Credit: Barry Yanowitz

Buildings

Bungalows in New Dorp Beach. Rowhouses in Sheepshead Bay. Office towers in Lower Manhattan. Industrial warehouses along the waterfront in Sunset Park. New York City has a diverse building stock encompassing approximately 1 million structures of almost every imaginable type and combination of uses. These buildings are New York City's homes, work places, museums, historic landmarks, community centers, and places of worship—and they are also critical contributors to the rich and varied character of communities across the city.

However, because New York is a coastal city, its buildings have long been subject to climate risks, particularly the flooding associated with storm surge and sea level rise. In fact, when the Federal Emergency Management Agency (FEMA) released its first Flood Insurance Rate Maps (FIRMs) for New York City in 1983, it defined the 100-year floodplain—the area that has a 1 percent or greater chance of flooding in any given year—as an expanse that today includes approximately 35,500 buildings with more than 376 million square feet of space. While these maps demonstrated the city's long-standing vulnerability to flooding, Sandy showed that New York's buildings are even more vulnerable than previously thought. Sandy's floodwaters inundated an area that included approximately 88,700 buildings, more than half of which were located outside the 1983 floodplain boundaries that were in effect when the storm arrived. These buildings encompassed roughly 662 million square feet of space and housed more than 443,000 residents and 245,000 jobs. *(See map: Comparison of 100-Year Floodplain in 1983 FIRMs and Sandy Inundation Area)*

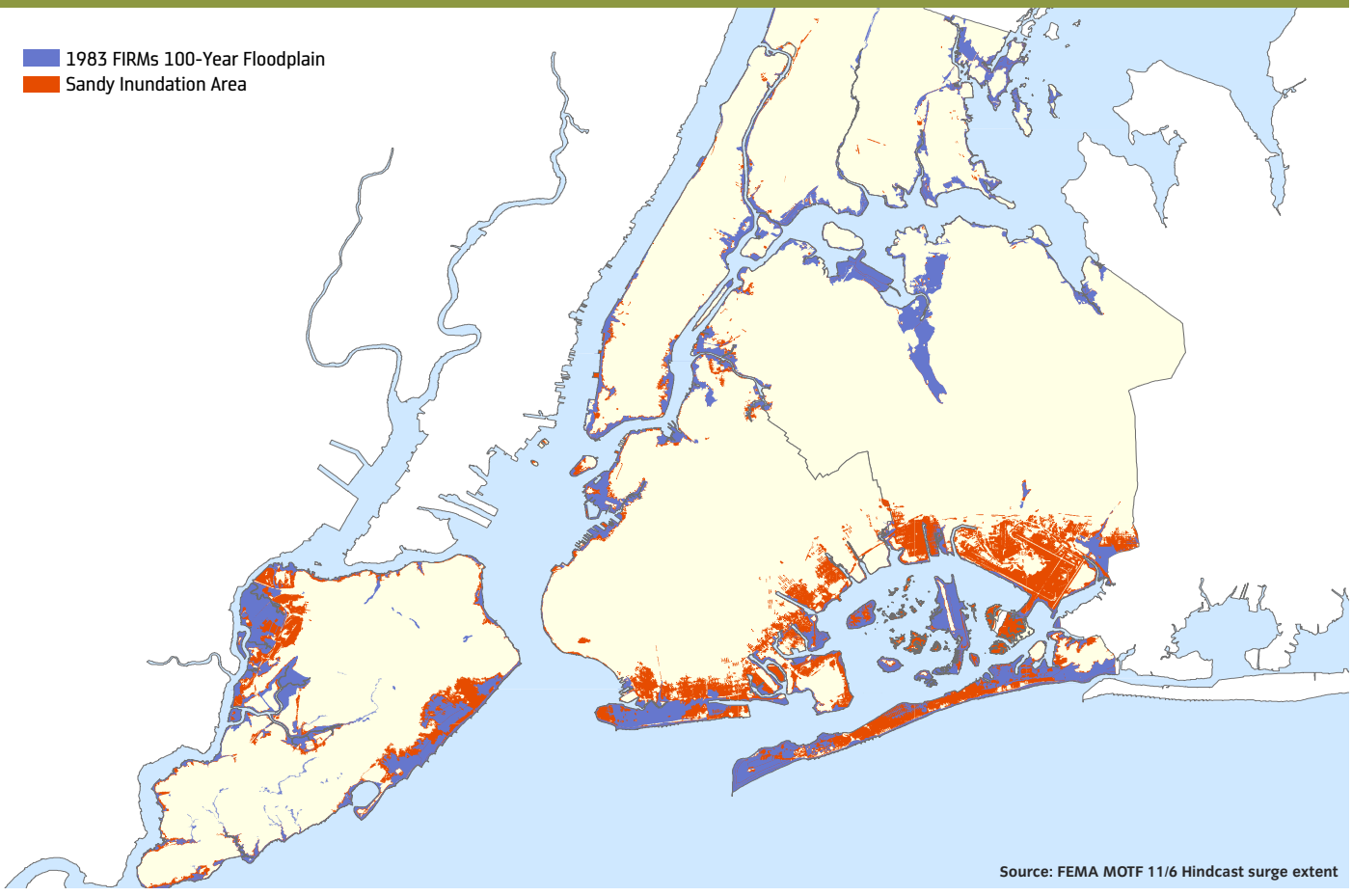
Sandy's impact is illustrative of the city's growing climate risks. For example, the 100-year floodplain, defined on recent Preliminary Work Maps (PWMs) created by FEMA, now encompasses more than 67,700 buildings, nearly twice the number of buildings in the 1983 FIRMs. In addition to the risks that the PWMs indicate these buildings now face, many of these properties also will be subject to significant new Federal flood insurance requirements.

However, even the revised FEMA flood maps do not reflect the full risk to New York City's building stock. 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, which, based on recent high end projections for sea level rise, could expand the size of the city's floodplain to include more than 88,000 buildings by the 2020s and more than 114,000 buildings by the 2050s (see Chapter 2, *Climate Analysis*). They also do not take into account other risks that climate change could exacerbate, including storm-related wind gusts.

Coastal protection measures are a significant and critical part of the City's efforts to protect buildings from current and future climate risks (see Chapter 3, *Coastal Protection*). While these measures should reduce the effects of storm surge, destructive waves, and sea level rise, they will not eliminate completely those impacts under all potential storm conditions, and they also will take time to design, fund, and build. Thus, they address only part of the challenge facing New York City's building stock. It is therefore equally important to supplement coastal protection measures by pursuing resiliency at the building level, offering multiple approaches to protect a wide range of the city's structures against the full spectrum of climate risks.

That is why this chapter proposes a two-part strategy for the city's building stock that is in keeping with the overarching goals of this report—to reduce the impacts of climate change, while also enabling the city to bounce back quickly when such impacts are felt. The two-part strategy seeks to strengthen new

Comparison of 100-Year Floodplain in 1983 FIRMs and Sandy Inundation Area



Source: FEMA MOTF 11/6 Hindcast surge extent

Common Building Types Across New York City


Credit: DOB/Samantha Modell

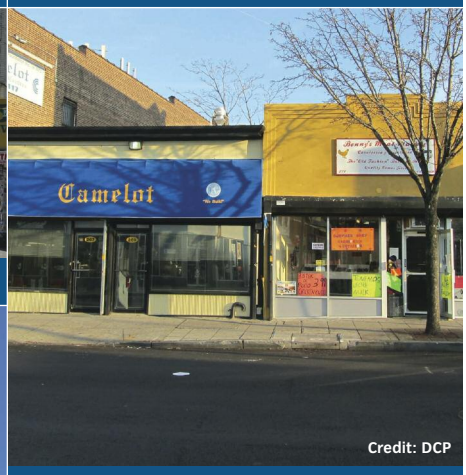
Detached 1- and 2-Family Home


Credit: Wikimedia/Jim Henderson

Attached 1- and 2-Family Home

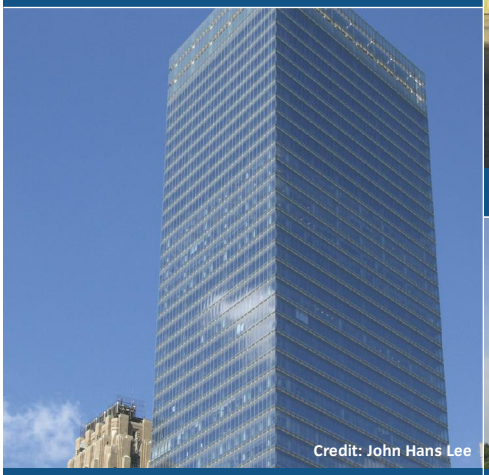
Credit: Wikimedia/Beyond My Ken

Low- to Mid-Rise Mixed-Use Building



Credit: DCP

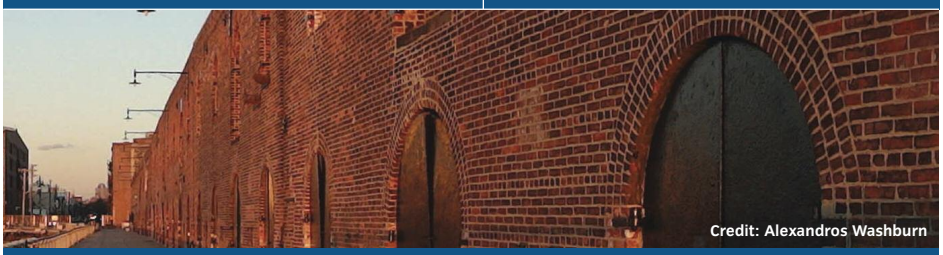
Low- to Mid-Rise Commercial Building


Credit: John Hans Lee

High-Rise Commercial Building


Credit: DOB/Samantha Modell

High-Rise Multi-Family Building


Credit: Alexandros Washburn

Low- to Mid-Rise Industrial Building

Categorization of New York City Buildings by Physical Characteristics

Building Height	• Low-rise: 1 or 2 floors • Mid-rise: 3 to 6 floors • High-rise: 7 floors and up
Construction Type (as defined by the Building Code)	• "Combustible" buildings: built using lighter, stud-frame construction; or wood joists on masonry bearing walls • "Non-combustible" buildings: built using steel, or masonry and concrete frames
Proximity	• Detached: freestanding • Semi-attached: sharing a wall with another building • Attached: sharing walls on both sides with adjoining buildings

and rebuilt structures to meet the highest available standards and to facilitate the retrofitting of as many existing buildings as possible so that they become significantly more resilient than they are today. This approach will benefit a full range of buildings—those that are and may become vulnerable; those that are new and preexisting; those that are residential and non-residential; those that were impacted by Sandy and those that were not.

