4. New York City's Hazard Environment

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 places in the country with an area of just 305 square miles.

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.

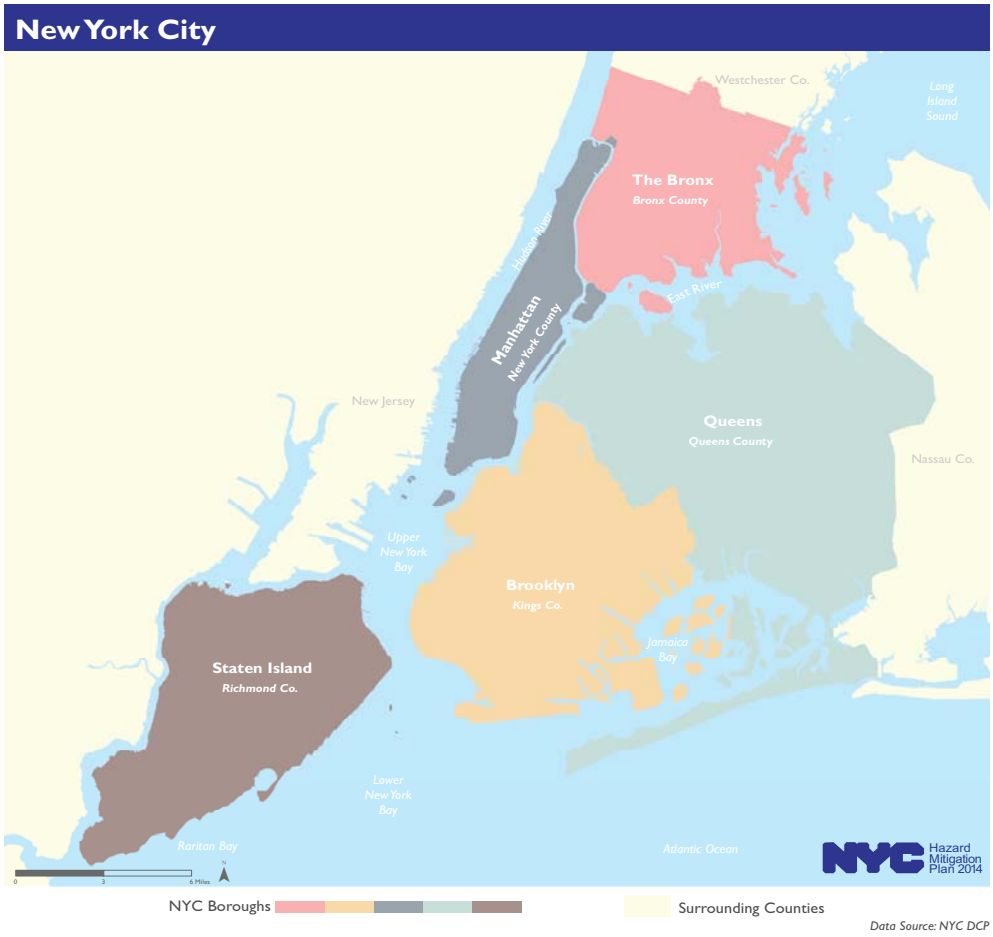
However, these defining characteristics—density, international stature, and complex infrastructure—also increase the potential significance of hazards.

A. The Natural Environment

i. *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, the East River, Jamaica Bay, and the Harlem River. The city is comprised of five boroughs: the Bronx, Brooklyn, Manhattan, Queens, and Staten Island (see Figure 3.4.3), 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.

Figure 3.4.3: The Five Boroughs of New York City



ii. 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. 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 ocean water, which drops in temperature over the winter, keeps air temperatures cooler longer into the season.

iii. Topography

Elevation generally ranges from less than 50 feet (for most of Manhattan, Brooklyn, and Queens) to nearly

Figure 3.4.4: New York City Topography, including the Highest Points for Each Borough

300 feet (in northern Manhattan and the Bronx). Figure 3.4.4, including the Highest Points for Each Borough 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.

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.

iv. Geomorphology

Geomorphology, the study of geographic 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, grinding up rock as it traveled south and carrying chunks of gravel, pebbles, and sand with it. The glacier began its retreat about 18,000 years ago.

