contracts	DDC	1	0	0	1	0	0	1	0	0	-1	2	Medium
CS.P.4	Hardening pumping stations	DEP	1	0	-1	1	1	0	0	0	-1	0	1	Medium
CS.P.5	Hardening wastewater treatment plants	DEP	1	1	1	1	1	0	1	0	-1	1	6	High
CS.P.6	Alternatives for Rockaway Wastewater Treatment Plant	DEP	1	0	0	0	1	0	0	1	-1	1	3	Medium
CS.P.7	VCBC mooring system and site access improvement	DOC	1	1	0	1	1	1	1	0	0	0	6	High
CS.P.8	Division I, II and III storehouse	DOC	1	0	-1	1	1	1	1	0	0	-1	3	Medium
CS.P.9	FDNY storehouse improvement	FDNY	1	1	0	1	1	0	1	0	0	0	5	Medium
CS.P.10	EMS Battalion	FDNY	1	0	0	1	1	0	1	0	0	0	4	Medium
CS.P.11	EMS fallback sites	FDNY	1	1	0	1	1	0	1	0	0	0	5	Medium
CS.P.12	FDNY emergency	FDNY	1	0	0	1	1	0	1	0	0	0	4	Medium

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	services													
CS.P.13	Outreach to residential building owners	HPD	1	0	1	1	1	0	1	1	1	1	8	High
CS.P.14	Resilient home design competition	HPD	1	0	0	1	1	1	1	0	0	0	5	Medium
CS.P.15	Bridge and tunnel improvements and study	MTA (Bridges and Tunnels)	1	0	-1	1	1	0	0	0	0	1	3	Medium
CS.P.16	Flood-hardening of vital communications, substations, transformers, mechanical equipment, revenue equipment, and other electronic systems at all MTA B&T facilities	MTA (Bridges and Tunnels)	1	0	-1	1	1	0	0	1	0	0	3	Medium
CS.P.17	Raising Governors Island seawall for Hugh L. Carey Tunnel	MTA (Bridges and Tunnels)	1	1	0	1	1	0	1	0	0	0	5	Medium
CS.P.18	Water-level monitoring/alarm systems/CCTV	MTA (MNR)	1	1	0	1	1	0	1	1	0	0	6	High

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CS.P.19	Power and communications/signal infrastructure mitigation	MTA (MNR)	1	0	0	1	1	0	1	1	0	0	5	Medium
CS.P.20	Hardening of vulnerable healthcare facilities	NYS DOH	1	0	0	1	1	0	1	1	1	0	6	High
CS.P.21	Protection of hurricane shelter windows	OEM	1	1	0	1	1	0	1	0	0	0	5	Medium
CS.P.22	Hazards U.S. Multi-Hazard (HAZUS-MH) modeling	OEM	1	0	1	1	1	0	1	1	0	0	6	High
CS.P.23	Backup power for evacuation centers	OEM	1	0	0	1	1	0	-1	1	0	0	3	Medium
CS.P.24	Storm shutters for the Emergency Operations Center	OEM	1	1	0	1	1	1	1	1	1	0	8	High
CS.P.25	Storm surge/tidal gauge real-time monitoring system	OEM	1	0	-1	1	1	0	1	0	0	-1	2	Medium
CS.P.26	Evacuation center/ hurricane shelter ADA retrofit program for DOE facilities	OEM	1	0	-1	1	0	0	1	1	0	0	3	Medium
CS.P.27	Updates to Urban Post-Disaster Interim	OEM	1	1	1	1	1	1	1	1	1	0	9	HIgh

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	Neighborhood Design Guidelines													
CS.P.28	Cleanup standards for waterfront brownfields	OER	1	1	0	1	1	1	1	1	1	1	9	High
CS.P.29	Building Code update for wind resiliency in new buildings	OLTPS	1	0	0	1	1	0	1	0	1	1	6	High
CS.P.30	Building Code update for wind resiliency in existing buildings	OLTPS	1	0	0	1	1	0	1	0	1	1	6	High
CS.P.31	Power exercises	USACE/NYCOEM/RCPT	1	0	0	1	1	1	1	0	0	0	5	Medium
Cyber Threats														
CY.P.1	Supplement IT Security	HRA	1	1	-1	1	1	-1	0	1	0	0	3	Medium
CY.P.2	Cyber-Security Strategy	MTA (MNR)	0	1	0	1	1	1	0	0	1	0	5	Medium
Disease Outbreaks														
DO.P.1	Pandemic Planning	MTA (MNR)	1	1	1	1	1	0	0	0	0	0	5	Medium
Drought														
D.P.1	Maximizing capacity for water delivery from the Catskill/Delaware system	DEP	1	1	-1	1	1	0	1	-1	-1	0	2	Medium

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Prioritization

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
D.P.2	Catskill Aqueduct capacity	DEP	1	1	-1	1	1	0	1	0	-1	0	3	Medium
D.P.3	Construction Code revision	DOB	1	1	1	1	1	1	1	1	0	0	8	High
D.P.4	Drought effects monitoring	FDNY	0	1	-1	1	1	1	1	0	0	0	4	Medium
Earthquakes														
EQ.P.1	Mechanical equipment seismic upgrade	DCAS	1	1	1	1	1	1	0	0	1	0	7	High
EQ.P.2	Seismic protection for sewers	DEP	1	1	1	1	1	1	1	0	0	0	7	High
EQ.P.3	Seismic inspection and retrofit for drinking water distribution system	DEP	1	1	1	1	1	1	1	0	0	1	8	High
EQ.P.4	Seismic study and retrofit for tall buildings	DOE	1	1	0	1	1	1	0	0	0	1	6	High
EQ.P.5	Building upgrades to seismic codes	HHC	1	1	-1	1	1	-1	0	1	0	0	3	Medium
EQ.P.6	HPD facility improvement	HPD	1	1	-1	1	1	-1	0	1	0	0	3	Medium
EQ.P.7	UPACA (Site 6)	NYCHA	1	1	-1	1	1	1	0	0	0	0	4	Medium
EQ.P.8	HAZUS-MH modeling	OEM	1	1	1	1	0	1	0	1	0	0	6	High
Extreme Temperatures														
ET.P.1	Power redundancy	DCAS	1	0	0	1	1	1	0	0	0	0	4	Medium

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	in City-owned buildings													
ET.P.2	AC upgrade for senior centers	DFTA	1	0	0	1	1	0	0	1	0	0	4	Medium
ET.P.3	AC availability and affordability	DOHMH	1	0	0	1	0	0	-1	0	0	0	1	Medium
ET.P.4	Urban heat island effect mitigation	DOHMH	1	1	0	1	0	0	1	1	1	0	6	High
ET.P.5	Cooling centers	NYCHA	1	0	0	1	1	0	-1	0	0	0	2	Medium
Flooding														
F.P.1	Flooding Prevention	DCAS	1	1	1	-1	0	1	0	0	0	0	3	Medium
F.P.2	Infrastructure flood protection	DCAS	1	1	-1	0	1	0	1	0	0	0	3	Medium
F.P.3	Flood Resilient Building Design Manual	DCP	1	1	1	1	1	1	1	1	0	1	9	High
F.P.4	Zoning for flood-resistant construction, Phase I and II:	DCP	1	1	1	1	1	1		1	0	0	7	High
F.P.5	Ecologically sensitive industrial area planning	DCP	1	1	1	1	1	1	1	0	0	0	7	High
F.P.6	Croton Falls pump station rehabilitation	DEP	1	1	-1	1	0	0	1	1	0	0	4	Medium

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
F.P.7	Bergen Basin and Tallman Island Wastewater Treatment Plant drainage upgrades	DEP	1	1	-1	1	0	1	1	0	-1	0	3	Medium
F.P.8	Server capacity improvements	DFTA	1	1	0	1	1	0	0	1	1	0	6	High
F.P.9	DHS electrical improvements	DHS	1	1	0	1	1	0	0	0	0	0	4	Medium
F.P.10	Borden Avenue facility	DHS	1	1	0	1	1	0	-1	0	0	0	3	Medium
F.P.11	Data system upgrade	DOB	1	1	1	1	1	1	1	1	0	0	8	High
F.P.12	Rikers Island roadway regrading	DOC	1	1	0	1	1	0	0	0	1	0	5	Medium
F.P.13	Water infiltration prevention	DOHMH	0	1	0	0	1	0	0	1	1	0	4	Medium
F.P.14	Flood-proofing 125 Worth Street vault	DOHMH	1	1	-1	1	1	-1	1	1	1	0	5	Medium
F.P.15	Permeable pavement	DOT	1	1	-1	1	1	1	1	0	0	1	6	High
F.P.16	Protection for the Manhattan 1,2, and 5 facility	DSNY	1	1	-1	1	1	0	1	1	0	0	5	Medium
F.P.17	Stapleton waterfront flood mitigation	EDC	1	1	0	1	1	0	1	1	0	0	6	Medium
F.P.18	Brooklyn Army Terminal passive	EDC	1	1	-1	1	1	0	1	1	1	0	6	High

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	flood barrier system													
F.P.19	EDC operations centers flood mitigation	EDC	1	1	-1	1	1	0	1	1	1	1	7	High
F.P.20	Flood effects reduction program	FDNY	1	1	-1	1	1	0	1	0	0	0	4	Medium
F.P.21	Dewatering pumps at FDNY facilities	FDNY	1	1	0	1	1	0	1	0	0	-1	4	Medium
F.P.22	New construction flood mitigation	FDNY	1	1	-1	1	1	0	1	0	0	0	4	Medium
F.P.23	Coney Island Hospital flood-proofing	HHC	1	1	-1	0	1	0	0	0	0	1	3	Medium
F.P.24	Coney Island Hospital emergency department mitigation	HHC	1	1	-1	0	1	0	0	0	0	1	3	Medium
F.P.25	Coney Island Hospital/critical system protection	HHC	1	1	-1	0	1	0	0	0	0	1	3	Medium
F.P.26	Metropolitan Hospital	HHC	1	1	-1	0	1	0	0	0	0	1	3	Medium
F.P.27	Metropolitan Hospital	HHC	1	1	-1	0	1	0	0	0	0	1	3	Medium
F.P.28	Coler Hospital	HHC	1	1	-1	0	1	0	0	0	0	1	3	Medium
F.P.29	Coler Hospital	HHC	1	1	-1	0	1	0	0	0	0	1	3	Medium
F.P.30	Building flood	HRA	1	1	-1	1	1	0	0	1	0	1	5	Medium

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	protection													
F.P.31	Portable generators	HRA	1	1	-1	1	1	0	0	1	1	0	5	Medium
F.P.32	Substation mitigation	LIPA	1	1	-1	1	1	0	0	1	0	0	4	Medium
F.P.33	Water-balance study	MTA (NYCT-Subway)	1	1	-1	1	1	0	0	0	0	0	3	Medium
F.P.34	Double Track Main Line, Phase 2	MTA/LIRR	1	1	-1	1	1	0	0	0	-1	0	2	Medium
F.P.35	Ventilation grate improvements	MTA/LIRR	1	1	-1	1	1	0	0	0	1	0	4	Medium
F.P.36	Long Island City Yard protection	MTA/LIRR	1	1	-1	1	0	1	0	0	0	0	3	Medium
F.P.37	Safeguarding of basement/cellar equipment	NYCHA	1	1	-1	1	1	0	0	1	1	0	5	Medium
F.P.38	New NYCHA building or development	NYCHA	-1	1	-1	-1	-1	-1	-1	0	0	0	-5	Low
F.P.39	NYCHA floodgates and barriers	NYCHA	1	1	-1	1	1	0	0	1	0	0	4	Medium
F.P.40	NYCHA boiler rooms and electrical equipment	NYCHA	1	1	-1	1	0	0	0	1	0	0	3	Medium
F.P.41	Sump pump protection	NYPD	1	1	-1	1	1	0	0	0	0	0	3	Medium
F.P.42	Building electrical protection	NYPD	1	1	-1	1	0	0	0	0	0	1	3	Medium
F.P.43	Boiler protection	NYPD	1	1	-1	1	1	0	0	0	0	1	4	Medium

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F.P.44	Short-term flood mitigation of OCME emergency management storage facility at 18th Street and FDR Drive	OCME	1	1	-1	1	1	0	0	0	1	1	5	Medium
F.P.45	Flood mitigation measures for New York City's backup Emergency Operations Center	OEM	1	1	-1	1	1	0	0	1	0	0	4	Medium
F.P.46	HAZUS-MH modeling	OEM	0	1	-1	1	1	0	0	1	0	0	3	Medium
F.P.47	National Flood Insurance Program (NFIP) Community Rating System	OEM	1	1	0	1	1	0	0	0	0	0	4	Medium
F.P.48	Public information and guidance	OEM	1	1	0	1	1	1	0	0	0	1	6	High
F.P.49	Outreach and education for owners of Severe Repetitive Loss properties	OEM	1	1	0	1	0	1	0	0	0	1	5	Medium
F.P.50	Local storm surge barrier for Gowanus Canal	OLTPS	1	1	0	1	1	0	1	0	1	0	6	High