How the Building System Works

Any understanding of the vulnerabilities of New York's buildings must start with an understanding of the types of structures in the city and how they are regulated.

Structural Characteristics and Uses of New York City's Building Stock

New York City's buildings can be categorized by the following attributes, all of which are relevant for resiliency:

- physical characteristics;
- building use; and
- building age.

(See photos: Common Building Types Across New York City)

New York's buildings can be categorized by building height, construction type (as defined by the Building Code), and proximity to other structures. Building height ranges from low-rise (1 or 2 floors) to mid-rise (3 to 6 floors) to high-rise (7 floors and up). Meanwhile, there are two main construction types: so-called "combustible" buildings that are built using lighter stud-frame construction or wood joists on masonry bearing walls; and "non-combustible" buildings that use steel or masonry and concrete frames. Buildings in New York also can be characterized by their proximity to each other: they can be detached (freestanding); semi-attached (sharing a wall with another building); or attached (sharing walls on at least two sides with adjoining buildings). *(See table: Categorization of New York City Buildings by Physical Characteristics)*

Finally, buildings in New York also can be categorized by their age. This is a key factor because it correlates to the rules applicable at the time of the building's construction—and therefore the type of construction used.

Ever since Peter Stuyvesant instituted the first building regulations in New York in 1648 (appointing fire wardens to inspect buildings for fire hazards), the City's regulations governing the construction and the location of buildings have evolved, ensuring that new buildings meet

increasingly high safety standards. While this approach has improved building safety over time, the corollary of this is that many older structures in the city were built according to codes that leave them more vulnerable to extreme weather events than buildings constructed to more modern standards.

Regulatory Framework for New York City's Building Stock

Buildings in New York City are governed by a wide variety of rules and regulations. Two City agencies share primary responsibility for overseeing New York's buildings: the Department of Buildings (DOB) and the Department of City Planning (DCP).

DOB regulates construction standards to ensure safe and lawful building use. DOB accomplishes its mission by enforcing several codes and regulations, including the City's Construction Codes (of which the Building Code is a part), the Electrical Code, and the Zoning Resolution. DOB also is responsible for enforcing the New York State Multiple Dwelling Law, which governs the habitability of multi-family buildings in New York City.

DCP, meanwhile, establishes citywide regulations for building use, density, and bulk through the Zoning Resolution. DCP also initiates planning and zoning changes for individual neighborhoods and business districts to promote the orderly growth and development of the city. Any changes to the Zoning Resolution initiated by DCP require the approval of the City Planning Commission and the City Council.

In addition to DOB and DCP, many other City agencies play critical roles in overseeing New York's building stock. These include the Fire Department of New York (FDNY), the Department of Housing Preservation and Development (HPD), and the Board of Standards and Appeals (BSA). *(See table: City Agencies That Regulate New York's Building Stock)*

Thanks to the efforts of these agencies and others, New York has a long history of working to improve the resiliency of its buildings. For example, the building codes and land use laws enacted in the 1960s (including a new Zoning Resolution passed in 1961 as well as critical building code revisions that culminated in a new Building Code in 1968) contained many measures that, while not explicitly designed to protect buildings from climate risks, did seek to make buildings generally safer, and thus also had the effect of improving flood protection.

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. This resulted in heavier buildings that were constructed of non-combustible materials such as steel, concrete, and masonry—materials that also reduced vulnerability to structural damage during storm surge and flooding events. Over time, older, light-frame buildings in central portions of the city tended to be replaced by bigger, heavier buildings, while light-frame, low-density buildings remained more common on the edges of the city.

City Agencies That Regulate New York's Building Stock

Agency	Regulatory Role	Applicable Regulations
Department of Buildings (DOB)	• Regulates construction standards to ensure safe and lawful building use	• Construction Codes (of which the Building Code is a part) • Electrical Code • Zoning Resolution • New York State Multiple Dwelling Law
Department of City Planning (DCP)	• Regulates building uses, density, and bulk through the Zoning Resolution • Initiates planning and zoning changes for individual neighborhoods, as well as citywide changes, subject to the approval of the City Planning Commission and the City Council	• Zoning Resolution
Fire Department of New York (FDNY)	• Regulates the maintenance and safe use of buildings with regard to fire hazards	• Fire Code
Department of Housing Preservation and Development (HPD)	• Maintains and administers basic standards for the safety and habitability of housing	• Housing Maintenance Code
Board of Standards and Appeals (BSA)	• Adjudicates appeals of interpretations of the Zoning Resolution, as well as variances and certain special permits	• Zoning Resolution

The City began actively and deliberately incorporating resiliency into its building regulations in 1983, when FEMA first released its FIRMs for New York City, which set the boundaries of the 100-year floodplain (see Chapter 2). In the FIRMs, the 100-year floodplain itself is divided into subzones that further delineate the level of risk, including V Zones, in which the physical impact of waves during flooding is expected to be greatest, and A Zones, where waves are expected to be less significant. These maps also show the associated Base Flood Elevations (BFEs), or the height to which floodwaters potentially could rise.

These maps are relevant to New York's building regulations because of the role they play in the National Flood Insurance Program (NFIP), which allows property owners to purchase flood insurance from the Federal government. First, properties in the 100-year floodplain are required to carry flood insurance, usually from the NFIP, if they are encumbered by Federally backed mortgages (see Chapter 5, *Insurance*). Additionally, under Federal law, if jurisdictions such as New York want their citizens to be able to purchase insurance from the NFIP, then these jurisdictions must incorporate nationally recognized flood-resistant construction standards into their own building codes. Generally, these standards apply to new and substantially improved buildings (i.e., buildings for which the cost of alteration is greater than 50 percent of their value, prior to improvement) in the floodplain. The City adopted these standards in 1983.

In addition to adhering to requirements established by the NFIP, New York City also is required to comply with a State regulation that mandates that New York City's local building codes be at least as protective as the State's own Building Code. This is relevant because, in

2010, New York State adopted an even higher elevation standard than was required under the NFIP, mandating that new and substantially improved buildings in the 100-year floodplain must include "freeboard"—an incremental elevation above the BFE to which a building must be flood-protected. Freeboard is one way to compensate for uncertainties relating to flood modeling and to future sea level rise. Pursuant to this State requirement, 1- and 2-family homes were required to add 2 feet of freeboard to the BFE, while most non-residential buildings were required to add one foot of freeboard. The applicable elevation, BFE plus freeboard, is referred to as the Design Flood Elevation (DFE). New York City adopted the State's standard as part of an Emergency Rule issued by DOB in January 2013. *(See graphic: Flood Protection Terms)*

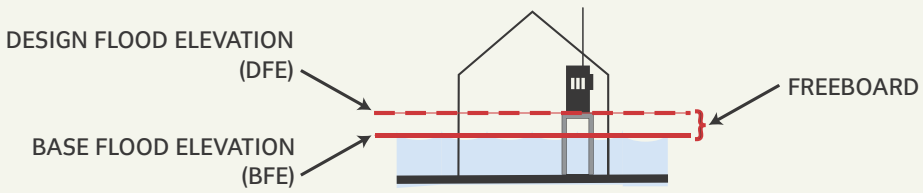
In New York City, these Federal, State, and local standards are incorporated into Appendix G of the Building Code, which outlines the flood-resistant construction techniques that are required for new and substantially improved buildings in the 100-year floodplain. Appendix G is therefore a critical tool for protecting vulnerable buildings. *(See chart: Overview of Appendix G: Flood-Resistant Construction)*

Pursuant to Appendix G and consistent with the standards above, in residential buildings anywhere in the 100-year floodplain, living areas are not permitted below the DFE. Only parking, building access, and storage are permitted below such elevations. For residential buildings in A Zones, any area below the DFE must be "wet flood-proofed," a technique designed to allow floodwaters to enter and leave a structure through flood openings or vents. This approach allows hydrostatic forces—the pressure exerted by the sheer weight of water—to equalize on both sides of building walls and thus prevents structures from collapsing. Residential buildings in A Zones also may comply with Appendix G by elevating their lowest floor above the DFE. *(See graphic: Wet Flood-Proofing Method)*

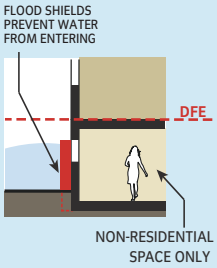
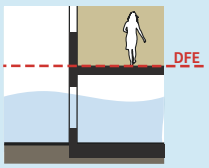
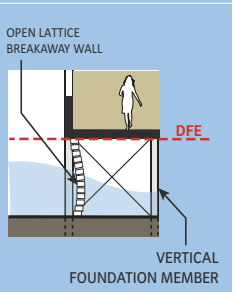
For a residential building in a V Zone, the entire structure must be elevated on piles to prevent the lateral force of waves from damaging the structure. In addition, areas below the DFE are required to be open or built with "breakaway" walls, such as non-supporting open-lattice walls, that can give way under water pressure without causing the building to collapse.

Requirements for commercial buildings differ from those of residential buildings. In A Zones, commercial buildings must have their lowest floor elevated above the DFE or be "dry flood-proofed" (made watertight) below the DFE. Dry flood-proofing techniques are designed to prevent water from entering a structure (using,

Flood Protection Terms

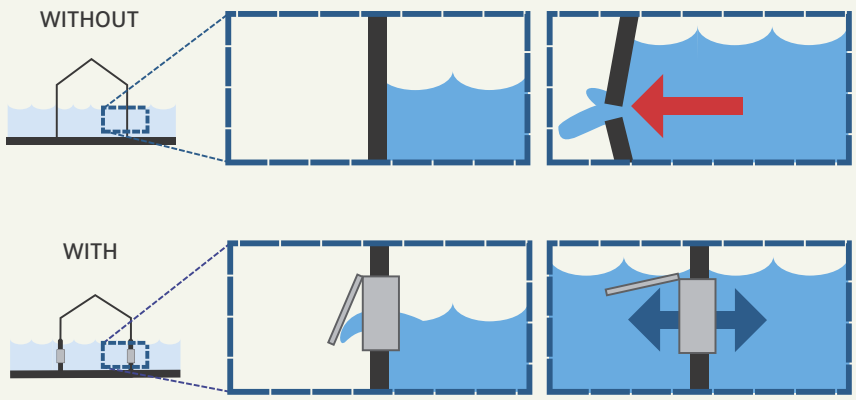


Overview of Appendix G: Flood-Resistant Construction

	A ZONE		V ZONE
FLOOD PROTECTION STRATEGY	**DRY FLOOD-PROOFING** WATERTIGHT STRUCTURE e.g., FLOOD SHIELDS	**WET FLOOD-PROOFING** WATER TO RUN-IN / RUN-OUT e.g., FLOOD VENTS	**ELEVATED STRUCTURE** VIRTUALLY OPEN STRUCTURE e.g., OPEN LATTICE BREAKAWAY WALLS
GROUND FLOOR CONFIGURATION	 LOWEST OCCUPIED FLOOR ALLOWED TO BE EXCAVATED BELOW GRADE NOT PERMITTED FOR ENTIRELY RESIDENTIAL BUILDINGS	 LOWEST OCCUPIED FLOOR TO BE AT OR ABOVE DESIGN FLOOD ELEVATION	 BOTTOM OF LOWEST STRUCTURAL MEMBER TO BE AT OR ABOVE DESIGN FLOOD ELEVATION
PERMITTED USE BELOW DFE	✓ PARKING ✓ ACCESS ✓ STORAGE ✓ NON-RESIDENTIAL ✗ RESIDENTIAL	✓ PARKING ✓ ACCESS ✓ STORAGE ✗ NON-RESIDENTIAL ✗ RESIDENTIAL	✓ PARKING ✓ ACCESS ✓ STORAGE ✗ NON-RESIDENTIAL ✗ RESIDENTIAL