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 (see

Figure 3.4.5 : Geological Landforms of New York City

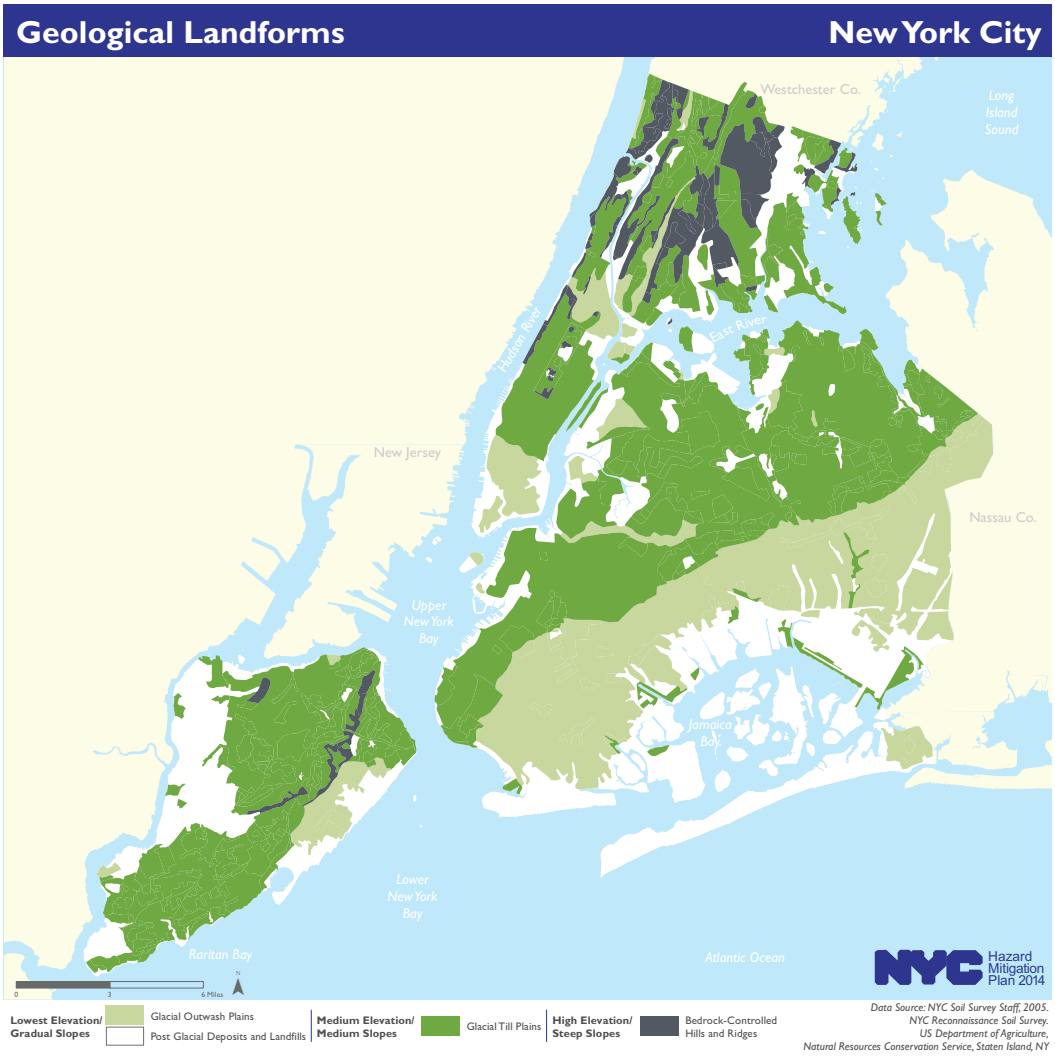


Figure 3.4.5). While other areas of the city are generally higher in elevation, due to the presence of bedrock closer to the earth's surface, these low-lying areas are generally more vulnerable to storm surge and gradual sea level rise.