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F.P.51	Plan for flood protection along the Williamsburg, Greenpoint, and Long Island City coastlines	OLTPS	1	1	-1	1	1	1	1	0	1	0	6	High
F.P.52	Floodgate repairs at Oakwood Beach, Staten Island	OLTPS	1	1	-1	1	1	-1	0	0	1	0	3	Medium
F.P.53	Primary and secondary dune systems in Rockaway Peninsula	OLTPS	1	1	1	1	1	1	1	0	0	0	7	High
F.P.54	Offshore breakwaters adjacent to and south of Great Kills Harbor	OLTPS	1	1	1	1	1	1	1	0	-1	0	6	High
F.P.55	Flood protection in Hunts Point	OLTPS	1	1	-1	1	1	-1	1	0	-1	0	2	Medium
F.P.56	Flood protection in East Harlem	OLTPS	1	1	-1	1	1	-1	1	0	-1	1	3	Medium
F.P.57	Lower Manhattan flood protection	OLTPS	1	1	-1	1	1	-1	1	0	-1	1	3	Medium
F.P.58	Integrated Flood Protection System for Red Hook	OLTPS	1	1	-1	1	1	1	1	0	-1	0	4	Medium
F.P.59	Protection of Farragut substation	OLTPS	1	1	0	1	1	1	1	0	1	0	7	High

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F.P.60	Newtown Creek flood protection	OLTPS	1	1	1	1	0	1	1	0	-1	1	6	High
F.P.61	Flood protection research	OLTPS	1	1	0	1	1	1	1	0	1	0	7	High
F.P.62	Prevention of drainage pipe flooding	OLTPS	1	1	0	1	1	1	1	0	0	0	6	High
F.P.63	Floodgate at Mill Creek	OLTPS	1	1	1	1	1	1	1	0	1	0	8	High
F.P.64	Community Rating System	OLTPS	1	1	0	1	1	1	1	0	1	0	7	High
F.P.65	Coney Island Creek wetlands and tidal barrier	OLTPS	1	1	0	1	0	1	1	0	1	0	6	High
F.P.66	Integrated flood protection for southern Manhattan	OLTPS	1	1	0	1	1	1	1	0	1	0	7	High
F.P.67	Flood protection of vital infrastructure at LaGuardia Airport	PANYNJ (Aviat.)	0	1	-1	1	0	-1	1	1	0	0	2	Medium
F.P.68	Flood protection of vital infrastructure at Kennedy Airport	PANYNJ (Aviat.)	0	1	-1	1	0	-1	1	1	0	0	2	Medium
F.P.69	Drainage improvements at Kennedy Airport	PANYNJ (Aviat.)	0	1	-1	1	0	-1	1	1	0	0	2	Medium
F.P.70	Protection of Kennedy Airport	PANYNJ (Aviation)	0	1	-1	1	0	-1	1	1	1	0	3	Medium

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	fuel farm tanks													
F.P.71	LaGuardia Airport dike wall	PANYNJ (Aviation)	0	1	-1	1	0	-1	1	1	1	0	3	Medium
F.P.72	Kennedy Airport sanitary lift station	PANYNJ (Aviation)	0	1	-1	1	0	-1	1	0	1	0	2	Medium
F.P.73	Kennedy Airport runway upgrade	PANYNJ (Aviation)	0	1	-1	1	0	-1	1	1	0	0	2	Medium
F.P.74	Kennedy Airport runway upgrade	PANYNJ (Aviation)	0	1	-1	1	0	-1	1	1	0	0	2	Medium
F.P.75	Improvements to George Washington Bridge anchorage drainage system	PANYNJ(TBT)	0	1	-1	1	0	-1	1	1	1	0	3	Medium
F.P.76	Flood-proofing at Olmsted site	Parks	0	1	0	0	-1	0	0	0	0	0	0	Low
F.P.77	Tidegate upgrade in Flushing Meadow Corona Park	Parks	1	1	1	1	1	1	1	0	1	0	8	High
Infrastructure Failures														
IF.P.1	Expansion of cogeneration	DEP	1	1	0	1	0	1	1	1	1	1	8	High
IF.P.2	Repair of the Delaware Aqueduct leak	DEP	1	1	1	1	1	1	1	0	-1	0	6	High
IF.P.3	Utilities on Buono Bridge	DOC	0	1	0	-1	1	0	0	0	-1	0	0	Low

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IF.P.4	Facility electrical power and data infrastructure upgrade	DOHMH	1	1	1	1	1	1	1	1	1	0	9	High
IF.P.5	DOHMH generators and retrofits	DOHMH	1	0	1	1	1	1	1	1	1	0	8	High
IF.P.6	Session Initiation Protocol (SIP)	DoITT	1	1	1	1	1	1	0	0	1	1	8	High
IF.P.7	Citywide IVR for employee announcements	DoITT	1	1	1	1	1	1	0	0	1	1	8	High
IF.P.8	Telecommunications Planning and Resiliency Office	DoITT	1	1	1	1	1	0	0	1	1	1	8	High
IF.P.9	IP routing network	DoITT	1	1	1	1	1	1	0	0	1	1	8	High
IF.P.10	Purchase of mobile substation	LIPA	1	1	1	1	1	0	0	1	1	0	7	High
IF.P.11	Purchase of mobile switchgear	LIPA	1	1	0	1	1	0	0	1	1	0	6	High
IF.P.12	Emergency generators in NYCHA properties	NYCHA	1	0	0	1	1	0	0	1	-1	0	3	Medium
IF.P.13	Stand-alone power generation in NYCHA developments	NYCHA	1	0	-1	1	1	-1	0	0	0	0	1	Medium
IF.P.14	Backup generators for Police	NYPD	1	0	1	1	1	0	0	0	0	0	4	Medium

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	Department facilities													
IF.P.15	Flood mitigation of 520 First Ave. (Manhattan Morgue) and Forensic biology building	OCME	0	0	1	1	1	0	0	0	0	1	4	Medium
IF.P.16	Kings and Queens facilities	OCME	0	0	1	1	1	0	0	0	0	0	3	Medium
IF.P.17	Generator assessment and installation of quick-connects for critical infrastructure	OEM	0	0	0	1	1	0	0	1	0	0	3	Medium
IF.P.18	Backup generators for gas stations and terminals	OEM	1	0	0	1	1	0	0	1	0	0	4	Medium
IF.P.19	Protection from utility service interruptions	OLTPS	1	1	0	1	1	0	1	0	1	0	6	High
IF.P.20	Distributed generation (DG) and micro-grids	OLTPS	1	1	1	1	1	1	0	0	1	0	7	High
Multi-Hazards														
MH.P.1	Overhead electric system improvements	Con Ed	1	0	0	1	0	0	1	1	-1	0	3	Medium

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Prioritization

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
MH.P.2	Underground electric system improvements	Con Ed	1	0	0	1	0	0	0	1	-1	0	2	Medium
MH.P.3	Gas system Improvements	Con Ed	1	0	0	1	0	0	0	1	-1	0	2	Medium
MH.P.4	Storm-hardening of critical facilities	Con Ed	1	0	0	1	0	0	1	1	-1	0	3	Medium
MH.P.5	Window upgrades	DCAS	1	1	0	1	1	1	1	-1	-1	0	4	Medium
MH.P.6	Retail resiliency study	DCP	1	0	0	1	1	0	0	1	0	-1	3	Medium
MH.P.7	Building Identification Numbers (BINs)	DCP	1	0	0	1	0	0	1	0	0	0	3	Medium
MH.P.8	BIN Working Group recommendations	DCP	1	0	0	1	0	0	1	0	0	0	3	Medium
MH.P.9	Inspection and upgrade program for DEP facilities	DEP	0	0	0	1	0	0	1	0	0	1	3	Medium
MH.P.10	Groundwater development	DEP	0	1	1	1	0	1	1	0	0	0	5	Medium
MH.P.11	Groundwater treatment plant	DEP	1	0	0	1	0	1	1	0	0	1	5	Medium
MH.P.12	Laptops for DFTA essential staff	DFTA	1	0	0	1	0	1	1	1	1	0	6	High
MH.P.13	Generator for neighborhood hub	DFTA	1	0	0	1	0	0	-1	0	0	0	1	Medium
MH.P.14	Headlamps for home-delivered	DFTA	1	0	0	1	0	1	1	0	1	0	5	Medium

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	meals deliverers													
MH.P.15	Upgrades to DHS buildings	DHS	1	0	0	1	0	0	1	0	0	1	4	Medium
MH.P.16	DHS building roof improvements	DHS	1	0	0	1	0	1	1	0	1	1	6	High
MH.P.17	Window upgrade in DHS buildings	DHS	1	0	0	1	0	0	1	0	0	1	4	Medium
MH.P.18	Power redundancy at DHS buildings	DHS	1	0	0	1	0	1	0	0	1	0	4	Medium
MH.P.19	DHS shelter protection	DHS	0	0	0	-1	0	0	1	0	0	1	1	Medium
MH.P.20	Bellevue shelter facility improvements	DHS	1	0	0	1	0	0	-1	0	0	1	2	Medium
MH.P.21	LIFE Family Residence facility improvements	DHS	1	0	0	1	0	0	-1	0	0	1	2	Medium
MH.P.22	Mobile command stations	DOB	1	0	0	0	0	1	1	0	1	-1	3	Medium
MH.P.23	DOB backup generators	DOB	1	0	0	1	0	0	-1	0	0	-1	0	Low
MH.P.24	DOB radios	DOB	1	1	0	1	0	0	1	0	1	-1	4	Medium
MH.P.25	DOB vehicles	DOB	1	0	0	1	0	1	-1	0	1	-1	2	Medium
MH.P.26	Stormwater management	DOC	1	0	0	1	0	0	1	0	0	0	3	Medium
MH.P.27	Rikers Island ferry dock	DOC	1	0	0	1	0	0	1	0	0	0	3	Medium

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MH.P.28	Roof and façade improvements	DOC	1	0	0	1	0	1	1	0	0	0	4	Medium
MH.P.29	Emergency Operations Center improvements	DOC	1	0	0	1	0	1	1	0	0	0	4	Medium
MH.P.30	Off-island satellite Emergency Operations Center (EOC) for Rikers Island	DOC	1	0	0	1	0	1	1	0	0	1	5	Medium
MH.P.31	MDC cellar/backup emergency system	DOC	1	0	0	1	0	1	-1	0	1	0	3	Medium
MH.P.32	Provision of power redundancy	DOE	1	0	0	1	0	1	0	0	1	0	4	Medium
MH.P.33	Protection of DOE facilities from electrical system damage from trees	DOE	1	0	0	1	0	0	0	0	0	0	2	Medium
MH.P.34	DOE green roof installation	DOE	1	1	0	1	0	0	1	0	0	1	5	Medium
MH.P.35	Surge protection for DOE critical electrical systems	DOE	1	0	0	1	0	0	1	0	0	0	3	Medium
MH.P.36	Emergency power at DOE facilities	DOE	1	1	0	1	0	1	-1	0	1	0	4	Medium
MH.P.37	Emergency preparedness plans and training for DOE custodian engineers	DOE	1	0	0	1	0	1	1	1	1	0	6	High

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	and building managers													
MH.P.38	Psychological First Aid (PFA)	DOHMH	1	1	0	1	0	1	1	0	1	0	6	High
MH.P.39	"Mental Health First Aid" public education program	DOHMH	1	0	0	1	0	1	1	0	1	-1	4	Medium
MH.P.40	Mental health system IT improvement	DOHMH	1	0	0	1	0	1	1	1	1	-1	5	Medium
MH.P.41	Mental health system power backup	DOHMH	1	0	0	1	0	1	-1	0	1	0	3	Medium
MH.P.42	Mental health system support network	DOHMH	1	0	0	1	0	1	1	1	1	1	7	High
MH.P.43	Mental health volunteer preparedness and response	DOHMH	1	0	0	1	0	1	1	1	1	1	7	High
MH.P.44	DOHMH IT systems protection	DOHMH	1	0	0	1	0	1	1	1	1	0	6	High
MH.P.45	DOHMH primary data center availability	DOHMH	1	0	0	1	0	1	1	1	1	-1	5	Medium
MH.P.46	Riverside clinic upgrade	DOHMH	1	0	0	1	0	1	1	1	1	-1	5	Medium

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MH.P.47	DOHMH warehouse and print shop capacity	DOHMH	1	0	0	1	0	1	1	1	1	0	6	High
MH.P.48	Health data and provider portal	DOHMH	1	0	0	1	0	1	1	1	1	0	6	High
MH.P.49	Enhanced emergency response communication operations at DOHMH headquarters	DOHMH	1	1	0	1	0	0	1	1	1	0	6	High
MH.P.50	Generators for healthcare facilities	DOHMH	1	0	0	1	0	0	-1	1	0	0	2	Medium
MH.P.51	Small grants program to support community-based social cohesion	DOHMH	1	1	0	1	-1	0	0	1	1	1	5	Medium
MH.P.52	"Hub the Hood" program	DOHMH	1	1	0	1	-1	0	0	1		0	3	Medium
MH.P.53	DOHMH facility repair and upgrade	DOHMH	1	1	-1	1	-1	-1	0	1	0	0	1	Medium
MH.P.54	Notification system for City employees	DoITT	1	1	-1	1	1	0	0	0	0	0	3	Medium
MH.P.55	Hardening of NYCWiN network	DoITT	1	1	-1	1	1	0	0	1	0	0	4	Medium
MH.P.56	Data Center Site B	DoITT	1	1	-1	1	1	0	0	1	0	0	4	Medium
MH.P.57	Secure HAZMAT at	DOT	1	1	0	1	1	0	1	0	0	0	5	Medium