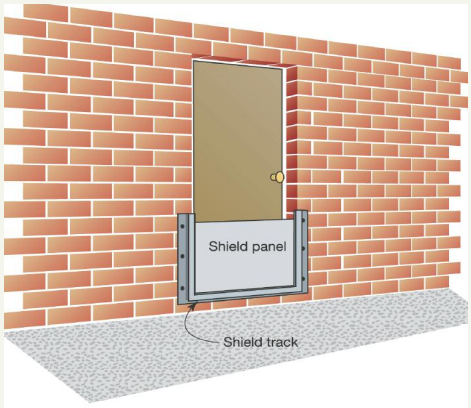
Source: DCP

Wet Flood-Proofing Method



Without wet flood-proofing, pressure from floodwaters builds up on one side of a building's walls, often causing structural damage. With wet flood-proofing, openings or vents permit floodwaters to enter an enclosed area, allowing this pressure to equalize on both sides of the building's walls thereby preventing the structural damage.

Dry Flood-Proofing Method Using Temporary Flood Shields



One method of dry flood-proofing is a temporary flood shield that can help prevent low-level flooding from entering through an opening such as a door or window.

Source: FEMA

for example, sealants, flood shields, or aquarium glass) and to strengthen structural components to resist hydrostatic forces from floodwaters. In V Zones, such dry flood-proofing of commercial uses is not permitted. Instead, as with residential buildings, the lowest occupied floor must be elevated above the DFE. *(See graphic: Dry Flood-Proofing Method Using Temporary Flood Shields)*

For all new and substantially improved buildings, Appendix G further requires that, regardless of intended use, flood damage-resistant materials must be used below the DFE. Such materials must be capable of withstanding direct and prolonged contact with floodwaters, without sustaining any damage that requires more than cosmetic repair. In addition, pursuant to Appendix G, mechanical equipment (electrical, heating, ventilation, plumbing, and air conditioning systems) either must be located above the DFE or, if located below the DFE, must be protected so as to prevent it from being inundated with water.

Under Mayor Bloomberg, the City has been even more aggressive about building resiliency, focusing not just on surge and flood but also on other climate risks. For example, in 2008, the Mayor and the City Council Speaker convened the Green Codes Task Force—an expert panel of architects, engineers, regulators, and other stakeholders—to recommend changes to the City's codes and regulations to make buildings more sustainable. The group's 111 recommendations included proposals to augment building standards in the 100-year floodplain to account for rising sea levels and to ensure "passive survivability"—providing residents with safe living conditions in the event of citywide utility failures. To date, 39 of the group's recommendations have been adopted by City agencies and the City Council. Meanwhile, in 2011, DCP released *Vision 2020: New York City Comprehensive Waterfront Plan*, a 10-year plan for the city's 520-mile waterfront that explicitly included increasing climate resiliency as one of eight overarching goals, addressing in detail the need to consider climate risks as a part of waterfront development.

In the immediate aftermath of Sandy, the City reexamined its existing flood-resistant construction rules so that rebuilding and new construction would reflect the best available data on coastal flood risk. As a result, on January 13, 2013, in collaboration with the City Council, Mayor Bloomberg issued Executive Order 230, "An Emergency Order to Suspend Zoning Provisions to Facilitate Reconstruction in Accordance with Enhanced Flood Resistant Construction Standards." This emergency order suspended height and other zoning restrictions so that buildings could meet new advisory flood elevation standards published by FEMA in February, without being penalized under the Zoning Resolution (for example, if elevation put a structure into conflict with zoning height limitations). This measure was designed as a temporary tool so that buildings being built or retrofitted post-Sandy would be constructed safely, according to the then-best available information.

In an effort to further promote resiliency, the Mayor and the City Council Speaker convened the Building Resiliency Task Force (BRTF), an expert panel of engineers, architects, developers, and property owners, along with representatives of City government. The BRTF, which worked closely with those involved in developing this report, was charged with undertaking a comprehensive review of current code standards and proposing changes with the goal of ensuring that, going forward, buildings would be constructed to the most modern standards of resiliency. Managed by the Urban Green Council, the local chapter of the US Green Building Council, the BRTF is developing proposals that will be released in 2013. These proposals will expand upon and complement the recommendations outlined in this chapter.

Credit: DOB/Dan Eschanasy

The effects of flooding and storm surge resulted in severe structural damage to many buildings during Sandy.

What Happened During Sandy

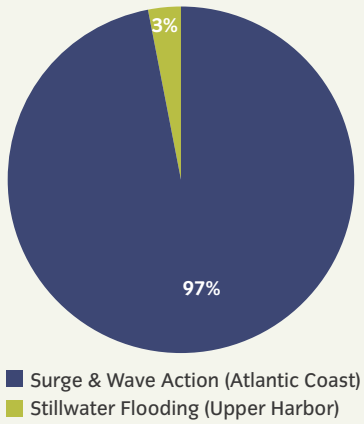
Building damage from storm surge and inundation during Sandy was widespread and in many cases severe. Sandy flooded an area that included approximately 88,700 buildings, or 9 percent of the city's building stock. These buildings encompassed 662 million square feet of space that included more than 300,000 housing units and 23,400 businesses. The storm completely destroyed or rendered structurally unsound hundreds of buildings and damaged thousands more. More than 100 of these impacted homes and businesses were destroyed by storm-related fires, which were predominantly electrical in nature and caused largely by the interaction of electricity and seawater.

Following Sandy, both the Federal government (through FEMA) and City government (through DOB) inspected the damage caused by the storm. At the Federal level, as of February 15, 2013, FEMA had completed inspections of nearly 70,000 housing units that registered with FEMA for disaster assistance. These inspections demonstrated that building damage varied widely, both in terms of the dollar value of losses and the level of flooding sustained. For example, of the approximately 47,000 owner-occupied housing units inspected by FEMA, 49 percent had sustained damage in excess of $10,000, with 12 percent sustaining damage in excess of $30,000. Of the approximately 22,000 rental housing units inspected, 26 percent sustained "substantial damage", the highest damage classification used by FEMA, indicating that damage was 50 percent or more of the pre-flood market value of the building.

The City's building-level damage assessments following Sandy were similarly comprehensive. These were led by DOB and represented the largest building inspection initiative in New York City history, teaming DOB inspectors and engineers with private-sector engineers who volunteered to serve the effort in Rapid Assessment Teams. The result of this initiative was a series of "tags" applied to buildings, ranging from "red" (indicating structural damage) to "yellow" (indicating that portions might be unsafe or might have significant non-structural damage) to "green" (indicating less serious damage or no damage at all).

The first set of these tags was issued by DOB Rapid Assessment Teams that were sent to the most impacted sections of the city immediately following Sandy (DOB Post-Storm Tags). Of the roughly 82,000 buildings receiving DOB Post-Storm Tags, approximately 73,000 of the buildings were tagged as green (or 89 percent of the total), 7,800 were tagged as yellow (or 10 percent of the total), and 930 were tagged as red (or 1 percent of the total). Of the red-tagged buildings, 220 were further categorized as destroyed.

Buildings Assigned Red or Destroyed Tags, Categorized by Flood Type



Source: DOB December Tags, DCP PLUTO

In December 2012, DOB conducted a follow-up assessment of the buildings that received DOB Post-Storm Tags, focusing on the roughly 8,700 buildings that had earlier been tagged yellow or red (including those tagged as destroyed). This assessment sought to standardize DOB's classification methodology across the boroughs. Generally, this assessment took a more conservative approach, for example, assigning yellow tags for damage to building systems only in larger buildings with elevators. As a result, a number of properties were reclassified (DOB December Tags). Of the roughly 8,700 buildings receiving DOB December Tags, approximately 1,300 were given yellow tags, and 780 were given red tags, of which 230 were further categorized as destroyed.

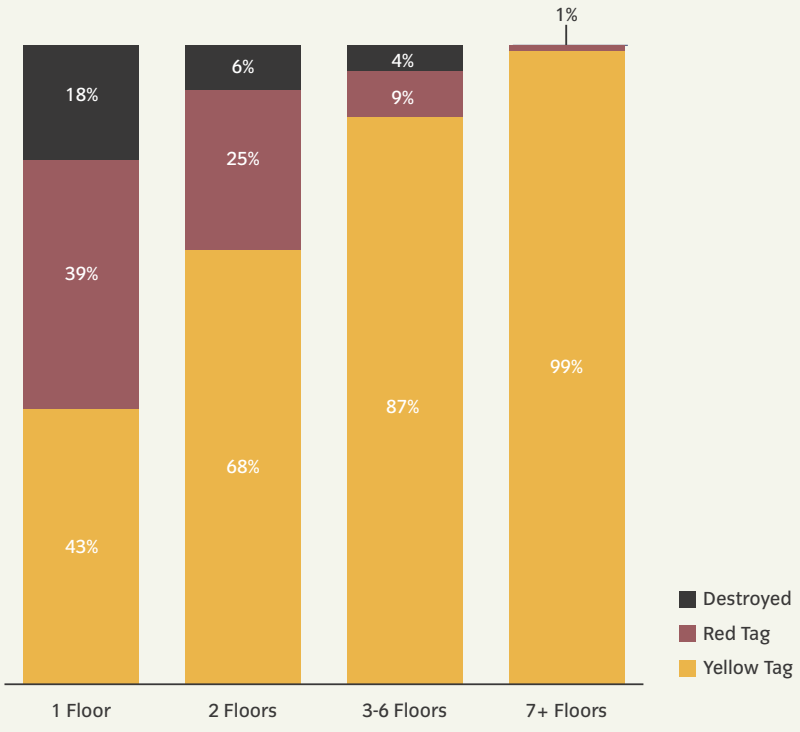
Though the figures diverge from one another, the story that they tell about the impact of Sandy on the city's building stock is relatively consistent. Namely that, with respect to the buildings that were seriously damaged by Sandy (those receiving either yellow or red tags, including those further classified as destroyed), the majority (between 63 percent and 91 percent) received yellow tags. This indicates that most Sandy-related damage was non-structural in nature, largely due to flooding of building systems and equipment (including electrical, sanitary, and life safety systems) located on ground floors or in basements—a conclusion that is buttressed by the fact that the aforementioned figures likely *understate* the number of buildings citywide that could have received yellow tags, given that DOB's focus was generally on areas of the city where structural damage to buildings was greatest.

Though the damage indicated by yellow tags, in most cases, did not structurally compromise buildings, it did, in many cases, have profound impacts on building occupants, displacing residents and businesses likely also to be contending with extensive damage to building contents. Some yellow tagged buildings also required significant and costly repairs, including work on ground floors and basements.

Two sets of factors proved to be strong predictors of how Sandy affected buildings. First, flood characteristics such as surge force and depth of inundation correlated strongly with the degree of damage suffered by a building. Thus, shoreline areas that experienced the strong lateral forces of waves had many more damaged buildings than areas with stillwater flooding. In fact, wave action along the Atlantic Coast (including Southern Brooklyn, South Queens, and the East and South Shores of Staten Island) accounted for the majority of damaged buildings, and for nearly all buildings tagged red or destroyed citywide, whether those tags were DOB Pre-Storm Tags or DOB December Tags. (*See chart: Buildings Assigned Red or Destroyed Tags, Categorized by Flood Type*)

Other, perhaps less intuitive, predictors of Sandy's impact on any given building included building age and physical characteristics. For example, buildings predating the 1961 Zoning Resolution and the 1983 FIRM standards fared much worse than newer buildings, more frequently sustaining significant damage. Moreover, where more recently constructed buildings did suffer damage, such damage tended to be moderate rather than severe.

Buildings Assigned Destroyed, Red, and Yellow Tags, Categorized by Building Height



Source: DOB December Tags, DCP PLUTO

Building height was another key predictor of the degree of building damage from Sandy. One-story buildings proved particularly susceptible to severe damage. Although such buildings accounted for less than 25 percent of the buildings in the area inundated by Sandy, they represented roughly 75 percent of the buildings that sustained the most severe damage according to the DOB December Tags (those receiving red tags, including those further tagged as destroyed). By contrast, high-rise buildings experiencing inundation generally did not sustain structural damage according to the DOB December Tags. They, however, often did experience damage to building systems that were housed in basements or otherwise insufficiently elevated. (*See chart: Buildings Assigned Destroyed, Red, and Yellow Tags, Categorized by Building Height*)

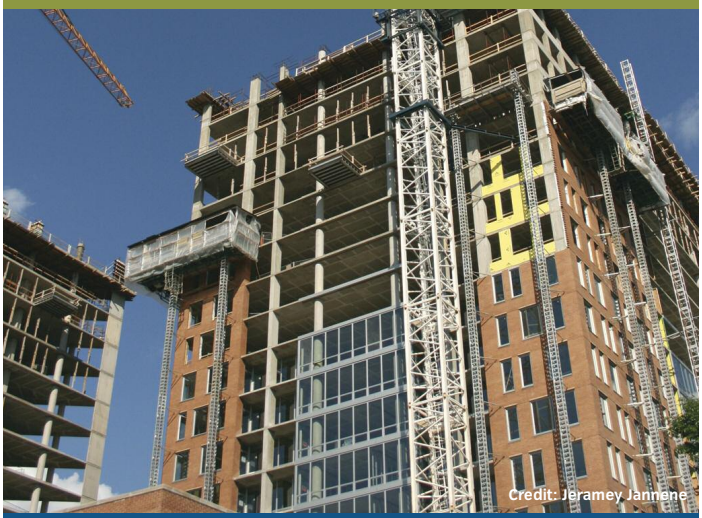
Construction type, which tends to correlate with building height, also served as a predictor of Sandy-related damage for buildings. As stated above, low-rise structures suffered the most severe damage. Though such structures are often of combustible construction, not all are. However, where low-rise structures were also of combustible construction, the damage tended to be even more severe. In fact, while 85 percent of the 1-story buildings in the area inundated by Sandy were combustible structures, 99 percent of 1-story buildings receiving red DOB December Tags (including those further tagged as destroyed) were of a combustible construction type. Conversely, high-rise structures, which often are of a non-combustible construction type, tended to experience less severe structural damage. (*See photos: Combustible Construction Type and Non-Combustible Construction Type*)

The building type most vulnerable to Sandy's effects turned out to be 1-story combustible buildings constructed before 1961—including bungalows found in many coastal areas of the city. Buildings matching these characteristics represented 18 percent of the buildings in the inundated areas of the city, but 73 percent of all structurally damaged or destroyed buildings in the city. Structures of this type were approximately four times more likely to sustain severe damage than their share in the inundation area would suggest. (*See chart: Share of Total Buildings in the Sandy Inundation Area Compared to Share of Building Damage, Categorized by Building Type*)

Combustible Construction Type

Combustible structures, such as the wood stud-frame building above, tend to be lighter and shorter and suffered more severe structural damage during Sandy.

Non-Combustible Construction Type



Non-combustible structures, such as the reinforced concrete frame building above, tend to be heavier and bigger, and primarily suffered non-structural damage to building systems and equipment during Sandy.

Share of Total Buildings in the Sandy Inundation Area Compared to Share of Building Damage, Categorized by Building Type

Buildings in the Sandy Inundation Area	Year of Construction	1 Floor		2 Floors		3 to 6 Floors		7 Floors or Higher		
		Combustible	Non-Combustible	Combustible	Non-Combustible	Combustible	Non-Combustible	Combustible	Non-Combustible	
Total Buildings	Pre-1961	18%	3%	37%	1%	11%	1%	0%	1%	100%
	Post-1961	2%	1%	16%	1%	6%	1%	0%	1%	
Buildings Assigned Red or Destroyed Tags	Pre-1961	73%	1%	16%	0%	5%	0%	0%	0%	100%
	Post-1961	1%	0%	3%	0%	1%	0%	0%	0%	

Percentages reflect the share of buildings in each category – either Total Buildings in the Sandy Inundation Area or Buildings with Red or Destroyed Tags– that have the characteristics defined in the chart. For example, 1-story buildings of a combustible construction type built pre-1961 represented 18 percent of the buildings in the Sandy Inundation Area, but 73 percent of the buildings tagged red or destroyed.

Source: DOB December Tags, DCP PLUTO

Although both size and construction type did play a role in the poor performance of many damaged and destroyed 1-story buildings, it is noteworthy that other 1-story structures and other combustible structures generally did not fare as poorly as 1-story combustible structures that also were built prior to the introduction of modern building codes. Thus the rules and regulations contained in these codes did appear to have played a particularly critical role in determining how well impacted structures fared.

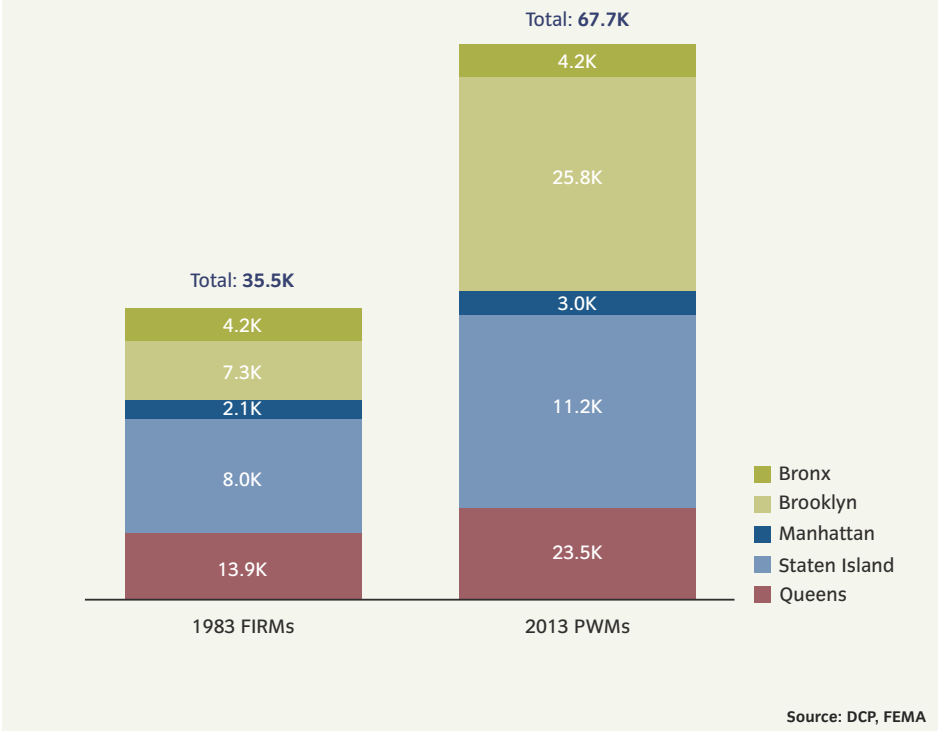
What Could Happen in the Future

New York City's buildings face a variety of risks related to climate change.

Major Risks

Now and into the future, the risk of storm surge combined with sea level rise is likely to present the greatest threat to New York City's building stock. Flood risk is illustrated by the recent PWMs created by FEMA, which show more than 67,700 buildings now to be in New York City's 100-year floodplain, up from the approximately 35,500 indicated in the 1983 FIRMs—an increase of roughly 90 percent. These 67,700 buildings, in turn, encompass nearly 535 million square feet of space and house approximately 398,000

Expansion of the Number of Buildings in the 100-Year Floodplain



Source: DCP, FEMA

Risk Assessment: Impact of Climate Change on Buildings

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Increasing numbers of buildings face weekly and daily flooding
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Large and growing number of buildings likely would face significant flooding risk
Heavy downpour				Minimal impact
Heat wave				INDIRECT: impact primarily relating to increased risk of power outages
High winds				Building codes are calibrated to anticipated wind speeds though in-place stock and equipment may be vulnerable

residents and 271,000 jobs. Though these figures are significant in many ways, they tell only part of the story of the city's vulnerability. *(See chart: Expansion of the Number of Buildings in the 100-Year Floodplain)*

As vulnerable as New York's building stock may be today, it is very likely to become even more vulnerable in the future. According to climate projections from the New York City Panel on Climate Change (NPCC) described in Chapter 2 (*Climate Analysis*), sea levels are forecast to rise through the 2020s and 2050s. During this period, the floodplain will expand, with a corresponding increase in the number of buildings in the 100-year floodplain—rising to more than 88,000 by the 2020s and more than 114,000 by the 2050s based on recent high end projections of sea level rise. In addition to exposing more New Yorkers to greater risk, an expansion of this scale also would have significant financial impacts on hundreds of thousands of New Yorkers, ranging from new requirements relating to flood insurance, to more expensive flood insurance premiums, to new requirements for property owners to alter ground-level and underground spaces to comply with national flood-resistant construction standards (see Chapter 5).