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	DOT facilities													
MH.P.58	Redundant power for all mission-critical DOT sites	DOT	0	1	1	1	1	1	0	0	0	0	5	Medium
MH.P.59	Continuity of Operations sites	DOT	1	1	-1	1	0	-1	0	0	0	0	1	Medium
MH.P.60	Information tracking	DOT	0	1	0	1	1	1	0	1	1	0	6	High
MH.P.61	High-reflectivity pavements	DOT	1	1	-1	1	0	0	0	0	1	1	4	Medium
MH.P.62	Critical facility loss estimation	DOT	1	1	0	0	0	0	1	0	1	-1	3	Medium
MH.P.63	Staten Island Ferry fleet upgrade	DOT	1	1	0	1	0	-1	0	0	0	0	2	Medium
MH.P.64	Staten Island Ferry vessel improvement	DOT	1	1	0	1	-1	0	0	0	1	0	3	Medium
MH.P.65	COOP trailer compound	DSNY	1	1	-1	1	0	0	0		1	0	3	Medium
MH.P.66	Industrial property upgrades	EDC/BNYDC	1	1	-1	1	1	1	1	0	0	0	5	Medium
MH.P.67	Hardening Staten Island Ferry and private ferry terminals from climate change-related threats	EDC	1	1	-1	0	0	-1	1	1	0	1	3	Medium
MH.P.68	Construction of new ferry landings to support private	EDC	1	1	-1	1	0	-1	0	1	0	0	2	Medium

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	ferry services													
MH.P.69	Waterfront fueling facilities	EDC	1	1	-1	1	0	-1	0	1	1	0	3	Medium
MH.P.70	Mobile/portable ferry ticketing machines	EDC	1	1	-1	1	0	-1	0	1	1	-1	2	Medium
MH.P.71	Use of the Staten Island Ferry's Austen Class vessels for East River Ferry service during weather-related storm disruptions	EDC/DOT	1	1	-1	1	0	-1	1	1	0	0	3	Medium
MH.P.72	Storm shutters project	FDNY	1	1	1	1	1	0	1	0	0	0	6	High
MH.P.73	Backup communications carrier	FDNY	1	1	-1	1	1	-1	0	0	0	0	2	Medium
MH.P.74	Voice-over IP architecture	FDNY	1	1	0	1	-1	0	0	0	0	1	3	Medium
MH.P.75	Next-generation satellite phones	FDNY	1	1	-1	1	1	-1	0	0	0	0	2	Medium
MH.P.76	FDNY facilities survey	FDNY	1	1	0	1	0	0	1	0	0	0	4	Medium
MH.P.77	DCOC cell phone coverage	FDNY	0	1	0	0	-1	0	0	0	0	0	0	Low
MH.P.78	FDNY cable network	FDNY	1	1	1	1	1	0	0	0	0	1	6	High

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MH.P.79	Spare radios	FDNY	1	1	0	1	1	0	0	0	0	0	4	Medium
MH.P.80	Home-work plans	FDNY	1	1	1	-1	-1	0	0	0	0	0	1	Medium
MH.P.81	Gas vendors	FDNY	1	1	0	1	0	0	0	0	0	-1	2	Medium
MH.P.82	Cache of vaccinations	FDNY	1	1	1	1	-1	-1	0	0	0	-1	1	Medium
MH.P.83	Urban search and rescue team	FDNY	1	1	0	1	0	1	0	0	0	0	4	Medium
MH.P.84	Coney Island Hospital HVAC	HHC	1	1	-1	1	0	-1	0	1	0	0	2	Medium
MH.P.85	Coney Island Hospital power pre-connections	HHC	1	1	-1	1	0	-1	0	1	1	1	4	Medium
MH.P.86	Metropolitan Hospital HVAC	HHC	1	1	0	1	1	0	0	1	0	1	6	High
MH.P.87	Metropolitan Hospital pre - connections	HHC	1	1	0	1	1	0	0	1	0	1	6	High
MH.P.88	Bellevue Hospital	HHC	1	1	0	1	1	0	0	1	0	1	6	High
MH.P.89	Bellevue Hospital power pre-connections	HHC	1	1	0	1	1	0	0	1	1	1	7	High
MH.P.90	Central Office Emergency Command Center (ECC) and alternate ECC	HHC	1	1	0	1	1	-1	0	1	1	0	5	Medium
MH.P.91	Henry J. Carter	HHC	1	1	-1	1	1	0	0	1	1	1	6	High

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HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	Hospital improvements													
MH.P.92	Outreach to residential building owners	HPD	1	1	-1	1	0	0	0	1	1	1	5	Medium
MH.P.93	Flood protection for critical facilities.	HRA	1	1	1	1	0	1	1	1	0	1	8	High
MH.P.94	Overhead electric infrastructure	LIPA	-1	-1	0	0	-1	-1	0	0	1	1	-2	Low
MH.P.95	Storm damage mitigation	LIPA	-1	0	-1	-1	0	0	0	1	1	1	0	Low
MH.P.96	Exploration of loss-reduction actions for landmarked properties	LPC	1	1	1	1	1	1	1	0	0	0	7	High
MH.P.97	Public education and outreach for landmarked buildings	LPC	1	1	1	1	1	1	0	0	0	1	7	High
MH.P.98	Marine Parkway/Cross Bay Bridge mitigation master plan	MTA (Bridges and Tunnels)	1	1	0	1	1	0	0	1	0	1	6	High
MH.P.99	Engineering flood studies at non-tunnel facilities	MTA (Bridges and Tunnels)	1	1	0	1	-1	0	0	1	1	1	5	Medium
MH.P.100	Far Rockaway depot green roof	MTA (Buses)	1	1	1	1	1	1	1	1	1	0	9	Medium

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MH.P.101	Hazards/threats planning	MTA (MNR)	1	1	0	1	1	0	0	1	1	0	6	High
MH.P.102	Fueling capabilities/backup for emergency response	MTA (MNR)	1	1	0	1	1	0	0	1	1	0	6	High
MH.P.103	Penn Station access	MTA (MNR)	1	1	1	1	1	1	0	1	0	0	7	High
MH.P.104	Harlem-125 Street Station improvements	MTA (MNR)	1	1	1	1	1	1	0	0	0	0	6	High
MH.P.105	Emergency management equipment	MTA/LIRR	1	1	1	1	1	-1	0	1	0	1	6	High
MH.P.106	NYCHA grounds, pavements, and drainage improvements	NYCHA	1	1	-1	1	1	1	1	0	1	0	6	High
MH.P.107	Category 4 distributed power-generation feasibility studies	NYCHA	1	1	-1	1	1	-1	0	1	0	0	3	Medium
MH.P.108	Morrisania Air Rights	NYCHA	-1	1	-1	-1	1	-1	0	0	0	0	-2	Low
MH.P.109	NYCHA AC improvements	NYCHA	1	0	-1	1	1	0	-1	0	0	0	1	Medium
MH.P.110	NYPD precinct facility protection	NYPD	1	1	1	1	1	-1	0	0	0	0	4	Medium

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MH.P.111	NYPD facility protection	NYPD	1	1	1	1	1	-1	0	0	0	0	4	Medium
MH.P.112	NYPD critical facilities protection	NYPD	1	1	1	1	1	-1	0	0	0	0	4	Medium
MH.P.113	OCME unified agency command enter	OCME	1	1	1	1	1	1	1	0	1	0	8	High
MH.P.114	Educational outreach to private sector	OEM	1	1	-1	1	1	0	0	0	0	1	4	Medium
MH.P.115	OEM facilities protection	OEM	1	1	-1	1	1	0	0	0	0	0	3	Medium
MH.P.116	HAZUS-MH software	OEM	1	1	1	1	1	-1	1	1	0	0	6	High
MH.P.117	Community Emergency Response Team (CERT) Curriculum	OEM	1	1	1	1	1	1	0	1	1	1	9	High
MH.P.118	Infrastructure systems modeling	OEM	1	0	1	1	0	0	0	1	0	0	4	Medium
MH.P.119	Loss estimation	OEM	1	0	1	1	1	0	0	0	0	0	4	Medium
MH.P.120	Natural hazard event database	OEM	1	0	1	1	1	1	0	0	0	0	5	Medium
MH.P.121	CERT collaboration with community groups	OEM	0	1	1	1	1	1	0	1	1	1	8	High
MH.P.122	Ready New York update	OEM	1	1	1	1	1	1	0	1	0	0	7	High

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MH.P.123	Public/private mitigation initiatives	OEM	1	1	0	1	1	0	0	1	0	1	6	High
MH.P.124	Regional critical infrastructure mapping	OEM	1	0	-1	1	1	0	0	1	0	0	3	Medium
MH.P.125	Subway depths mapping:	OEM	-1	0	1	1	1	0	0	1	0	0	3	Medium
MH.P.126	Vegetation data	OEM	-1	0	1	1	0	0	0	1	0	0	2	Medium
MH.P.127	Zoning for hazard-prone areas	OEM	1	1	-1	1	0	0	1	1	0	1	5	Medium
MH.P.128	Mitigation public outreach	OEM	1	1	-1	1	1	0	1	1	1	1	7	High
MH.P.129	Emergency Operations Center (EOC)	OEM	1	1	-1	1	1	-1	1	1	-1	1	4	Medium
MH.P.130	OEM Warehouse	OEM	1	1	0	1	1	1	0	1	0	0	6	High
MH.P.131	New York City mitigation guide and education	OEM	1	1	1	1	1	1	1	1	1	1	10	High
MH.P.132	Building community capacity	OEM	1	0	-1	1	1	1	0	1	1	0	5	Medium
MH.P.133	Urban Post-Disaster Housing site identification in New York City	OEM	1	1	1	1	1	1	1	1	1	0	9	High
MH.P.134	Executive decision-making guide for	OEM	1	1	1	1	0	1	1	1	1	0	8	High

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	deployable post-disaster housing													
MH.P.135	Request for Proposal for Urban Post-Disaster Housing	OEM	1	1	1	1	0	1	1	1	1	0	8	High
MH.P.136	Storm shutter protection at OEM headquarters	OEM	1	1	-1	1	1	0	1	1	1	0	6	High
MH.P.137	NYC Brownfield Incentive Grant (BIG) program	OER	1	1	-1	1	1	0	1	1	1	1	7	High
MH.P.138	Fuel advance warning system	PANYNJ (Aviation)	1	0	1	1	1	1	0	1	1	0	7	High
MH.P.139	Kennedy Airport electrical system resiliency	PANYNJ(Aviat.)	1	1	0	1	1	0	0	0	0	0	4	Medium
MH.P.140	LaGuardia Airport central electric substation	PANYNJ(Aviat.)	1	1	1	1	1	0	0	1	1	0	7	High
MH.P.141	LaGuardia Airport electrical system enhancement	PANYNJ(Aviat.)	1	1	1	1	1	-1	0	1	0	0	5	Medium
MH.P.142	LaGuardia Airport power system redundancy	PANYNJ(Aviat.)	1	1	1	1	1	-1	0	0	0	0	4	Medium
MH.P.143	Kennedy Airport power system redundancy	PANYNJ(Aviat.)	1	1	1	1	1	-1	0	1	0	0	5	Medium

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MH.P.144	Stewart Airport standby emergency generator	PANYNJ(Aviat.)	1	1	1	1	1	1	0	1	1	0	8	High
MH.P.145	Stewart Airport power system redundancy	PANYNJ(Aviat.)	1	1	1	1	1	1	0	1	0	0	7	High
MH.P.146	Kennedy Airport fuel storage	PANYNJ(Aviat.)	1	1	1	1	1	1	-1	1	1	0	7	High
MH.P.147	Intelligent Transportation System (ITS) program at Kennedy and Newark Airports	PANYNJ(Aviat.)	1	1	1	1	1	-1	0	0	0	0	4	Medium
MH.P.148	Emergency generator capacity for Red Hook and Howland Hook container terminals	PANYNJ(Ports)	1	1	1	1	1	1	-1	1	1	0	7	High
MH.P.149	Lincoln Tunnel electrical and power system improvements	PANYNJ(TBT)	1	1	1	1	1	-1	0	1	0	0	5	Medium
MH.P.150	George Washington Bridge (GWB) electrical and power system improvements	PANYNJ(TBT)	0	1	1	1	1	-1	-1	1	0	0	3	Medium
MH.P.151	GWB tower transformers	PANYNJ(TBT)	1	1	1	1	1	1	0	1	1	0	8	High

The prioritization analysis of proposed actions is for planning purposes only and will not be used to determine eligibility for funding or implementation of potential projects in the future.