Other Risks

Going forward, high winds are projected to pose a moderate risk to the building stock of New York.

While the NPCC does not provide specific projections for wind speeds, their projections do suggest an overall increase in the frequency of the most intense hurricanes, which are accompanied by high winds. Though the Building Code already requires new and substantially improved buildings to protect against top winds associated with a Category 3 hurricane, older buildings that predate modern standards and have improperly installed and maintained external elements may be vulnerable. This is especially true in areas with open exposures—for instance, along the coast—and with respect to older 1- and 2-family homes. And all structures, including high-rise buildings, will continue to face potential damage to façades from airborne debris during the sorts of extreme wind events that could occur in the future.

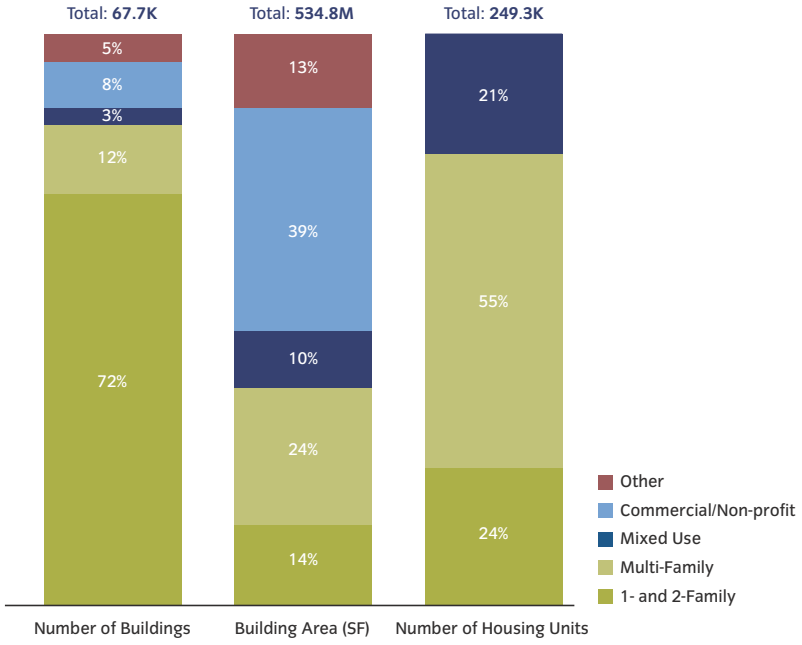
In addition, the city's future wind risk profile in the face of climate change is uncertain. While current Building Code requirements are based on data from area airports—John F. Kennedy International Airport, LaGuardia Airport and Newark Liberty International Airport—a detailed mapping of the city's wind profile could provide a much more accurate assessment of the risks that buildings face with potentially increased storm activity.

Meanwhile, heavy downpours, increased precipitation, and higher temperatures in the future are expected to have a minimal impact on buildings. Though increased precipitation may raise the possibility of flooding, the levels of flooding currently projected are not believed to present anywhere near the same threat to life and property that storm surge poses now and in the future. Similarly, currently forecasted increases in average temperatures should not affect significantly the resiliency of building structural elements or in-house mechanical and electrical systems. However, without resiliency investments, the power outages that may come with heat waves certainly would affect the occupants of the city's buildings (see Chapter 6, *Utilities*).

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

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

Buildings, Building Area, and Housing Units in the 2013 PWMs Broken Down by Land Use



Source: FEMA, DCP PLUTO

Overview and Approach

As the impact of Sandy demonstrated, buildings constructed in accordance with modern codes and standards tend to be better able to withstand extreme weather events—that is, they tend to be more resilient. Yet these codes and standards cannot remain static. They must evolve continually to incorporate the best available technologies and methodologies. The building initiatives to address climate risks, therefore, include a focus on enhancements to New York's building codes, with the goal of achieving two ends:

1. Strengthen new and substantially improved buildings to meet the highest possible standards;
2. Protect existing buildings—which remain the city's biggest challenge given their numbers—by encouraging targeted retrofits over time.

Strengthen new and rebuilt structures to meet the highest resiliency standards moving forward

For new and substantially improved buildings (that is, buildings for which the cost of alteration is greater than 50 percent of their previous value), the highest resiliency standards can be incorporated early in the design phase of construction in a manner that would effectively mitigate future losses. The City, through the Mayor's Office of Long-Term Planning and Sustainability (OLTPS), therefore will work with the City Council to enhance the Construction Codes so that these buildings are designed to reflect the best available information on climate risk and resiliency.

Retrofit as many existing buildings as possible to improve resiliency

Meanwhile, the City also must deal with its substantial in-place inventory of existing buildings that are or will be vulnerable to climate risks. In many ways, existing buildings represent a bigger challenge than new buildings. Most of the buildings in the city's 100-year floodplain are older, constructed to codes and standards that did not incorporate flood resistance. In fact, approximately 72 percent of the structures in the city's 100-year floodplain were erected before 1961, when the current Zoning Resolution was passed, and 85 percent before 1983, when the City adopted FEMA's flood maps and incorporated flood-resistant construction standards for new and substantially improved buildings in the 100-year floodplain.

New York City's buildings also, in many cases, can be found amid urban site conditions that make retrofits challenging. The city's building stock differs dramatically from that of communities in other coastal flood-prone areas, such as the Gulf Coast and the Southern Atlantic Coast, which have sought to incorporate flood resistance even into their preexisting building stock. While construction in these coastal areas consists primarily of lower-density homes, buildings in New York City's 100-year floodplain include substantial numbers of higher density, and often attached multi-family, and commercial/nonprofit buildings. Thus, while more than 70 percent of the 67,700 buildings in the 100-year floodplain of FEMA's PWMs are 1- and 2-family homes, a majority of the building area and housing units in the floodplain can be found in higher-density buildings. Specifically, approximately 34 percent of the 535 million square feet located in the 100-year floodplain can be found in multi-family buildings or mixed-use structures (which also tend to be multi-family), and roughly 39 percent can be found in commercial/nonprofit space. Similarly, while 1- and 2-family homes represent only 24 percent of the approximately 249,000 housing units in the 100-year floodplain, roughly 76 percent can be found in multi-family or mixed-use buildings. *(See chart: Buildings, Building Area, and Housing Units in the 2013 PWMs Broken Down by Land Use)*

The very nature of the city's structural inventory poses a challenge to using methodologies such as elevation to retrofit New York's building stock. For example, many property types common in New York City's neighborhoods have multiple stories and are constructed from materials such as masonry and concrete that make elevation difficult. Many also are attached or semi-attached, which means that elevation would require coordination with neighboring properties, and may be physically difficult and financially infeasible. Additionally, whereas in other jurisdictions, abandonment of ground floor and underground space may be a viable alternative to actual elevation, in many parts of New York, because of the high

value of usable real estate, doing so would result in significant financial loss to property owners.

Greater flood protection in developed areas also poses urban design challenges—both for retrofitting and new construction. Such protection can interfere with the visual connectivity between the first floor of a building and the public sidewalk, creating uninviting entranceways, and leading to architecture that fails to engage pedestrians. In New York, traditional flood-protection methods, therefore, have the potential to impact the neighborhood fabric in a negative way and could undermine the vitality of street life.

For example, if buildings in dense urban areas are elevated, spaces left unoccupied at the street level could pose security risks to area residents. Elevation also can make commercial corridors—which provide critical services and employment—untenable by inhibiting access to street-level retail. Visual and physical accessibility of retail from the sidewalk is more important in New York than elsewhere because New Yorkers walk to shopping and services more than anyone else in the United States. Elevating stores also can isolate them from the street environment. In addition, dry flood-proofing of retail or industrial structures can be technically difficult or costly. Meanwhile, even where elevation may be physically possible (as in the case of smaller, wood-framed structures), the narrow lots in New York City limit the space needed to stage construction and make post-elevation access challenging. *(See sidebar: Urban Site Conditions and Flood Protection Challenges)*

In short, these and other constraints make it prohibitively expensive, physically infeasible, or both, for owners of many properties in the floodplain to elevate their structures or to otherwise retrofit their buildings to meet national flood-resistant construction standards in full. In fact, as of the writing of this report, it is estimated that owners of approximately 39 percent of buildings in the 100-year floodplain of the PWMs (or roughly 26,300 buildings) would face significant challenges if they sought to retrofit in these ways due just to their challenging site conditions such as narrow lots or attached structures—without even taking into account issues such as cost and the ability to secure financing.

Given these obstacles, some policy advocates have suggested alternative approaches to improve the resiliency of New York's housing stock, such as government purchases of large numbers of vulnerable properties in the floodplain. Buyouts intended to turn exposed properties into natural or open spaces may make sense in limited circumstances in very high-risk areas where vulnerability is a function of the land itself, and not of shortcomings in the buildings that exist there as of the writing of this report. However, such buyouts raise many issues. They would need to result in an open space or buffer area that serves a useful purpose, and to do so, would require near-unanimous participation of area residents to be effective—a challenge in many circumstances. Additionally, even if unanimity (or near-unanimity were achieved), the approach can be expensive—diverting limited resources from other investments that may be more cost-effective or have a more widespread impact. Given the scale of New York's building stock in the coastal area, the fact that buildings can be constructed to address the flood risks faced in the vast majority of coastal neighborhoods, and the limited alternative options for a growing population in New York City and the region, wholesale abandonment of or retreat from the city's waterfront is simply not a practical option.

The City, therefore, proposes an approach pursuant to which buyouts would be a tool in the City's tool kit, but one that would be used sparingly and, where used, would most commonly be used with the goal of redeveloping acquired properties in a more resilient fashion. In most cases, the City will prioritize the use of limited resources to retrofit the largest number of existing buildings to a significantly higher standard of resiliency. This strategy focuses on avoiding catastrophic loss in building types that proved most vulnerable during Sandy and otherwise seeks to allow inhabitants to reoccupy buildings quickly—after complying with all City evacuation orders and once reentry is deemed to be safe—by focusing efforts on elevating or otherwise protecting critical building systems. As with all retrofits, these building improvements would be completed in compliance with existing City construction rules, including the requirement that alterations greater than 50 percent of building value, prior to improvement, be considered "substantial improvements." Substantially improved buildings must comply with the same flood-resistant construction standards as new buildings.

Strategy: Strengthen new and substantially rebuilt structures to meet the highest resiliency standards moving forward

Initiative 1

Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain

As described above, the current rules for flood-resistant construction incorporate elevations from the most recently adopted FEMA FIRMs, which have not been significantly updated since 1983. In 2010, FEMA began working with the City to update these maps to reflect better information on current flood risk. As part of this effort, FEMA released PWMs in June 2013. These maps provide an updated approximation of the final boundaries of the floodplain and BFEs that will be found in the final FIRMs that are expected to be issued by FEMA in 2015, with City adoption thereafter.

To enable new and substantially improved buildings, as well as existing buildings that retrofit voluntarily, to withstand appropriate flood risk, the City has proposed an amendment to the Zoning Resolution to allow these buildings to be elevated, without being penalized by zoning height limitations, to the higher of the BFE in the current effective FIRMs or the best available flood maps (currently the PWMs), in each case, plus 1 to 2 feet of freeboard. The proposed changes would also allow additional flexibility for other resiliency measures, including the elevation of mechanical equipment and relocation of existing underground parking.

When the new FIRMs are finalized, the City will further update the Building Code to reference the elevations contained therein and to require freeboard of 1 to 2 feet above these elevations.

Looking to a future where sea level rise could result in flood elevations even beyond the mandated freeboard, the City also will conduct a study of the implications of permitting zoning relief for up to 3 feet of freeboard. This analysis will serve as a necessary first step towards potential future adoption of corresponding zoning changes.

Towards a similar end, the City and the NPCC will establish a set of interim metrics to be measured in 2025 that will indicate whether sea levels around New York appear to be rising at expected rates. Every six years—in conjunction with every second Construction Codes review cycle—the NPCC and the City will review observed sea level rise. If, by 2025, sea level rise surpasses the metrics put forth by the City and the NPCC, the Building Code will be amended at that time, with corresponding zoning relief, to require 3 feet of freeboard above the BFE in FEMA's FIRMs (rather than the proposed 1 to 2 feet).

The Construction Codes (of which the Building Code is a part) will be amended in yet other ways, including additional changes that will help protect building systems and enable continued building operation in the event of utility failures during a flooding event. For example, new and substantially improved buildings in the 100-year floodplain will be required to install backflow preventers for sewer

connections, to seal points of entry further from floodwaters, and will be required to safeguard toxic materials.

The Construction Codes also will be amended to reduce restrictions on the length of cables that carry telecommunications service, allowing these cables to reach elevations above the DFE.

In addition, the City will revise existing provisions that restrict options for elevating critical equipment. For example, to encourage building owners to protect fuel tanks from flood damage, the current limits on the size of fuel tanks located above grade will be revised to allow for more flexibility. Also, DOB will issue a clarification on how mechanical equipment rooms contribute to floor area in a building.

In 2013, the City, through OLTPS, will seek to implement the foregoing changes to the Construction Codes. Also in 2013, DCP will continue to take the foregoing zoning changes through the public review process, with the goal of adoption before the end of the year. By 2015, DCP also will launch an analysis of the implications of allowing up to 3 feet of freeboard above the BFE, pending the scheduled release of the final FIRMs.

Initiative 2

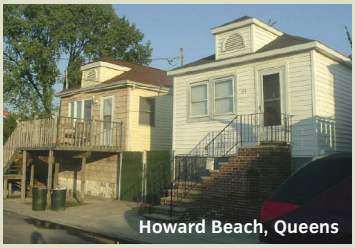
Rebuild and repair housing units destroyed and substantially damaged by Sandy

Roughly 23,000 private residential buildings encompassing nearly 70,000 housing units sustained some level of damage during Sandy. More than 2,000 of these buildings were significantly damaged and must be completely rebuilt or substantially improved, incorporating the highest resiliency standards. To address the damages sustained and to more effectively prepare these significantly damaged buildings for future storm events, the City either will assist owners or, in limited cases meeting City criteria, will facilitate the acquisition of properties by new owners whom it will assist, in rebuilding and substantially improving these properties based on the best floodplain data available over time. Additionally, the City will seek to incorporate resiliency measures into approximately 500 to 600 multi-family properties that sustained minor damage, including those developed under the City's Mitchell Lama Program and other affordable housing programs.

The Mayor's Office of Housing Recovery Operations (HRO) and HPD will lead these efforts. Federal Community Development Block Grant (CDBG) funding in the amount of approximately $530 million has been allocated to the first phase of these programs. HRO and HPD plan to

Urban Site Conditions and Flood Protection Challenges

As described previously, site conditions in New York City make it both physically and financially difficult for the owners of many buildings in the 100-year floodplain to retrofit their buildings to current Federal flood-resistant construction standards. These challenges come into sharp focus when common building types in neighborhoods across New York City are examined.


Howard Beach, Queens

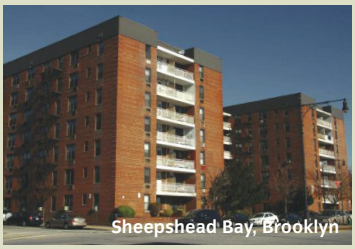
1- AND 2- FAMILY HOMES ON NARROW LOTS

Narrow lots lack space needed to stage construction when elevating a building.


Bayside, Queens

ATTACHED AND SEMI-ATTACHED HOMES

Reconfiguration of one building affects adjoining ones, and, with multi-story buildings, elevation requires removing floors and front and rear facades, in effect demolishing and rebuilding.


Sheepshead Bay, Brooklyn

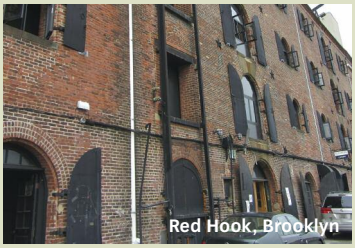
MULTI-STORY BUILDINGS

These buildings would, under current Federal flood-resistant construction standards, either have to eliminate all ground-floor and basement units, displacing families and forfeiting rental income, or elevate, which is highly impractical.


South Street Seaport, Manhattan

BUILDINGS WITH COMMERCIAL GROUND FLOORS

Commercial spaces thrive on ground-floor access. Raising the lowest floor to higher base flood elevations hampers commerce and complicates accessibility.


Red Hook, Brooklyn

INDUSTRIAL BUILDINGS

Though Federal flood-resistant construction standards allow dry flood-proofing of industrial spaces, this approach is costly and less reliable for flood levels higher than 3 feet.

Credit from top to bottom: Tim F via Flickr, WikiMedia, mercurialn via Flickr, Gryffindor via WikiMedia, Adam Elmquist via Panoramio

use a portion of these funds to repair and rebuild a subset of properties that were damaged significantly and, therefore, must be rebuilt or substantially improved.

Initiative 3

Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain

The City, through DCP, will undertake a series of citywide and neighborhood-specific land use studies to address key planning issues in severely affected and vulnerable communities. As part of these studies, the City will identify ways to facilitate the voluntary construction of new, more resilient building stock and to encourage voluntary retrofits of existing vulnerable buildings over time. To be undertaken in close consultation with local residents, elected officials, and other community stakeholders, these land use studies will focus in particular on the challenges posed by the combination of flood exposure of the applicable neighborhoods, the vulnerability of the building types that are found in these neighborhoods (e.g., older, 1-story bungalows) and site conditions in these areas, such as the narrow lots in Midland Beach that can make replacement or retrofit of vulnerable buildings expensive or complicated.

Both citywide zoning changes and detailed neighborhood studies will promote the voluntary development of new, resilient buildings through strategies such as:

- allowing more flexibility in the measurement of height of elevated buildings and allowing parking to be placed underneath, provided steps such as landscaping are taken to address the quality of the streetscape; and
- enabling or even encouraging construction of new buildings that meet modern standards on existing small lots, either individually or in combination with other lots to be rebuilt.

Zoning changes to encourage the voluntary retrofit of existing buildings could include:

- permitting building owners to construct an additional floor above existing top floors to replace space below the DFE that is limited in use to meet flood protection standards;
- promoting best practices for the alternative use of ground floor space below the DFE, where Federal flood-resistant construction standards do not permit residential uses and may not permit commercial or other uses;
- increasing the building space allowed for mechanical systems, enabling property owners to more easily elevate building systems; and
- permitting greater flexibility in the design of stairs, ramps, and other accessibility features where elevation is required for flood-protection purposes.

DCP's proposed Flood Resilience text amendment addresses some of these issues on a citywide basis. Subject to available funding, the goal is for DCP to commence additional studies in 2013. Thereafter, DCP would move to implement any changes deemed to be appropriate based on the results of its study.

To supplement these studies as well as post-Sandy housing recovery efforts more broadly, DCP also has worked with representatives of the local design community to develop a set of urban design principles to consider while designing flood-resilient buildings. These principles—included in DCP's *Designing for Flood Risk* study to be released in June 2013—can help mitigate the negative impacts of building elevation on streetscape, building access, ground floor activity, architectural quality, and neighborhood character. *(See sidebar: Designing for Flood Risk: Urban Design Principles)*

Initiative 4

Launch a competition to encourage development of new, cost-effective housing types to replace vulnerable stock

Many property owners are facing the reality that their homes are not only vulnerable to risks such as coastal flooding, but shortly they also may be facing substantial increases in their insurance premiums. In some cases, elevation of existing structures may be possible; in other cases, however, such elevation may be difficult or even impossible.

Subject to available funding, the City, through HPD, will launch an international competition called the Resilient Housing Design Competition. This competition will award prizes to private sector developers who design and develop new, high-quality housing prototypes that offer owners of vulnerable building types (e.g., older, 1-story bungalows) a cost-effective path that is consistent with City building and zoning requirements to replacing these structures. The winners of this competition will be given the opportunity to place these structures into service in connection with a City-sponsored development project. Prototypes will have applicability throughout the five boroughs. The goal is for HPD to launch this competition in 2013. Phase 1 of the competition will be an open international call for the creation of these prototypes, with a focus, in particular, on prototypes that address site conditions that are particularly challenging. Up to 10 winners will be selected for total cash prizes of up to $2 million, awarded by a panel of judges, which, among other considerations, will evaluate the likelihood that the prototypes actually will be deployed by New York City property owners.