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Prioritization

Section IV: Mitigation Strategy

HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
MH.P.152	Multi-facility real-time traffic information software	PANYNJ(TBT)	0	1	1	1	1	1	0	0	0	0	5	Medium
MH.P.153	Intelligent Transportation System (ITS) program	PANYNJ(TBT)	0	1	0	1	1	-1	0	0	-1	0	1	Medium
MH.P.154	Green roofs on Parks buildings	Parks	1	1	-1	1	1	1	1	1	1	1	8	High
MH.P.155	Green Streets	Parks	1	1	-1	1	1	1	1	1	1	1	8	HIgh
MH.P.156	Wetlands and other land in a natural state	Parks	1	1	-1	1	-1	-1	1	0	1	1	3	Medium
MH.P.157	Seawall, pier, and marina structural repairs	Parks	1	1	1	1	1	-1	1	0	1	0	6	High
MH.P.158	Upgrades to Parks buildings' systems	Parks	1	1	-1	1	1	0	1	0	0	0	4	Medium
MH.P.159	SBS outreach.	SBS	1	1	-1	1	1	1	0	0	0	1	5	Medium
MH.P.160	Toolkit and training materials for city volunteer groups	SBS	1	1	-1	1	1	1	0	0	0	1	5	Medium
MH.P.161	Small business outreach	SBS	1	1	-1	1	1	1	0	0	0	1	5	Medium
MH.P.162	Hazard mitigation education for	SBS	1	1	-1	1	1	1	0	0	0	1	5	Medium

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Section IV: Mitigation Strategy

HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	businesses													
MH.P.163	Ready New York materials	SBS	1	1	-1	1	1	1	0	0	0	1	5	Medium
MH.P.164	Toolkit and training materials for BIDs and LDCs on mitigation best practices	SBS	1	1	-1	1	1	1	0	0	0	1	5	Medium
MH.P.165	Hazardous mitigation seminar for BIDs and LDCs	SBS	1	1	-1	1	1	1	0	0	0	1	5	Medium
MH.P.166	Dissemination of hazard information	SBS	1	1	-1	1	1	1	0	0	0	1	5	Medium
MH.P.167	Rockaway Reformulation Study	USACE/NYSDEC	1	1	1	1	1	0	1	1	0	0	7	High
MH.P.168	T-groins at Coney Island	USACE/NYSDEC	1	1	1	1	1	0	1	1	0	0	7	High
Severe Weather														
SW.P.1	Protection of NYCDOT facilities from high winds	DOT	1	1	0	1	-1	0	0	0	0	0	2	Medium
SW.P.2	Sign inspection program	DOT	0	1	1	1	1	1	0	1	1	0	7	High
SW.P.3	Rooftop equipment protection at HRA facilities	HRA	1	1	-1	1	-1	0	0	1	1	0	3	Medium
SW.P.4	Increased line clearance tree trim	LIPA	-1	1	-1	1	1	0	1	1	1	0	4	Medium

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Prioritization

Section IV: Mitigation Strategy

HMP Index No.	Mitigation Action	Lead Agency	S	T	A	P	L	Ec	Ev	TIMLINE	Project Cost	GOALS and OBJECTIVES	Prioritization Score	Prioritization
	program													
SW.P.5	Bridge reinforcement	MTA (Bridges and Tunnels)	1	1	-1	1	-1	1	0	0	0	1	3	Medium
Winter Weather														
WS.P.1	Improved Snow & Ice Melt: Permeable pavement	DOT	0	1	-1	0	1	-1	1	1	1	1	4	Medium
WS.P.2	Public Outreach	OEM	1	1	0	1	1	0	1	1	0	0	6	High

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5. Implementation and Administration

The implementation strategy for existing and potential actions is located in the Existing and Potential Mitigation Action tables (Table 5 and Table 6), respectively. Both tables further identify the following categories of information for each action that will guide New York City in the implementation and administration of the actions: description, lead and supporting agencies, timeframe, cost, funding source, and priority (see Table 4). It also serves to coordinate agencies to avoid duplicating or conflicting efforts. The Mitigation Strategy produced for New York City contains a wide variety of prioritized actions that will mitigate the effects of natural hazards on population, the economy, and property. Some mitigation actions in the Strategy can take as little as three months to implement, while others may take more than 50 years. Actions range from a $20,000 training program to major infrastructure improvements costing $760 million.

A. Capability Assessment

The Capability Assessment evaluates the tools in the city's toolbox for implementing mitigation strategies to reduce disaster losses. The primary capability types to accomplish mitigation and reduce long-term include: planning and regulatory, administrative and technical, financial, and education and outreach (see **Figure 2**).

New York City, through its various agencies and departments, has local policies, regulations, funding, and practices currently in place that will help facilitate its hazard mitigation strategy. These mechanisms include: building and construction codes, floodplain management plans, land use plans, local laws and ordinances, master and comprehensive plans, and zoning and land use regulations.

Planning and Regulatory: These capabilities are based on the implementation of ordinances, policies, local laws and State statutes, and plans and programs that relate to guiding and managing growth and development.

Administrative and Technical: These capabilities includes city agency or community staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions.

Financial: These capabilities include resources that a jurisdiction has access to or is eligible to use to fund mitigation actions.

Education and Outreach: These capabilities include programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information.

Figure 2: Capability Assessment Types

The Planning Team and Steering Committee created the following table to assess New York City's current capabilities to implement mitigation actions. It contains the agency responsible, classification, description for each initiative or capability, and how it relates to hazard mitigation. In addition to OEM's hazard mitigation planning program, as outlined in the Plan Maintenance section of the HMP, the following planning mechanisms (Table 9, Table 10, Table 11, and Table 12) will serve to implement many of the actions described in the plan:

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
Land Use Plan - *DCP Initiated Rezoning*	DCP	DCP is responsible for zoning amendments that change the applicable use, bulk, and density regulations for a location or area. Since 2002, DCP has sponsored 80 area-wide rezoning projects that are adopted into law, covering approximately one sixth of the city. All rezonings are required to pass through the City Environmental Quality Review (CEQR). Many of the rezonings incorporate additional provisions for waterfront access and green spaces and hazard mitigation considerations, such as flood-resilience measures, where appropriate.	These rezonings incorporate goals established in the Flood Resilience Text Amendment and the Waterfront Revitalization Program and help mitigate the impact of the following hazards: coastal erosion, coastal storms/hurricanes, tornadoes/windstorms, extreme temperatures, earthquakes, flooding, winter storms, and utility disruptions.
Local Waterfront Revitalization Plan - *VISION 2020: New York City Comprehensive Waterfront Plan*	DCP	*Vision 2020* is a 10-year plan for the future of the city's 520 miles of shoreline. This plan provides a sustainable framework for more water transport, increased public access to the waterfront, and economic opportunities that will help make the water part of New Yorkers' everyday lives.	*Vision 2020* and associated waterfront revitalization plans address flooding hazards and associated risks such as: coastal erosion, coastal storms/hurricanes, and tornadoes/windstorms.
Plan - *Urban Waterfront Adaptive Strategies (UWAS)*	DCP	*Urban Waterfront Adaptive Strategies* is a resource to help guide planners and policy makers in New York City and beyond in identifying and evaluating potential coastal protection strategies.	*Urban Waterfront Adaptive Strategy* addresses flooding hazards and associated risks such as: coastal erosion, coastal storms/hurricanes, tornadoes/windstorms, and utility disruptions.
Plan - *Designing for Flood Risk*	DCP	*Designing for Flood Risk* identifies key principles to guide the design of new buildings in flood zones to promote construction that can not only withstand coastal flood events, but also supports the vibrancy of the urban public realm.	*Designing for Flood Risk* addresses flooding hazards and associated risks such as: coastal erosion, coastal storms/hurricanes, tornadoes/windstorms, and utility disruptions.

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
Plan - *Hazard Mitigation Plan*	DCP/OEM	The *Hazard Mitigation Plan* (HMP) is a federally mandated compliance document required for update every five years to maintain eligibility for certain disaster recovery and future mitigation funding. DCP has partnered with OEM under a FEMA-funded grant to update the City's 2009 HMP.	The HMP addresses a comprehensive list of identified hazards: coastal erosion, coastal storms, disease outbreaks, drought, earthquakes, extreme temperatures, flooding, severe weather, wild fires, winter storms, CBRN, Cyber Threats, and Infrastructure Failures.
Plan - *New York City Design Manual for Risk and Resilience: A Guide for New Construction and Retrofitting of Existing Buildings in Flood Zones*	DCP	The plan provides guidance for planning and design of new construction and retrofitting existing buildings in areas subject to flooding. Guidance mitigates property damage and life safety dangers posed by structural and superficial damage buildings.	The plan addresses flooding hazards and associated risks such as: coastal erosion, coastal storms/hurricanes, tornadoes/windstorms, and utility disruptions.
Site Plan Review Requirements - *City Planning Commission Discretionary Review*	DCP	In cases where discretionary action by the City Planning Commission is necessary, various borough and technical staff members review site plan applications for consistency with sound planning policy, environmental reviews consistent with CEQR guidelines, and any other relevant findings as applicable.	Discretionary reviews ensure consistency with environmental review and address a wide range of hazards, such as flooding, coastal erosion, and hurricanes, as appropriate.
Steep slope ordinances – *Hillsides Preservation Districts; Special Natural Area Districts*	DCP	The City Planning Commission reviews site plans to maximize protection of natural areas, including the goals of reducing hillside erosion, landslides, and excessive stormwater runoff associated with development. This is accomplished through conserving vegetation and protecting natural terrain.	Natural area preservation helps ensure consistency with DCP's sustainability goals and address a wide range of hazards, such as flooding, coastal erosion, and hurricanes, as appropriate.
Zoning/land use restrictions – Zoning Resolution	DCP	The Zoning Resolution sets forth the regulations governing land use and development. Articles I through VII contain the use, bulk, parking, and other applicable regulations for each zoning district.	The zoning resolution helps promote green, sustainable land use and mitigates a wide range of hazards, including: coastal erosion, coastal storms/hurricanes, tornadoes/windstorms, extreme temperatures, earthquakes, flooding, winter storms, and utility disruptions.

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
Zoning/land use restrictions - *Flood Resilience Zoning Text Amendment*	DCP	The Flood Resilience Zoning Text Amendment encourages flood-resilient building construction throughout designated flood zones. The amendment removes regulatory barriers that would hinder or prevent the reconstruction of storm-damaged properties. It also enables new and existing buildings to comply with new, higher flood elevations issued by the Federal Emergency Management Agency (FEMA) and to new requirements in the Building Code.	The Flood Resilience Text Amendment addresses flooding hazards and associated risks such as: coastal erosion, coastal storms/hurricanes, tornadoes/windstorms, and utility disruptions.
Codes Building Site/Design - *New York City Construction Codes*	DOB	The New York City Construction Codes are patterned after the International Code Council (ICC) family of codes. The codes are updated on a 3-year cycle similar to the revision cycles of the ICC codes. This ensures the codes are updated regularly to the most recent safety and technological advances.	Many mitigation strategies and goals—such as protecting public health and safety, preserving properties, sustaining a healthy environment, and disaster preparedness—can be achieved by applying the Codes to building construction and site preparation. The Codes address, to a certain extent, many of the risks identified, such as flood, drought, extreme heat, earthquakes, wind, and building collapses.
Plan Review Requirements - *Plan Review*	DOB	Except for minor alterations and repairs, construction work generally requires a construction permit, which can only be obtained if the work is found to be in compliance with NYC Construction Codes. If an owner chooses not to have the project done by a NYS-registered design professional, the work must then be reviewed by a DOB plan examiner before a permit is given. DOB possesses an extensive plan review system to ensure lawful compliance with the City's Building Code, Electrical Code, Zoning Resolution, New York State Labor Law, and New York State Multiple Dwelling Law.	By ensuring construction work is designed in accordance with the NYC Construction Codes and other applicable laws, buildings and properties are protected a variety of hazards.
Land Use Plan - *Parks Department Parkland Plan*	Parks	The Planning Division coordinates specific plans for new uses of parkland and for remediation of environmental damage.	Planning staff have grant experience and experience remediating brownfields and other damaged sites.
Local Waterfront Revitalization Plans - *Consistency Review*	Parks	Local discretionary actions, including those subject to land use (ULURP), environmental (CEQR) and Board of Standards and Appeals (BSA) review procedures, are reviewed for consistency with the New York City Waterfront Revitalization Program	Staff are aware of requirements for appropriate siting of waterfront infrastructure to reduce damage from hazard events.

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
		policies.	
Site Plan Review Requirements - *Parks Department Site Review*	Parks	The Forestry Division reviews site plans for capital work and ensures that all trees and horticulture are protected. Parks also reviews any work that might affect street trees and governs the removal or planting of any public tree in New York City.	Protection of existing trees helps mitigate future events due to rainwater absorption, reduction of flooding, and other factors.
Site Plan Review Program – *Tree and Horticulture Protection*	Parks	The Forestry division reviews site plans citywide for capital work and ensures that all trees and horticulture are protected. The Capital division reviews plans for projects in parks to ensure the protection of trees and horticulture.	Trained forestry staff review design and construction practices to ensure preservation of healthy trees to reduce risk and protect the environment.
Master/Comprehensive Plan - *PlaNYC*	OLTPS	PlaNYC is the city's long-term, comprehensive sustainability plan that focuses on improving the city's environment while accommodating an increase in population of almost one million people by 2030.	PlanNYC will help prepare the city for population growth, combat climate change, and become more resilient to future hazards.
Plan – *A Stronger, More Resilient New York*	OLTPS, EDC	The report, produced by the Special Initiative on Rebuilding and Resiliency (SIRR), addresses how to create a more resilient New York City in the wake of Hurricane Sandy, with a focus on preparing for and protecting against the impacts of climate change. The report presents actionable recommendations both for rebuilding the communities impacted by Sandy and increasing the resilience of infrastructure and buildings citywide.	The SIRR report offers strategies to make New York City more resilient in the face of coastal storms, flooding events, and other climate changed-related effects.
Codes Building Site/Design – *PlaNYC Green Building Task Force*	OLTPS	OLTPS will lead a task force that will develop amendments to the City's Building Code to incorporate climate change impacts.	Amendments to the building code will make the built environment more resistant to future hazards.