Initiative 5

Work with New York State to identify eligible communities for the New York Smart Home Buyout Program

In February 2013, New York State announced a program pursuant to which the State would purchase highly vulnerable properties, tear down existing structures, and convert such properties into permanent open space. The City—through multiple agencies and departments including HRO, HPD, DCP, the Department of Environment Protection (DEP), and the Department of Parks & Recreation (DPR)—will evaluate opportunities for collaboration with the State in connection with this program based on an objective set of criteria developed by the City, including extreme vulnerability, consensus among a critical mass of contiguous local residents, and other relevant factors. It is anticipated that the eligibility criteria will be met in a relatively limited number of New York City areas. Funds allocated for this program statewide include $171 million in CDBG funding from New York State, together with other State sources.

Initiative 6

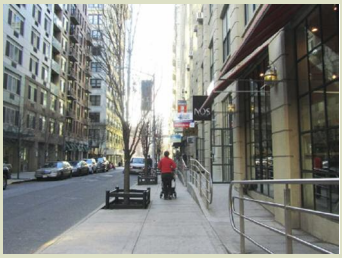
Amend the Building Code and complete studies to improve wind resiliency for new and substantially improved buildings

In recent memory, New York City has not been struck by a regional wind event. However, though current Building Code requirements are calibrated to withstand a Category 3 hurricane, as the climate changes, the frequency of extreme wind events is likely to increase.

To address this uncertainty and improve the City's approach to protecting buildings from wind risks, the City will take the precautionary measure of amending the Building Code to clarify current wind-resistance specifications for façade elements and will restrict the use of pea gravel and small dimension stone as ballast on roofs. The City, through OLTPS, will implement these Building Code changes in 2013. Subject to available funding, DOB also will initiate a study to help the City more accurately map the wind profiles facing New York City's buildings across all five boroughs, identifying sites that face the greatest risk. The goal is to commence this study in 2013, with completion expected in 2015.

Designing for Flood Risk: Urban Design Principles

FEMA and Building Code standards for flood-resistant construction require new or substantially improved buildings in flood zones to be flood-proofed or elevated above projected flood levels. However, elevating buildings more than a few feet above the sidewalk can have negative effects on streetscape, building access, public safety, ground floor activity, architectural quality, and neighborhood character. DCP has worked with representatives of the local design community to develop a set of urban design principles to guide the design of flood-resilient buildings.



VISUAL CONNECTIVITY

Having the windows and front door of a building face the public street can create a sense of security and comfort for pedestrians. These architectural elements also provide visual interest, which in turn promotes a walkable neighborhood. Elevating the first floor of a building can limit this visual connectivity. In residential neighborhoods, porches, stoops, and generous access elements can be designed in order to help to mitigate this disconnection. On commercial streets, this visual connectivity is important to the viability of local retail. A common best practice would be to dry flood-proof the commercial space so that it can be closer to sidewalk level and therefore maximize visual and physical connectivity.

FACADE ARTICULATION

Buildings often contribute to the character of a place by offering human-scale architectural elements, particularly on first floors. Elevated buildings with crawl spaces, parking, or storage can create blank walls at grade. Setting a building back from the property line slightly and using landscaping and/or other creative design solutions could help to buffer these voids in an active streetscape. If ground-level parking is the only feasible option, then garage doors and curb cuts should be designed to minimize their impact on the pedestrian realm.

INVITING ACCESS

Elevated buildings pose challenges for accessibility. Ramps can be difficult to accommodate, particularly on smaller lots. Even smaller buildings that are not required to meet Americans with Disabilities Act (ADA) standards have the challenge of integrating longer runs of stairs into building or landscape design. Introducing a 90-degree turn or landing, and paying careful attention to overall stair design could make a long run of stairs easier to climb and appear more inviting for pedestrians.

NEIGHBORHOOD CHARACTER

Some neighborhoods exhibit a relative uniformity of building form. Elevating buildings will necessarily produce variations in building height and, in some cases, placement on the lot. Designers should respect a neighborhood's character by taking cues from existing context in building massing, fenestration, rooflines, and other architectural elements.

Adapting to higher standards of flood resistance is both a challenge and an opportunity for architects to achieve higher standards of design. The opportunity exists to innovate and produce buildings that contribute to the public realm and have a positive long-term effect on those neighborhoods recovering from Sandy.

Source: DCP

Strategy: Retrofit as many buildings as possible so that they will be significantly more resilient than they are today

Initiative 7

Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted requirements

The City will propose a program that will encourage and, in some limited cases, require property owners to adopt targeted flood protection measures that are tailored to New York's dense urban environment and that will offer meaningfully greater protection than the status quo.

This program consists of two elements:

- an incentive program, which will fund a portion of eligible flood-protection costs for existing building stock, subject to available funding; and
- a requirement for large buildings—those with 7 or more stories that are more than 300,000 square feet in size—to undertake flood-protection measures by 2030.

Incentive Program

With the goal of ensuring that the vast majority of the built square footage currently in the 100-year floodplain is significantly better protected from flood risk going forward than prior to Sandy, the City will create, subject to available funds, a $1.2 billion program that will offer grants or, where appropriate, loans to building owners to help fund a percentage of the eligible costs of completing all or some of the Core Flood Resiliency Measures (as defined below).

The actual percentage of costs covered by this program will be based on a sliding scale, taking into account the uses of the applicable building (as defined by Department of Finance (DOF) tax class), the applicable building's size, and building value (using assessed value as a proxy). Prior to implementation of this program, the City will publish for public comment a proposed methodology for calculating the aforementioned sliding scale. Subject to the discretion of the City in cases of great need, the City will cap awards at $2 million per building.

Core Flood Resiliency Measures: As Sandy demonstrated, during an inundation event, damage to systems and equipment is the most common type of damage experienced by buildings. In addition to imposing costly repairs, damage to systems and equipment also delays recovery, preventing people from reoccupying their homes and getting their businesses up and running quickly after a storm.

The Core Flood Resiliency Measures will therefore include elevation or other flood protection of the following critical building equipment and utilities: fire protection equipment (including alarms and pumps); electrical equipment (including panels, switch gear, and transformers); heating, ventilation, and air conditioning (HVAC) equipment (including boilers, furnaces, and burners); plumbing equipment (including domestic water equipment and sump pump power feeds); telecommunications equipment; elevator equipment; and emergency generators and associated fuel tanks and pumps (subject to the approval of the Code amendments described above). (*See graphic: Flood Protection of Building Systems*)

Elevation or flood-proofing of this equipment will be required to meet the standard of the higher of the BFE, as set forth in the PWMs, or the FIRMs in effect as of the writing of this report, in each case, plus 1 to 2 feet of freeboard (as applicable). Upon adoption of the new FIRMs, elevation will be required to meet the standard of the BFE, as set forth in the new FIRMs, plus 1 to 2 feet of freeboard (as applicable).

For owners of 1- to 2-story buildings of a combustible type—those buildings most at risk of severe structural damage during a flood—Core Flood Resiliency Measures also will include structural reinforcement to prevent collapse in the event of inundation, including:

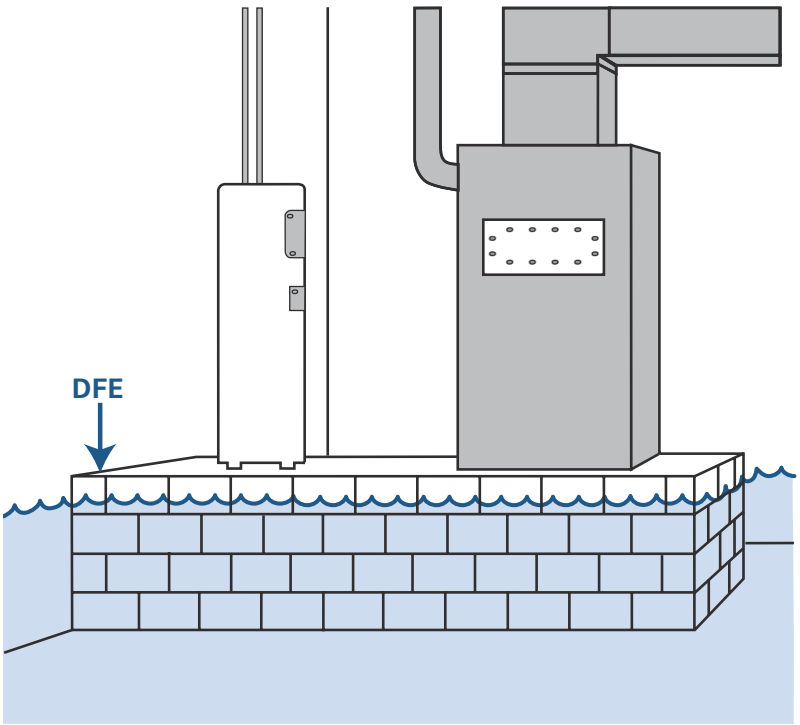
- upgrades to the foundation;
- reinforcement of exterior walls; and
- wet flood-proofing (see above).

These measures do not suggest that inhabitants should remain in their buildings during a flood or storm surge event. Regardless of the interventions completed, all residents and businesses should, of course, comply with any City evacuation orders to promote their safety. However, the goal is for the retrofits proposed above to allow residents and businesses to recover more quickly after a storm, once reentry is deemed to be safe.

Disbursement of Funds: For the first one to two years of the program, funds will be allocated to specific categories of uses to enable an equitable distribution of such funds across building types and geographies. Categories for which funds will be set aside during this one to two year period will be the following:

- $100 million reserved for 1- to 3-family homes (DOF tax class 1);

Flood Protection of Building Systems



Example of a building hot water heater and furnace elevated above the minimum flood protection level via a platform.

- $500 million to be divided among the boroughs based on their share of buildings in the 100-year floodplain; and
- $100 million reserved for affordable housing projects (i.e., projects where at least 50 percent of units have income restrictions pursuant to a regulatory agreement, or projects otherwise designated as "affordable" by the HPD Commissioner).

At the end of the initial one to two year period of the program, any reserved funds that remain unused will be made available to all eligible applicants.

The Core Flood Resiliency Measures incorporate lessons learned from FEMA's work in assessing the damage from Sandy, as well as guidance from FEMA's extensive experience with building mitigation. Yet existing NFIP rules do not offer insurance rate reductions for buildings that become materially less vulnerable with these retrofits. To address this challenge, the City will continue to work with FEMA to develop a system of mitigation premium credits that reduce the cost of insurance for property owners who invest in these and other alternative approaches (see Chapter 5).

New York City Economic Development Corporation (NYCEDC) and HPD will administer this program beginning in 2013. The City will pursue CDBG funds as well as Federal Hazard Mitigation Grant Program (HMGP) funding, and other new sources, for the required funding for the program (see Chapter 19, *Funding*).