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
Plan - *NYC Green Infrastructure Plan*	DEP	The plan presents an alternative approach to improving water quality that integrates "green infrastructure," such as swales and green roofs, with investments to optimize the existing system and build targeted, cost-effective "grey" or traditional infrastructure.	Green infrastructure projects capture rainwater that would otherwise enter the combined sewer system, thereby reducing street flooding and combined sewer overflows (CSOs) in New York Harbor. Grey infrastructure retains combined water and wastewater until the end of a rain event, reducing the volume of CSOs in New York Harbor.
Local Emergency Plans - *Water Shortage Operations Plan*	DEP	During droughts, DEP procedures are modified to maximize different water sources, prioritize leak detection programs that minimize water loss, and review hydrant-locking procedures to ensure areas with illegal hydrant use are compliant with water-use restrictions.	This capability reduces the impact of natural and non-natural water shortages on the city's population and critical water-dependent operations.
Long-term Water Shortage Plan - *Water Demand Management Plan 2021*	DEP	DEP plans for water shortage as a result of natural conditions and planned and unplanned infrastructure outage by identifying demand management strategies in government, residential, and commercial properties and by optimizing system operation to reduce water loss.	Reduces overall in-city water consumption in advance of planned shutdown of Rondout-West Branch Tunnel as part of Water for the Future, and mitigates future natural and non-natural water shortages.
Other Hazard Mitigation Plan - *Downstream Flooding Reduction Program*	DEP	The plan provides for the reduction of downstream flooding through attenuation of runoff by lowering reservoir elevation at a controlled rate in anticipation of forecasted storms and snow pack melting.	Mitigates impacts of flooding caused by forecasted storms and snow pack melting.
Other Hazard Mitigation Plan - *Reservoir Release Notification Plan*	DEP	The plan provides for the notification of reservoir releases/spilling rates at predefined levels to all downstream counties' emergency management officials.	Assesses and mitigates impacts of reservoir releases on stream and river flooding of downstream communities.
Hydrological/Hydraulic Studies – Reservoir Basin Hydrologic/Hydraulic Study	DEP	DEP conducts H&H studies to confirm probable maximum precipitation and probable maximum flood for reservoir basins.	Assess impacts of precipitation and flooding on reservoir operations and water quality.
Hydrological/Hydraulic Studies – High Hazard Dams	DEP	Bureau of Water Supply (BWS) maintains studies of its high hazard dams and dikes.	Assesses risk of dam failure, impacts to watershed communities, and impacts to in-city supply.

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
Hydrological/Hydraulic Studies – Hydraulic Analyses of Problem Areas	DEP	DEP performs hydraulic analyses of sewer systems in areas experiencing sewer problems to determine the need for and scope of future capital projects. These studies often occur before a drainage plan is developed and guide the determination of where improvements will be focused.	DEP's sewer construction program seeks to improve storm and wastewater drainage in areas lacking a fully built-out system or whose population and land use characteristics have changed significantly to warrant system reconstruction. Sewer upgrades may increase system capacity, alleviate flooding, and increase the reliability of the system.
Land Use Regulations - *Recreational Land Use Regulations*	DEP	BWS maintains regulations for the public recreational use of New York City-owned lands and waters.	Protects water quality in City reservoirs.
Property Set-Back Ordinance - *Wildland -Urban Interface*	DEP	Bureau of Water & Sewer Operations (BWSO) enforces a 25-foot setback around vegetated areas, where possible, to help mitigate potential for wildfire in the Staten Island Bluebelt.	Reduces impacts of wildfire on properties surrounding the Staten Island Bluebelt.
Site Plan Review Requirements - *Site Connection Applications for New Developments*	DEP	BWSO issues certifications indicating the ability of existing sewers to accommodate increased usage to all new development projects. Certification is needed before a construction permit is issued.	Ensures that the sewer system has the capacity to handle additional wastewater and stormwater flow from new developments.
Storm Water Ordinances – *Guidelines for the Design and Construction of Stormwater Management Systems*	DEP	DEP is responsible for providing adequate draining services to the city. DEP also governs the construction of private sewers and drains to ensure compliance and adequate drainage capabilities.	Ensures that new developments have adequate stormwater management systems to reduce pressure on City sewers
Watershed Ordinance – Watershed Rules and Regulations	DEP	DEP enforces and develops regulations to protect New York City's reservoirs from contamination from human activity and stormwater.	Protects water quality in City reservoirs.

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
Climate Change Plan - NYC Wastewater Resiliency Plan	DEP	DEP has developed cost-effective strategies for reducing flooding damage to wastewater infrastructure and safeguarding public health and the environment. This comprehensive study examined buildings and infrastructure at DEP's 96 pumping stations and 14 wastewater treatment plants, identifying and prioritizing infrastructure that is most at risk of flood damage. Through the study, DEP developed a set of recommended design standards and cost-effective protective measures tailored to each facility to improve resiliency in the face of future flood events.	DEP will consider climate risk in capital planning and incorporate a design standard of the 100-year floodplain plus 30 inches of sea level rise in all new wastewater infrastructure projects.
Maps of Right-To-Know Facilities	DEP	Mapping of facilities with hazardous substances located within the NYC flood map. Such maps may be used for planning purposes and as a resource to determine potential contamination during a flood event	Focuses facility-level planning and outreach in advance of coastal storms to mitigate flood risk.
Waterfront Vision and Enhancement Strategy (WAVES)	EDC	The Waterfront Action Agenda is the three-year implementation component of the Waterfront Vision and Enhancement Strategy (WAVES). It establishes a set of 125 specific, high-priority projects for realizing New York City's waterfront and waterways as a world-class destination, a globally competitive port, and a rich and vital natural resource that draws all New Yorkers to its edge and onto the water.	Several of the goals identified in the WAVES agenda address hazard mitigation, including restoring the natural waterfront, improving water quality, enhancing water-borne transportation, and increasing climate resilience.
New York City Fire Code	FDNY	The Fire Code is compiled and periodically revised by the Fire Department of New York (FDNY). The Fire Code deals with the operation and maintenance of buildings and fire safety systems, emergency planning and preparedness, regulation of hazardous materials, and regulation of businesses and activities involving fire safety concerns.	The Fire Code revision process and adoption takes into account changing factors and lessons learned through experience and applied fire science. The code helps protect property from structural collapses, fires, and other infrastructure failures.
Strategic Plans	FDNY	FDNY's Strategic Plans outline the goals and objectives deemed priority to the Fire Commissioner and the Chief of the Department and guide the Department's planning, decision-making, and resource allocation.	The Strategic Plans respond to the challenges anticipated in the coming decade, and the actions it plans to take to deter them, largely based on natural and non-natural hazards.

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
Continuity of Operations Plan (COOP)	FDNY	In the event of a disaster, the FDNY would implement its COOP. The Department yearly updates the COOP for its major bureaus, including Fire Operations, EMS Operations, Bureau of Health Services, Communications, Fire Prevention, and Fire Investigations.	Specific COOP plans are designed and implemented by bureau. The plans are encompassing, and draw from experience and best practices.
Community Wildfire Protection Plan	FDNY	The Community Wildfire Protection Plan positions fire protection agencies, community leaders, and natural resource professionals to be better prepared to protect the community's residents and natural resources from the negative impacts of wildfire.	The Community Wildfire Protection Plan enables the Department to deliver a planned, effective, and deliberate response to any wildfire and describes the impacts/damages associated with wildfires.
Evacuation Plans	MTA	Evacuation plans facilitate an orderly and efficient evacuation when ordered by the Mayor.	Reduces the risk of people without access to private cars being harmed during an event requiring evacuation. Even those with access to cars may not be able to evacuate due to congestion if all try to use them rather than using public transportation.
System Shut Down Plan	MTA	A plan to affect an orderly shutdown of the system to protect employees and assets.	Shutting the system down helps minimize damage to infrastructure and rolling stock as well as protect employees and customers.
Disaster Housing Recovery Plan	OEM	The Disaster Housing Plan provides guidance for the implementation of interim housing and the restoration of permanent housing following a catastrophic event. It is a start-up kit, outlining coordination and communication of all participants involved in post-disaster housing recovery. It serves as a template for any jurisdiction to implement after a disaster.	This plan guides the deployment of temporary housing after a disaster.
Community Recovery Playbook	OEM	A Guide to Using Community Development Block Grants for Disaster Recovery: helps people and communities receive assistance as quickly as possible through block grant distributions. It contains a user-friendly catalog of 60 block-grant-funded programs that can form the basis for a comprehensive housing recovery effort and associated waivers. The Housing Group/State Led Disaster Task Force/Recovery Authority can activate these programs immediately.	This playbook helps communities receive assistance after a disaster.

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
Housing Recovery Center Plan	OEM	Enables a one-stop-shop for people who need housing assistance and other related services after a catastrophic event. It outlines the Concept of Operations for the entire Housing Recovery Center network so all participating service providers can efficiently provide housing recovery services. This plan is a scalable and flexible administrative and management system that will be essential to coordinated and consistent operation of the housing recovery center(s).	This plan helps people in need of housing assistance after a disaster.
Participatory Urban Planning Toolkit	OEM	Resource for coordinating emergency management response and recovery operations with Non-Governmental Organizations. It contains a Participatory Urban Planning Interagency Task Force document with key roles and actions and a Communications Guide that facilitates recovery of the whole community.	This toolkit helps non-governmental organizations receive help in response and recovery operations after a disaster.
Hydrological/Hydraulic Studies – SLOSH Study	OEM	OEM performs SLOSH modeling for New York City to determine what areas would be inundated in a coastal storm.	These models guide planning and evacuation operations as outlined in the Coastal Storm Plan.
Other Hazard Mitigation Plan – Coastal Storm Plan	OEM	The Coastal Storm Plan describes the citywide efforts before, during, and after a coastal storm event, particularly a hurricane. The plan contains components relating to decisions-making, sheltering, advance warning systems, logistics, public information, debris management, and post-disaster reconstruction.	This plan guides the city's efforts in preparedness, response, and recovery for coastal storm events.
Other Hazard Mitigation Plan – Flash Flood Plan	OEM	The Flash Flood Plan contains detailed procedures to mitigate the effects of a flash flood on people and property and guides agency stakeholders through the decisions and actions that will be required before, during, and after such an event.	This plan guides the city's efforts in preparedness, response, and recovery for flash floods.

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Capability Type: Plans/Ordinances/Regulations	Agency	Description	How does this capability address mitigation and risk assessment?
Other Hazard Mitigation Plan – Heat Emergency Plan	OEM	The Heat Plan contains detailed procedures to mitigate the effects of extreme heat conditions on critical infrastructure, at-risk populations, and New York City operations. The contents of the plan guide New York City stakeholders (including city and state agencies, the private sector, non-profits, and volunteer organizations) through the complex decisions that may be necessary during a heat emergency.	This plan guides the city's efforts in preparedness, response, and recovery for extreme heat events.
H1N1 Playbook	OEM	The H1N1 Playbook guides interagency support to a public health response to an H1N1 outbreak in New York City.	This plan guides response to pandemic flu spread.
Earthquake Response Playbook	OEM	The Earthquake Response Playbook provides a framework for guiding and coordinating the City's initial (immediate hours and days) response to a major earthquake in the NYC area.	This plan guides response to a major earthquake.
Other Hazard Mitigation Plan – Winter Weather Emergency Plan	OEM	The Winter Weather Emergency Plan outlines procedures to reduce the hazardous effects of winter weather on general and at-risk populations. It details specific strategies for snow plowing and salt spreading on city streets and responding to incidents, such as frozen fire hydrants, heat outages, and carbon monoxide emissions.	This plan guides the city's efforts in preparedness, response, and recovery for winter weather storms.

Table 9: Planning and Regulatory Capabilities

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Capability Type: Administration/Staff/Technical	Agency	Description	How does this capability address mitigation and risk assessment? (New requirement 2014 Plan)
Planning Commission	DCP	The City Planning Commission is responsible for the conduct of planning relating to the orderly growth and development of the city, including adequate and appropriate resources for the housing, business, industry, transportation, distribution, recreation, culture, comfort, convenience, disaster protection and recovery, health and welfare of its population. The Commission meets regularly to hold hearings and vote on applications concerning the use, development and improvement of real property subject to City regulation. Its consideration of these applications includes an assessment of their environmental impacts where required by law.	The Planning Commission helps promote green and sustainable land use, ensures consistency with environmental review, and considers mitigation actions that address a wide range of hazards, such as flooding, coastal erosion, and hurricanes, as appropriate.
Hazard Mitigation Staff	DCP	As part of the Hazard Mitigation Plan Grant, the Department of City Planning has hired two new staff to help develop and manage the Hazard Mitigation Plan and associated projects, such as the New York City Design Manual for Risk and Resilience: A Guide for New Construction and Retrofitting of Existing Buildings in Flood Zones.	The new staff helps ensure that the HMP addresses a comprehensive list of identified hazards, such as: coastal erosion, coastal storms/hurricanes, tornadoes/windstorms, extreme temperatures, earthquakes, flooding, winter storms, and utility disruption.
Chief Building Official	DOB	New York City Department of Buildings (DOB) ensures the safe and lawful use of more than 950,000 buildings and properties through enforcing the City's Building Code, Electrical Code, Zoning Resolution, New York State Labor Law, and New York State Multiple Dwelling Law. DOB's main activities include performing plan examinations, issuing construction permits, inspecting properties, and the maintenance of construction codes and licensing trades.	DOB has the authority in ensuring code compliances and enforcing the rules and regulations related to hazards.

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Capability Type: Administration/Staff/Technical	Agency	Description	How does this capability address mitigation and risk assessment? (New requirement 2014 Plan)
Floodplain Administrator	DOB	The floodplain administrator has the capacity and responsibility to implement and enforce floodplain regulations that meet National Flood Insurance Program (NFIP) criteria.	The floodplain administrator has the authority for issuing/denying floodplain development building permits, inspecting properties for floodplain compliance, assisting in the preparation of floodplain maps, and helping residents to obtain information on flood hazards, flood map data, and proper construction measures. After a flood, the administrator determines what damage has occurred.
Advance Warning System	DOB	Provide advanced warning of wind and other weather hazards to registered construction superintendents, site safety managers, and the media.	This system allows construction sites to take mitigating steps prior to the onset of hazardous weather.
Storm Drainage Systems Maintenance Program – *City Park Drainage Maintenance*	Parks	The Central Technical Services Division and Borough Shops maintain catch basins and storm drains in all the city parks.	Catch basin and drain maintenance reduces flooding.
Stream Maintenance Program – *Bronx River Natural Resources Group*	Parks	The Natural Resources Group, in conjunction with the Bronx River Alliance, an associated non-profit, maintains and cleans rivers, other wetlands, and riparian areas in the city.	Wetlands absorb runoff and prevent flooding and damage to the built environment.
Vegetation Maintenance Program – *Tree Pruning Program*	Parks	The Central Forestry division oversees the block pruning and commitment-pruning program. Block pruning is done by contractors on a 7- to 8-year schedule and involves pruning of all street trees on a block. Commitment pruning addresses emergency issues, such as tree limbs obscuring traffic signals. Parks also performs in-park pruning of trees.	Pruning maintains tree health and reduces damage during extreme weather events by removing weak limbs.
Storm Drainage Systems Maintenance Program – *Sanitary, Storm, and Combined Sewer Maintenance and Programmatic Catch Basin Inspection and Cleaning*	DEP	DEP's Bureau of Water & Sewer Operations is responsible for the maintenance of sanitary, storm, and combined sewers. DEP inspects and cleans the city's 140,000 catch basins on a three-year cycle. The agency makes repairs to the sewer system as needed.	Programmatic sewer and catch basin maintenance increases system capacity and reliability and reduces the risk and extremity of street flooding.

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Capability Type: Administration/Staff/Technical	Agency	Description	How does this capability address mitigation and risk assessment? (New requirement 2014 Plan)
Stream Maintenance Program – *Watersheds Stream Maintenance*	DEP	DEP rehabilitates and stabilizes stream banks to mitigate turbidity as part of its filtration avoidance determination obligations in New York City watershed areas.	Reduces impacts of extreme weather and flooding on water quality in City reservoirs.
CBIDAS/Risk Based Inspection System (RBIS)	FDNY	The Coordinated Building Inspection and Data Analysis System (CBIDAS) is a state-of-the-art risk-based inspection system for collecting and sharing data in real time to prevent fires and protect firefighters. The FDNY's new Analytics Unit is working towards incorporating 13 different factors that will actively play in determining risk.	RBIS' purpose is to gauge risk, and appropriately mitigate it, by priority ranking, increasing the likeliness firefighters will enter and inspect a building before a fire incident occurs there.
Urban Search and Rescue Teams	FDNY	FDNY's Urban Search and Rescue (USAR) Teams have extensive training and experience in structural collapses, confined spaces, and high-angle rescues.	Utilizing USAR teams in unique, challenging settings enables FDNY to guarantee a level of professionalism and a technically proficient force to meet the ever-changing disaster-like situations, intermittently present to NYC.
Identification of Alternate Work Sites	MTA	Identify and maintain availability of alternative work locations available immediately for executive decision-makers required to participate in executive activates during an emergency in case current locations are unavailable or at risk.	Ensures management can continue to function and lead during an emergency.
Advance Warning System	MTA	Monitors forecasts of wind speed to issue speed restrictions or ensure suspension of service prior to major wind impact (all elevated structures).	Protects rolling stock, customers, and employees from possible harm during a high-wind event.
Survey Property for Areas Subject to Flooding	MTA	Identify and develop plans to protect against flooding under various weather scenarios.	Identifies appropriate project locations to mitigate potential water intrusion projects.
Commissioner's Orders	DOHMH	Issues the Commissioner's orders related to the enforcement of the NYC Health Code.	This capability will help enforce health codes that protect the public health of New York City residents.

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Capability Type: Administration/Staff/Technical	Agency	Description	How does this capability address mitigation and risk assessment? (New requirement 2014 Plan)
BioWatch and Bio Threat Response Laboratory (BTRL) and Other Specimens Testing	DOHMH	The Public Health Laboratory analyzes collected samples from BioWatch and trains others to assist in surge sampling. The BTRL operates in the public interest by testing samples/specimens deemed to pose a significant biological hazard of morbidity and mortality.	This capability helps protect the public health of New York City residents.
Critical Complaint Response	DOHMH	Critical Complaints (those needing to be addressed within 24 hours) for Environmental Health (FSCS, Child Care, PCS/Vector/VPHS Lead, OEI, and PHE/RAD)	Critical Complaint Response allows for better response to public health-related hazards.
Public Beach Surveillance	DOHMH	Beach water surveillance (including specimen transport) and notification of public of results.	This capability helps protect the health of New York City residents.
Larval Adult Mosquito Surveillance and Control	DOHMH	Provides larval surveillance and larvicide application to potential breeding sites. Performs mosquito population and arborirus surveillance. Applies adulticide if human health or the quality of life is impacted.	This capability helps protect New York City residents from mosquito-borne viruses.
Communicable Disease Surveillance and Investigation	DOHMH	Analyze electronic data from syndromic surveillance systems to detect citywide increases or clusters that may signify outbreak	Surveillance and Investigation helps detect disease outbreaks.
Life Safety Operations	NYPD	Life Safety and Site Security: Mobilized officers respond to an incident, secure devastated regions, and ensure the safety and wellness of citizens.	This capability aids response protocols.
Search and Rescue Operations	NYPD	Search and Rescue Operations: Conducted primarily by personnel assigned to the Special Operations Division, including Emergency Services, Harbor and Aviation personnel.	This capability aids response protocols.
Crime Suppression	NYPD	Crime Suppression: Ensure the safety and security of affected regions by suppressing opportunistic crimes.	This capability helps protect the safety of New York City residents.
Site Security and Force Protection	NYPD	Provides security and protection at important locations such as gas stations and critical infrastructure locations. Preserves evidence when necessary.	This capability helps protect the safety of New York City residents.

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Capability Type: Administration/Staff/Technical	Agency	Description	How does this capability address mitigation and risk assessment? (New requirement 2014 Plan)
Traffic Management	NYPD	Ensures the free flow of traffic to and from affected areas, assists stranded motorists when necessary, and performs escorts for critical relief supplies.	This capability assists in minimizing transportation disruptions caused by a disaster.
Personnel Management	NYPD	Deploys personnel resources based on operational needs. Includes extending tours and cancelling days off when necessary.	This capability aids response protocols.
Supply and Equipment Management	NYPD	Provides necessary supplies and equipment to affected areas to ensure personnel are able to perform their duties.	This capability aids response protocols.
NYC Brownfield Partnership	OER	Provides expert pro-bono environmental services through the NYC Brownfield Partnership.	This capability helps facilitate hazardous waste cleanup of contaminated properties.
Continuity of Operations (COOP):	OEM	Ensures City agencies can provide essential services to the public during emergencies, while maintaining internal critical functions. Agencies are developing plans that build contingencies around essential services, mitigate the impact of disruptions to services, and enhance the ability to provide CIMS operations, social services, and government operations.	The COOP planning process helps minimize disruptions and allows agencies to continue critical services after a disaster.

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Capability Type: Administration/Staff/Technical	Agency	Description	How does this capability address mitigation and risk assessment? (New requirement 2014 Plan)
Technical	OEM	Sahana is a database application that gives the City of New York the ability to manage the complex tasks needed to activate and operate the Coastal Storm Plan sheltering system or any other response operation that requires a large number of staff deployed, messaged (via phone, email, text) and tracked among facilities. The Sahana system can also track clients of a facility or group of facilities discretely using a check-in/check-out system. Pre-events scenarios are loaded into the deployment module of the system to facilitate immediate staff contact for deployment.	This capability aids response protocols for New York City's sheltering system pre-disaster.
Notify NYC	OEM	Notify NYC communicates localized emergency information quickly to city residents. This alert system includes the following types of notification types: emergency alerts, significant event notifications, public heath notifications, public school closing/delay advisories, and unscheduled parking rules suspensions.	This tool supports preparedness for New York City residents.
Advance Warning System	OEM	The Special Needs Advance Warning System (AWS) is an all-hazards tool designed to push targeted information to individuals with special needs during hazardous weather, utility or transportation disruptions, public health emergencies, and incidents requiring evacuation. AWS is designed to alert individuals with special needs to these and other hazards that may affect their independence and their daily lives.	This tool supports preparedness, disaster response, and post-disaster recovery.

Table 10: Administrative and Technical Capabilities

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Capability Type: Financial	Agency	Description	How does this capability address mitigation and risk assessment? (New Requirement 2014 Plan)
Capital Improvement or Development Plan – *Parks Department Capital Improvement Plan*	Parks	The Capital Projects division is responsible for capital improvements and reconstruction of playgrounds, structures, and parkland. The division currently has over $1 billion in active restoration contracts under way. The Operations division assists with drafting of maintenance and operational agreements for new park developments such as the Highline.	Capital architects and engineers and capital funds are available to assist with mitigation and design of mitigation.
Capital Improvement or Development Plan – *Drainage Plan for Areas Lacking Sewers*	DEP	The Bureau of Water and Sewer Operations (BWSO) develops drainage plans to provide adequate storm and sanitary infrastructure for areas of the City lacking a fully built-out sewer system. Build out is concentrated in populated areas lacking existing infrastructure and where improvements or a need is identified.	DEP's sewer construction program seeks to improve storm and wastewater drainage in areas lacking a fully built-out system or whose population and land use characteristics have changed significantly to warrant system reconstruction. Sewer upgrades may increase system capacity, alleviate flooding, and increase the reliability of the system.
Capital Improvement or Development Plan – *Trunk Water Main Master Plans*	DEP	BWSO creates plans for expansion and improvement of the water distribution system.	Provides adequate water supply and fire protection for existing and future development.
Capital Improvement or Development Plan – *Agency Capital Budget*	DEP	DEP's Capital Budget is used to achieve and maintain a state of good repair for the water and wastewater infrastructure as well as address increased regulatory requirements.	DEP's capital budget plans for future capital projects, including those cited here and in the Mitigation Actions worksheet.
Capital Improvement or Development Plan - *Green Infrastructure Grant Program*	DEP	DEP funds up to $6 million in design and construction costs for green infrastructure projects that manage 1 inch of stormwater from the contributing impervious area on private property in combined sewer areas of New York City.	Green infrastructure projects capture rainwater that would otherwise enter the combined sewer system, reducing street flooding and CSO volumes in New York Harbor.

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Capability Type: Financial	Agency	Description	How does this capability address mitigation and risk assessment? (New Requirement 2014 Plan)
Capital Improvement Program – Sewer Construction	DEP	DEP maps and studies areas of New York City to create a comprehensive plan for sewer upgrades.	DEP's sewer construction program seeks to improve drainage and wastewater infrastructure in areas lacking a fully built-out system or whose population and land use characteristics have changed significantly to warrant system reconstruction. Sewer upgrades may increase system capacity, alleviate flooding, and increase the reliability of the system.
Water and sewer funds	DEP	DEP's water and wastewater operating budget and debt service are paid by the New York City Water Board with revenue collected per water and sewer rates.	Water and sewer funds represent the primary source of funding for DEP operations and capital improvements, including those cited here and in the Mitigation Actions worksheet.
PS/OTPS Budget	FDNY	City budget allocations for Personal Services and Other Than Personal Services, such as office materials and supplies.	This capability allows for basic agency services.
Capital Budget	FDNY	City budget allocations for capital expenses including physical plant and large vehicle acquisitions.	This capability allows for basic agency services.
Grant Funding	FDNY	City budget funds received via the competitive grant application process from federal and state governments and private and non-profit sources.	This capability allows for basic agency services.
Revenue	FDNY	City budget that includes income sources such as payments received from FDNY ambulance transports and FDNY permit and license fees.	This capability allows for basic agency services.
Capital Program	MTA	Identifies and prioritizes capital projects to be undertaken over a five-year period.	Insures mitigation projects are included in capital funding envelope.
Financial Assistance Search Tool (FAST)	OER	Helps the public find grants and other financial assistance for environmental investigation and cleanup in NYC.	This capability helps facilitate hazardous waste cleanup of contaminated properties.
Brownfield Incentive Grant (BIG) Program	OER	Provides financial assistance to property owners seeking to investigate and clean up contaminated properties, as well as to community groups for public outreach, planning, and technical assistance.	This financial tool helps mitigate the impact of hazardous waste release.