Mandate for Large Buildings

In addition to the incentive program outlined above, the City also will require buildings in the 100-year floodplain that are 7 stories or taller and greater than 300,000 square feet in size to complete Core Flood Resiliency Measures by 2030, so that the City's largest buildings are not knocked out of service by future flood events.

Given the structural stability of buildings of this size, this mandate will apply to elevation or flood-protection of building equipment and utilities as described above, but will not require structural reinforcements. This mandate will be implemented via a change to the City's Building Code and will be administered by DOB.

This mandate will not apply to public housing developments—which are pursuing a parallel resiliency program—or hospitals, nursing homes, and adult care facilities—which will be subject to a different mandate (see Initiative 9, below, and Chapter 8, *Healthcare*). The mandate will apply to affordable housing projects. However, because of the sometimes precarious financial position of such projects, they will be entitled to apply for a hardship waiver from the HPD Commissioner. Buildings subject to the mandate will be eligible to apply for funds through the incentive program described above.

With respect to buildings subject to this mandate, there will be two ways to achieve compliance. One will be a more traditional compliance track, pursuant to which building owners will complete one of the following approved flood-protection strategies:
- elevation of applicable equipment and utilities at or above the applicable DFE;
- dry flood-proofing of equipment and utilities below and up to the applicable DFE; and
- dry flood-proofing of the building itself below and up to the applicable DFE.

Buildings subject to the mandate also will be offered an alternative compliance track, pursuant to which building owners will be deemed to have satisfied the mandate, provided that they have taken one of the following steps:
- put in place alternative building-based measures (for example, temporary barriers coupled with an action plan; regular drills by trained staff; and renewal certificates) that provide an equivalent level of protection to the traditional path, as certified by a structural engineer and approved by DOB; or
- achieved protection via a coastal defense system that protects the applicable building up to the applicable DFE, as certified by a structural engineer and approved by DOB.

Notwithstanding the foregoing, the alternative compliance track will not be available for the following life safety systems: emergency generators and associated fuel tanks and pumps (subject to the approval of the Code amendments described above); fire alarm system components; fire pumps (to the extent that such components are not submersible); domestic water systems (to the extent that components are not submersible); and sump pump power feed equipment.

In addition, property owners may appeal to DOB for a variance from the mandate if site constraints or other engineering factors render compliance impossible. The BSA also will be authorized to grant such variances.

The City will seek City Council approval for this mandate—through a Building Code change—by the end of 2013. When first implemented, DFEs will be as set forth in the PWMs. Upon adoption of the new FIRMs in 2015, DFEs will be as set forth therein.

Compliance with the mandate will be monitored by the City in two ways. First, by the end of 2020, subject buildings owners will be required to submit an interim report certifying that they have complied with the mandate, or to submit an affidavit describing a plan to achieve such compliance by 2030. Any buildings that become subject to this mandate in the future as flood maps are revised will have 15 years from the date that the applicable map is adopted to comply with the mandate.

Initiative 8

Establish Community Design Centers to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs

Property owners in neighborhoods affected by Sandy, or other potentially vulnerable areas in the 100-year floodplain, are working to understand how to rebuild or retrofit their buildings to be prepared for future extreme weather. The City, through HRO, will work with local partners and advocates to establish a physical presence in affected neighborhoods across the city in so-called Community Design Centers, in which a mix of professional and volunteer design staff would be on-call to help residents with reconstruction questions. The staff of each Community Design Center will also direct property owners to City programs that facilitate building repair and resiliency. The Centers could be managed by the City with support from local partners.

Initiative 9

Retrofit public housing units damaged by Sandy and increase future resiliency

New York City Housing Authority (NYCHA) developments across the city sustained significant damage during Sandy, including damage to electrical systems in approximately 250 NYCHA buildings. To address this issue, the City will implement targeted efforts to strengthen building resiliency against future extreme weather events by designing and constructing improvements to public housing directly impacted by Sandy.

Federal CDBG funding in the amount of $108 million has been allocated to this initiative. The first phase of this program will include the installation of permanent emergency generators or alternate measures to enhance power resiliency at NYCHA's most vulnerable impacted buildings. In addition, a combination of payments from NFIP policies, commercial insurance policies, and FEMA's Public Assistance Program may be available to provide funds to cover the cost of repairing damaged structures and making resiliency improvements on these damaged buildings. Subject to available funding, NYCHA will begin this

work in 2013. By September 2013, NYCHA will also begin a planning process to identify targeted resiliency measures (for example, raised boilers and electrical switch gear) to address vulnerability throughout buildings in its portfolio in the 100-year floodplain. *(See sidebar: New York City Housing Authority Resiliency Planning)*

Initiative 10
Launch a sales tax abatement program for flood resiliency in industrial buildings

Industrial properties are particularly vulnerable to flood damage, because they tend to be concentrated in coastal areas of the city. This vulnerability is heightened since many industrial businesses are located in 1- to 2-story structures and ordinarily store expensive equipment and inventory at ground level. Industrial businesses also frequently operate on thin profit margins.

Given this, the City will launch a sales tax abatement program directed at industrial businesses to help subsidize the cost of making flood resiliency improvements. The program will prioritize 1- to 2-story buildings with more than 4 feet between their actual ground elevation and the applicable BFE.

The New York City Industrial Development Agency (NYCIDA) will implement this program beginning in 2013, with total benefits pursuant to the program to be capped at $10 million.

Initiative 11
Launch a competition to increase flood resiliency in building systems

Approximately 88,700 buildings were located in areas impacted by Sandy. The number of properties at risk of coastal flooding, meanwhile, is likely to increase through the 2020s and 2050s, as sea levels rise and the floodplain expands.

To address this challenge, the City will launch a Resiliency Technologies Competition to allocate grants on a competitive basis to improve building resiliency. The competition will seek to fund demonstration projects that use innovative technologies to make building systems more resilient. NYCEDC will launch this competition in 2013 and expects to select winners in 2014. Approximately $40 million in Federal CDBG funding has been allocated to the competition.

Initiative 12
Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain

A number of vulnerable structures in the city's 100-year floodplain are designated as historic landmarks. Landmarks have restrictions applicable to them that may make it challenging for the owners of those structures to undertake resiliency retrofits. Consistent with its underlying mission and legislation, the Landmarks Preservation Commission (LPC), therefore, will clarify its regulations, with the goal of assisting owners of landmarked buildings and properties in landmarked districts in the 100-year floodplain who are contemplating retrofit projects.

Initiative 13
Amend the Building Code to improve wind resiliency for existing buildings and complete studies of potential retrofits

As indicated above, while the NPCC does not provide specific projections for wind speeds, its projections do suggest an overall increase in the frequency of the most intense storm events that have wind effects. Older buildings that predate modern standards are particularly vulnerable, especially in coastal areas with open exposures. In addition, all structures, including high-rise buildings, will continue to face potential damage to façades from airborne debris during the sorts of extreme wind events that could occur in the future.

To address these risks, in 2013, the City—through OLTPS—will amend the Building Code to expand the existing DOB Façade Inspection Safety Program for high-rise buildings to include rooftop structures and equipment. Subject to available funding, DOB also will initiate a study of potential wind resiliency retrofits and their potential costs and benefits, consulting with a committee of industry experts. The goal is to complete the study by 2016.

New York City Housing Authority Resiliency Planning

The New York City Housing Authority (NYCHA) operates 2,596 buildings in 334 developments throughout New York City. These developments are home to over 400,000 residents—approximately the size of the entire population of Miami, Florida. Residents include working families, low-income households, seniors, and other vulnerable populations. While these developments are located in all five boroughs, there are significant concentrations of public housing on the waterfront far from the urban core, as in the Rockaways in Queens, or in locations with limited public transportation, such as in Red Hook in Brooklyn.

In preparation for Sandy's arrival, therefore, NYCHA was required to take important steps to protect its residents and assets—including implementing evacuation plans in the City's evacuation zones. Despite these orders to evacuate, many NYCHA residents, like others throughout the city, chose to shelter in place.

Due to the large size and heavy construction of NYCHA buildings, the developments suffered little structural damage. However, in many cases, building mechanical and electrical equipment in basements was inundated. A total of 402 buildings housing 80,000 residents lost power as a result of the flooding of these building systems. Though NYCHA and community-based organizations worked to address the needs of these residents, the impact of the storm damage and the difficulty repairing it demonstrated the importance of making resiliency investments going forward.

As part of the recovery and rebuilding process, therefore, NYCHA is working to strengthen its buildings portfolio and incorporate measures such as the flood-proofing of critical building systems in areas impacted by Sandy. In addition, NYCHA is analyzing options for increasing the safety of buildings not impacted by Sandy but at risk of future flooding and other extreme weather damage. Over the next few months, NYCHA will begin a planning process to identify the best methods for increasing resiliency in vulnerable NYCHA buildings across the city, a process that will engage resiliency engineering experts and elicit input from NYCHA residents.

Example of large backup HVAC equipment on street

Credit: FEMA/Ashley Andujar

Initiative 14

Amend the Construction Codes and develop best practices to protect against utility service interruptions

Disruptions to building services—due either to the failure of in-building systems or of the utility networks on which they rely—can render a building unusable during a range of climate events, such as storms and heat waves. To begin to address these risks, the City—through OLTPS—will develop a list of relevant best practices and, in certain cases outlined below, will amend existing regulations.

The first step that the City will take will be to require, by 2014, common access to potable water in high-rise multi-family buildings during emergency situations. This will be done to help upper-floor residents who may lose access to such water in their units in the event of the failure of building electric pumps. The City also will develop requirements, beginning in 2013, to enable exit lighting to continue to function during an extended blackout.

Additionally, by 2013, the City will develop best practices relating to voluntary backup power generation and, will amend relevant codes to allow buildings to comply with these best practices. Proposed code changes will allow for reliable, safe, and resilient alternative fuel sources and cogeneration systems for emergency power, as well as building-mounted solar power. New guidelines for "quick-connect utility hook-ups" also will be promulgated, facilitating the rapid restoration of electricity and heat during utility outages.

The City will further develop, by 2014, best practices for emergency planning relating to longer-term survivability and will create model "building emergency plans" available to building owners. Among other provisions, the model plans will encourage large commercial buildings to pre-negotiate disaster recovery agreements with service providers and will encourage multi-family residential buildings to provide clear communication protocols for essential personnel.

The City also will study, by 2015, strategies to limit heating and cooling losses through building exterior walls, windows, and roofs. The purpose of this study will be to determine how to extend the length of time during which homes and businesses can continue to operate after the loss of electrical power.