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Table 11: Financial Capabilities

Capability: Education and Outreach	Agency	Description	How does this capability address mitigation and risk assessment? (New Requirement 2014 Plan)
Floodplain Maps/Flood Insurance Studies – *NFIP Compliance*	DOB	As part of the NFIP, New York City has adopted floodplain maps developed by FEMA.	Informs the public of floodplain requirements by communications and provides floodplain design training fpr design professionals.
Public Education/Awareness Programs – Recreation and Education Programming	Parks	The Recreation Division runs 34 recreation centers and provides extensive recreation and education programming. The Urban Park Rangers provide classroom and on-site environmental programming and operate 10 Nature Centers. The Operations division runs educational programs promoting the use of marinas and the waterfront. Parks is also associated with non-profit partners such as the City Parks Foundation and Historic House Trust. These partners augment the agency's educational and cultural offerings.	Increasing public awareness of risk factors related to climate changes increases social resilience.
Anticipate Future Vulnerabilities and Needs – *DEP Long-term and Strategic Planning*	DEP	Assess and communicates DEP's long-term and strategic goals, vulnerabilities, and opportunities for management of the water supply system for optimal dependability/reliability.	On a three-year cycle, DEP reassesses long-term and strategic goals, including hazard mitigation, resilience, regulatory reform, and dependability.
Hazard Awareness Program – Annual Right to Know and Hazardous Communication	DEP	DEP conducts annual Right to Know and Hazard Awareness Communications with its employees and submits SARA III reports that inform the public of any hazardous and toxic chemicals at DEP facilities.	Reduces risk and mitigates impacts of hazardous materials release at DEP facilities.
Public Outreach - *Right-To-Know Outreach*	DEP	Provides recommendations (via palm card and email blast) to private and public facilities to address chemical safety and spill prevention during flood events.	Educates facilities about proper hazardous materials management handling procedures during flood events to reduce the risk of hazardous materials release.

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Capability: Education and Outreach	Agency	Description	How does this capability address mitigation and risk assessment? (New Requirement 2014 Plan)
Public Outreach - *Bureau of Public Affairs*	DEP	DEP's Bureau of Public Affairs is responsible for the agency's communications with the public, public officials, and members of the media. Public Affairs staff distributes valuable information about readiness, hazard mitigation, and response through in-person outreach, mailings, press releases, and events.	Educates the community about proper preparation for and response to hazards including flooding, drought, coastal storms, extreme weather, air contamination, and hazardous materials release.
Fire Safety Education	FDNY	Meets the fundamental mission of protecting the lives and property of New York City residents and visitors through fire safety education programs held and offered throughout the city. The Fire Safety Education Unit's strategy to reduce fire deaths and injuries is to focus on prevention by identifying and rectifying unsafe behaviors.	Through the outreach programs the Fire Safety Education unit manages, it is able to address fire safety issues and concerns throughout the city, directly impacting and affecting members focus and awareness on relevant fire safety issues.
CPR Training	FDNY	Equips New Yorkers with the skill to act in the event of cardiac arrest by offering free instruction across the five boroughs. The program, taught by certified FDNY EMS personnel, has successfully trained over 50,000 New Yorkers in CPR.	Community CPR training guarantees public awareness of CPR and moves to increase the survival rate dramatically of those who experience cardiac arrest.
Fire Code Outreach	FDNY	Contemporaneous with, and as part of the latest Fire Code revision process, the FDNY is hosting information sessions for all affected industries.	By addressing industries impacted by Fire Code revisions, the FDNY is able to provide justification and ensure understanding across the board for changes, ensuring compliance that ultimately protects lives and property.
Rebuild by Design Roundtables	RPA	RPA is partnering with MAS and VAI in Phase III of Rebuild by Design, a competition launched by the President's Hurricane Sandy Task Force to identify and implement locally appropriate but regionally scalable design solutions to the region's resilience challenges. This effort will involve knowledge building and knowledge-sharing, a broad public engagement campaign, and convening stakeholders on key resiliency, rebuilding, and disaster preparedness issues.	This capability promotes capacity building, education, and public outreach.

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Capability: Education and Outreach	Agency	Description	How does this capability address mitigation and risk assessment? (New Requirement 2014 Plan)
Outreach to all employees about personal planning for a possible hurricane.	MTA	All employees receive a communication early in hurricane season advising them to develop a hurricane plan with their families. It includes information on how to do this and what should be included.	Most MTA employees will be expected to work before, during, and/or after the storm; this program ensures they are aware of the need to work out a plan in advance so their families will be safe while they are at work.
Translation and Interpretation	DOHMH	Makes critical health information available to non-English-speaking (or less English-proficient) New Yorkers through translation and interpretation	Prevents the spread of infectious diseases through education and outreach to vulnerable populations
Community and Government Relations	DOHMH	Assists elected officials in responding to constituent issues/ concerns and maintains communications with key external stakeholders during critical public health events.	This capability promotes education and public outreach on public health matters.
Health Information Campaigns	DOHMH	Raises the public's awareness of personal and community health topics and issues through leaflets, posters, bulletins, billboards, and electronic media.	This capability promotes education and public outreach on public health matters.
Messaging, Communication and News Media Relations	DOHMH	Communicates internally and externally via email messaging and DOHMH websites; disseminates accurate and timely health information to the public through mass media.	This capability promotes education and public outreach on public health matters.
Ready New York	OEM	The Ready New York campaign encourages New Yorkers to be ready for all types of emergencies, develop a disaster plan, and keep informed about the hazards that may impact New York City.	This program promotes preparedness for all hazards that may affect the city.
"Cleaning up New York City"	OER	Educates the public about environmental investigation, environmental cleanup, and community protection and engagement during the cleanup process.	This capability promotes education on the hazardous waste removal cleanup process.

Table 12: Education and Outreach Capabilities

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6. Emergency Planning and Operations:

OEM has developed many plans and protocols that guide New York City's response to emergencies, from extreme weather to a power outage. These plans focus on the other three phases of a disaster: preparedness, response, and recovery. These phases complete the disaster cycle, with mitigation as the four phase.

An essential and important plan for New York City is the Coastal Storm Plan (CSP), which is a series of operational plans that detail the City's response to a coastal storm, but can be utilized to direct many all-hazard operations.

Coastal Storm Plan
In 2000, New York City first released its citywide plan for hurricanes. In 2006, the Coastal Storm Plan was updated to account New York City's changing population and the lessons learned from Hurricane Katrina. The plan was re-designed to anticipate a Category 4 hurricane making landfall in Atlantic City, New Jersey—the worst-case scenario for a hurricane affecting New York City—and was activated for Hurricane Irene in 2011 and Hurricane Sandy in 2012. OEM continues to revise and improve the plan based on experience and new information.

The current CSP is New York City's blueprint for responding to coastal storms. It is flexible, readily tailored to the size and impact of any storm, and it is comprehensive. The plan is a series of plans, each focusing in a different component: storm tracking and notification, decision-making, special needs advance warning system, evacuation (including procedures used to evacuate at-risk populations such as homebound residents and residents of healthcare facilities), sheltering, commodity distribution, logistics, debris management, public information, recovery and restoration.

Evacuation Operations
The New York City Office of Emergency Management (OEM) has a robust evacuation plan within the CSP which coordinates New York City's many transportation agencies.

OEM has designated a series of coastal evacuation routes on major roadways throughout the Bronx, Brooklyn, Queens, and Staten Island. These routes are clearly signed to direct drivers out of evacuation zones and towards evacuation centers. The New York City Department of Transportation (DOT), in coordination with OEM, erects and maintains evacuation route signage. The New York City Police Department (NYPD) supports movement of traffic along these routes through designated traffic control post locations and pre-positioning of tow trucks to quickly clear obstructions.

OEM also works closely with the Metropolitan Transportation Authority (MTA) to plan for and implement enhanced subway and bus service during evacuations. These efforts are designed to increase capacity along routes serving evacuation zones and modify certain routes to improve

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subway and bus connections. In addition, MTA disseminates special messaging on buses and trains to direct people to evacuation centers.

OEM's Homebound Evacuation Operation addresses the evacuation of people with special needs who are not able to evacuate on their own. Working with New York City's 311 and 911 services, this effort categorizes people in need of assistance according to their level of mobility, and transportation is arranged through either MTA Paratransit or the New York City Fire Department in conjunction with the Department of Education's Office of Pupil Transportation.

One of the key components of the evacuation operation is planning for shutdown of transit service and transportation facilities, which must be completed in time for the onset of tropical-storm-force winds (39 mph), otherwise known as zero-hour. OEM works with the National Weather Service to establish the zero-hour and use it to plan for shutdowns. To allow sufficient time to secure equipment, MTA subway service must cease hours prior to zero-hour.

The Regional Bridge and Tunnel Closure Protocol provides a framework for coordinated closure of the New York area's bridges and tunnels. This is crucial for ensuring a status of the road network and preventing incidents of stranded motorists. The protocol was developed in partnership with the 13 major bridge, tunnel, highway, and law enforcement agencies in New York and New Jersey and establishes a common understanding of closure practices, wind-speed thresholds, and messaging.

Health and Medical

The healthcare facility evacuation operation is a critical sub-plan of the CSP because New York City has half of the healthcare facilities in New York State. In a worst-case scenario, up to 25 hospitals, 71 nursing homes, 39 adult care facilities, and 6 psychiatric hospitals—representing around 30,000 patients/residents—would be required to evacuate. A successful evacuation requires each facility to expend every effort and available resource. It also requires coordination and support between government agencies and partners.

In the Healthcare Facility Evacuation Plan, the goal is to begin the evacuation of healthcare facilities 72 hours before the onset of tropical-force winds and complete the operation within 48 hours. The evacuation is managed by the Healthcare Facility Evacuation Center (HEC), a tactical communications center that centralizes support for an ordered evacuation of healthcare facilities. Run by the New York State Department of Health with support from city, state, regional, and federal partners, the HEC supports evacuating healthcare facilities with information, resources, and troubleshooting. It finds beds for evacuating facilities when those facilities cannot locate beds through existing relationships, arranges transportation between facilities, provides guidance to receiving facilities on how to maximize their surge capacity, and troubleshoots evacuation issues.

Sheltering

The CSP includes a Shelter Plan, which was designed to activate and manage a safe, accessible, secure, staffed, and supplied emergency shelter system to give refuge from coastal storms to

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more than 700,000 New Yorkers and visitors who are unable to find alternative shelter outside storm surge areas. The more than 400 shelters, 64 evacuation centers, and eight special medical needs shelters are grouped into "solar systems" across the five boroughs, each consisting of one evacuation center and 5 to 10 hurricane shelters each. Each hurricane shelter is assigned to an evacuation center that acts as the hub of a solar system.

The New York City sheltering system is intended to be fully integrated and accommodating to the diversity of New Yorkers seeking sheltering during an emergency. To that end, OEM has developed a number of plans and procedures that provide people with disabilities the opportunity to meaningfully access the city's sheltering system. This inclusive approach dictates that the City's emergency plans and supporting materials do not segregate the needs of and responses to people with disabilities into any separate and discrete "special needs" plan. Rather, the plans, operational guides and manuals, and accompanying training all contain components that address functional needs that people with disabilities will likely encounter during an emergency.

Facilities:

Upon arriving at an evacuation center, individuals complete a triage form used to determine how to best assist any person in need of an accommodation. Hurricane shelters support the needs of the majority of people with disabilities. If the shelter does not provide the level of accessibility a person needs, the individual may choose to be transported to a shelter that provides more suitable support. Accessible transportation is provided to everyone who needs it.

The eight special medical needs shelters are intended to shelter individuals whose needs exceed the capabilities of hurricane shelters but who do not require hospitalization. All are wheelchair-accessible. The New York City Health and Hospitals Corporation is responsible for the medical operations within the special medical needs shelters.

All staff is required to make sure that people with disabilities are able to safely enter the special medical needs shelter and access its services. To confirm the accessibility of their facility, staff is required to complete an accessibility checklist before opening the facility and use it to continually check accessibility during each shift. The checklist also requires that any accessibility issues be immediately raised and addressed by the facility manager.

Signage indicating accessible areas of a shelter is provided to each facility, and specially designed signage encourages shelter residents to ask for any accommodation they may need. "Emergency communications boards" are also distributed to all the facilities in the shelter system. Containing pictures and symbols related to emergency situations and basic needs, these aids are used to help individuals who have difficulty communicating.

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Training:

OEM has created a number of training programs to address issues related to people with disabilities and people with special needs. A suite of online and in-classroom training courses is available to all CSP staff types. Supplemental training and instructional videos can be made available in the event of an actual incident. These training opportunities address issues related to working with and accommodating people with disabilities and include general and specific communication tips for people with a variety of disabilities.

Logistics:

Since Hurricane Sandy there has been a doubling of supplies at special medical needs shelters, including wheelchairs, special medical needs cots, crutches, airway kits, bandage compress kits, diabetic testing kits, electrolytes kits, spill kits, first aid kits, and sphygmometer kits. Items to accommodate people with disabilities at general shelters include durable medical equipment such as wheelchairs and raised toilet seats with grab bars.

Emergency Communication:

New York City uses the Advance Warning System (AWS), a communication tool that sends emergency messages to agencies providing services to people with disabilities, seniors, and people with health vulnerabilities. The agencies then convey the information to their clients and contracted agencies. Through the AWS, emergency information is provided to individuals specific to their needs through trusted, pre-existing relationships. Often, the contact agency will play a role in an individual's emergency plan, providing an essential service that supports continued independence in the community.

Although the AWS is extensive, some individuals who live independently in the community and are not affiliated with a service provider are encouraged to sign up for Notify NYC to receive specialized emergency alerts and updates. Notify NYC messages can be received via text message, phone call, Twitter, Facebook, nyc.gov, and mayoral press releases.

Animal Sheltering:

The CSP provides for the co-location of companion and service animals (for example, guide dogs) with their owners in all hurricane shelters. Therefore, individuals with pets who do not have any other shelter options are allowed to bring their pets with them to hurricane shelters.

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7. New York City Office of Emergency Management's Housing Recovery Projects related to Hazard Mitigation

OEM has mitigated the possible impacts of disaster on communities through two special efforts: the Urban Post-Disaster Housing Prototype Program and the Regional Catastrophic Preparedness Grant Program's Housing Recovery Program. OEM continues to build resiliency for New York City through these programs, and to leverage the capabilities developed through them to identify sites for temporary housing and develop a community-based site planning process that uses deployable housing to restore neighborhoods.

Because of New York City's high population density, lack of open space, and a mission to resettle as many residents as possible in their former neighborhoods, the Urban Post-Disaster Housing Prototype Program was born. The program will outline a new plan for interim housing that will provide more suitable living spaces for New Yorkers displaced by disaster than conventional interim housing solutions used in other parts of the country. The cornerstone of the project is a three-story, three-unit housing prototype now being built in Brooklyn that will be in place for one year. The unit on the ground floor will serve as a gallery to provide public education about the project and raise awareness about resiliency. The second and third floor will be occupied by OEM staff and media representatives, where living conditions will be evaluated as part of a partnership with NYU-Poly Environmental Psychology Program.

Three projects were critical to the prototype's development and serve as resources for urban recovery. First, the 2008 "What If New York City…" design competition for urban post-disaster housing gathered ideas from around the world. Then the Urban Interim Housing Unit Specification used the best ideas from the competition, along with information from the modular building industry, to create a universal performance specification with stringent requirements for safety, environmental quality, durability, and universal design that any municipality can use to procure housing at massive speed and scale. Finally, the Playbook for Urban Neighborhood Design addresses how to use rapidly deployable housing to reconstruct neighborhoods and keep people close to home.

As of fall 2013, OEM has created a portfolio of housing recovery resources that identify policies and prevention strategies that support community resiliency building and educate the public on housing recovery. These include the Disaster Housing Recovery Plan; the Community Recovery Playbook: A Guide to Using Community Development Block Grants for Disaster Recovery; the Housing Recovery Center Plan; the Design Center Guidance document; and the Participatory Urban Planning Toolkit. All these resources focus on the planning, response, and recovery needs specific to urban areas, and were developed with a planning team of over 200 representatives from local, state, and federal government offices; community-based organizations; and the private sector. While these resources focus on the greater New York

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metropolitan area, they are applicable to any jurisdiction in the country. The resources focus on strengthening economic and community recovery as well as restoring housing after disaster.

The Disaster Housing Recovery Plan provides guidance for the implementation of interim housing and the restoration of permanent housing following a catastrophic event. The Plan breaks the work of housing recovery into manageable pieces by creating interagency task forces that bring together the right people from local, state, and federal agencies, as well as non-profit organizations and the private sector, to address problems efficiently.

After a catastrophic event, the greatest amount of relief and recovery funding will come through the U.S. Department of Housing and Urban Development's Disaster Community Development Block Grants for Disaster Recovery (CDBG-DR). The Community Recovery Playbook is an easy-to-use resource that helps federal, state, and local emergency management professionals, non-governmental organizations, and businesses involved in post-disaster housing and community recovery collaborate to implement block grant-eligible programs.

The Housing Recovery Center Plan describes how to plan, manage and operate one-stop-shop assistance centers for people who need housing assistance after a catastrophic event. As repair and rebuilding are a key part of recovery, the Design Center Guidance document was created to help develop special centers for design and construction services that are resources for homeowners and also support community-based resiliency projects.

Engaging the whole community is the most effective route to recovery, and the Participatory Urban Planning (PUP) Toolkit for post-disaster land use planning promotes effective coordination between the government, community-based organizations and the public at large. In 2013-2014, PUP will be used throughout the region to form partnerships between government emergency response agencies and local housing advocates. In collaborative exercises, local representatives working with government agencies will identify potential sites for temporary housing in their communities.

Through these tools, New York City has developed many capabilities to respond to and prepare for disaster.

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SECTION V: PLAN MAINTENANCE

SECTION V: PLAN MAINTENANCE

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1. Introduction

The Plan Maintenance section of New York City's 2014 Hazard Mitigation Plan (HMP) Update describes the formal process that will ensure the Plan remains an effective and relevant document. This section establishes the method and schedule for monitoring, evaluating, and updating the HMP during a five-year plan-update cycle. It also establishes how New York City will maintain community involvement in the Plan.

a) Plan Maintenance Approach

- Incorporate hazard mitigation actions into existing planning mechanisms.
- Determine how mitigation projects and actions will be monitored.
- Establish indicators of effectiveness or success.
- Develop an evaluation and revision schedule to ensure the Plan is up-to-date at the end of the five-year cycle.
- Establish a process for public input and community involvement during the planning cycle.

b) FEMA Requirements Addressed in this Section

The Hazard Mitigation Planning Team (Planning Team) created the plan maintenance strategy consistent with the process and steps presented in the Federal Emergency Management Agency's (FEMA) How-To-Guide: Bringing the Plan to Life (FEMA 386-4). The following FEMA requirements are addressed in this section:

- **Requirement §201.6(c)(4)(i):** [The plan maintenance process ***shall*** include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

- **Requirement §201.6(c)(4)(ii):** [The plan ***shall*** include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, where appropriate.

- **Requirement §201.6(c)(4)(iii):** [The plan maintenance process ***shall*** include a] discussion on how the community will continue public participation in the plan maintenance process.

2. Monitoring

The Planning Team will monitor the implementation of mitigation actions identified in the 2014 New York City HMP Update. To facilitate plan maintenance, The Hazard Mitigation Unit (HMU) at the New York City Office of Emergency Management (OEM) is the point of contact for hazard mitigation-related issues and serves as the lead coordinator on the plan update. OEM will also maintain adequate mitigation planning staff to support the Unit in monitoring and evaluating the Plan. During the five-year planning cycle, the Unit will undertake the following initiatives:

- Collect annual reports from the agencies involved in implementing mitigation projects or activities identified in the Mitigation Strategy section of this Plan.
- Maintain and update the mitigation action table.
- Participate in resiliency and mitigation-related initiatives
- Conduct site visits and obtain reports of completed or initiated mitigation actions to incorporate into the next plan revision as needed.
- Research and document new disaster information pertaining to New York City during the planning cycle and incorporate into a revised Risk Assessment section as needed.
- Organize annual meetings with Mitigation Planning Council (MPC) members to discuss relevant hazard mitigation issues, provide status updates, and discuss available grant opportunities.
- Organize meetings with the Mitigation Planning Council Steering Committee (Steering Committee) to discuss relevant hazard mitigation issues, provide status updates, and discuss available grant opportunities.
- Coordinate, compile, and disseminate hazard mitigation funding information and applications.
- Convene a meeting of the Steering Committee following a natural disaster or when funding is announced to prioritize and submit potential mitigation actions for funding.
- Promote and educate hazard mitigation to local, regional, national, and international partners to forge relationship and partnerships

The above activities outline plan maintenance during the four years leading up to the fifth year of the planning cycle (2014–2018). Beginning in March 2018, the HMU will lead a more intensive planning effort and reconvene the Planning Team to ensure New York City has an updated HMP by the end of 2018. OEM will be responsible for compiling, documenting, and incorporating all changes derived from the activities listed above into a revised plan document.

The maintenance cycle will work closely with the Mayor's Office of Long Term Planning and Sustainability to ensure it is consistent and streamlined with *A Stronger, More Resilient New York*, the City's resiliency plan that will be updated every four years starting in 2015.

3. Evaluation

The New York City HMP will be evaluated annually to determine the effectiveness of its projects, programs, and policies. The HMU will be responsible for scheduling and organizing the MPC and Steering Committee meetings, collecting, analyzing and incorporating annual reports, and providing revised drafts to the MPC. Each year, OEM and Steering Committee members will assess the current version of the Plan and determine the improvements necessary for the plan update. OEM will evaluate the Steering Committee to determine if other agencies should be added.

A thorough examination of the Plan will take place during the fifth year of the process to ensure New York City has an updated HMP at the end of the planning cycle. The MPC will review the goals and action items to determine their relevance to changing situations in the City, as well as changes in state or federal policy, and to ensure they are addressing current and expected conditions. The Steering Committee will look at any changes in City resources that may influence the plan implementation (such as funding) and program changes to determine need for reassignment. The Steering Committee will review all sections of the Plan to determine if this information should be updated or modified, given any new available data. The Steering Committee will evaluate the content of the Plan using the following criteria:

- Are the mitigation actions effective?
- Are there any changes in land development that affect mitigation priorities?
- How are other citywide initiatives able to complement and support the mitigation strategies?
- Do the goals, objectives, and action items meet social, technical, administrative, political, legal, economic, and environmental criteria as defined in FEMA's STAPLEE analysis?
- Are the goals, objectives, and mitigation actions relevant given any changes in New York City?
- Are the goals, objectives, and mitigation actions relevant given any changes to state or federal regulations or policy?
- Is there any new data that affects the Risk Assessment portion of the Plan?

4. Update

The Planning Team will update the HMP every five years to reflect the results of the annual reports and on-going plan evaluation by the HMC. Throughout the planning cycle, the HMU will compile new information and incorporate it into the Plan. The HMU will also assess and incorporate recommended comments expressed by FEMA in the initial review into the plan revision. At the end of the planning cycle, the Planning Team will submit the updated Plan to the New York State Office of Emergency Management (NYS OEM) and FEMA for review. After FEMA has approved New York City's 2019 HMP, the City will again formally adopt the Plan by Executive Order. Table 1 is an outline of how the Plan will be updated after the 2014 FEMA-approval:

Timeframe	Participants	Outcome
First Quarter 2015	Steering Committee, HMC	• Reconvene Steering Committee to discuss mitigation action progress and possible plan improvements.
First quarter 2016	MPC, HMC	• Reconvene MPC to discuss progress on mitigation actions.
Second quarter 2016	OEM	• Apply for plan update grant funding.
First quarter 2017	Steering Committee, HMC	• Reconvene Steering Committee to discuss mitigation action progress and discuss possible plan improvements.
Second quarter 2018	Steering Committee, MPC, Planning Team	• Reconvene Planning Team and begin plan update. • Coordinate monthly meetings with Steering Committee. • Reconvene MPC and schedule one-on-ones as required.
Fourth quarter 2018	NYS OEM, Planning Team	• Submit draft plan update to NYS OEM for review and comments.
First quarter 2019	FEMA, Planning Team	• Submit plan to FEMA for final approval.
First quarter 2019	New York City	• Re-adopt the FEMA-approved HMP.

Table 1: Plan Update Schedule

5. Incorporation into Existing Planning Mechanisms

As part of the local capability assessment conducted during the planning process, the Planning Team and Steering Committee identified current plans, programs, policies/ordinances, and studies/reports that will augment or help support mitigation planning efforts. The Steering Committee, which will meet on an annual basis, will be the mechanism for ensuring the City integrates hazard mitigation into its future planning activities. The New York City capability assessment is located in the Mitigation Strategy Section. Following the HMP approval and adoption, the Steering Committee will work to incorporate, where applicable, the HMP into the planning mechanisms identified in Table 6 of Section 4: Mitigation Strategy.

Throughout the plan maintenance cycle, the Planning Team will work to integrate hazard mitigation goals and actions into the general operations of New York City agencies. The Planning Team will work with agencies to identify opportunities as outlined below:

- Update work plans, policies, or procedures to include hazard mitigation concepts.
- Establish mitigation funding within capital and operational budgets.
- Issue plans, policies, executive orders, regulations, or other directives to carry out mitigation actions.
- Add hazard mitigation elements to redevelopment plans.

6. Continued Public Involvement

New York City is dedicated to continued public involvement in the hazard mitigation planning and review process. During all phases of plan maintenance, the public will have the opportunity to provide feedback. The 2014 Plan will be maintained and available for review on the OEM website through 2019. Individuals will have an opportunity to submit comments for the Plan update at any time by email. The HMC will compile all comments and present them at the annual Steering Committee meetings where members will consider them for incorporation into the revision. To help publicize the revised plan, six months prior to the submission of the 2019 Plan update, OEM will post a notice on its website requesting feedback on an updated draft HMP. The Planning Team will hold community involvement meetings with representatives from academic institutions, the private sector, community groups, and neighboring jurisdictions. Finally, OEM will send a notice to Citizen Corps members, informing them of the Plan update. This will provide the public an opportunity to express their concerns, opinions, or ideas about any updates/changes that are proposed to the Plan.