v. Barrier Islands

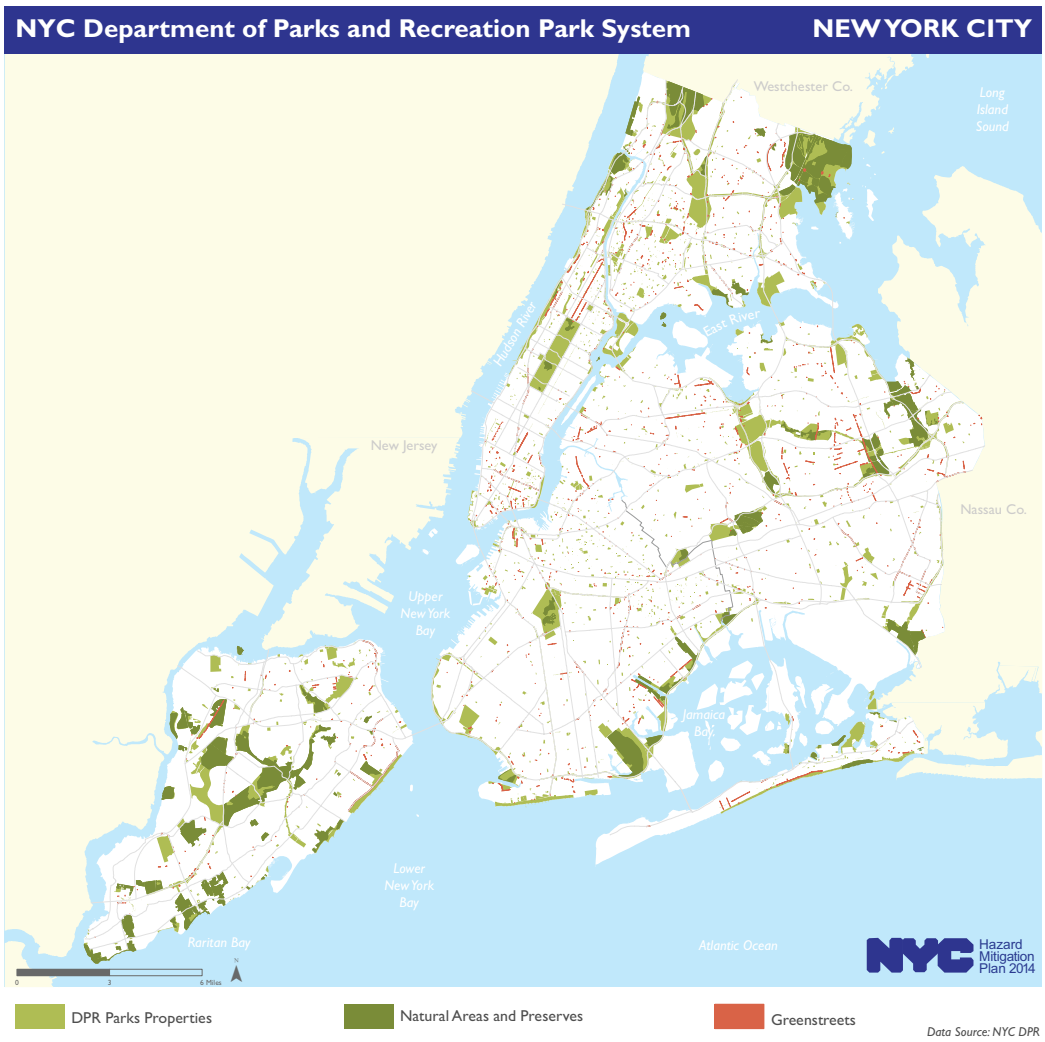
A barrier island is a long offshore deposit of sand parallel to the coastline. Generally barrier islands are made up of beach, dunes, barrier flat, and salt marsh, separated from the mainland by a shallow sound, bay, or lagoon. Barrier islands act as a buffer against storms by absorbing the most severe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

Long Island, which stretches over 100 miles and includes Brooklyn and Queens on its western shore, is buffered by five barrier islands; including Coney Island in Brooklyn, and two spits including the Rockaway Peninsula in Queens. All of the inlets are artificially stabilized with structures and are dredged to allow for navigation by commercial and recreational boats.

vi. 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

Figure 3.4.6: New York City Department of Parks & Recreation Park System



five boroughs (see Figure 3.4.6). 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.

The properties in the City's park 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 a wide range of recreational amenities and opportunities. Especially in recent years, the city's waterfront parks have also 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 City'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 offer public enjoyment and education along with passive recreation opportunities. They also provide many ecological 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 3.4.5), in particular, play an important role in protecting the quality of waterways by absorbing nutrients and filtering sediment and contaminants, helping to manage stormwater runoff, and buffering coastal areas from the impacts of flooding through wave attenuation.

There are two major wetland types in New York City: freshwater wetlands and tidal wetlands.

Freshwater wetlands play an important role in New York City's ecosystem by connecting the freshwater streams to tidal marshes for aquatic and other organisms. Freshwater wetlands and their floodplains also convey, detain, and store stormwater runoff. Today, however, there are few natural freshwater wetlands and streams remaining in New York City, with most 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. Tidal wetlands are the areas where the land meets the sea. These areas are periodically flooded by seawater during high or spring tides or, are affected by the cyclic changes in water levels caused by the tidal cycle. Salt marshes and mud flats are some typical types of tidal wetlands found along New York's marine shoreline. Tidal wetlands are classified by the amount of water covering the area at high and low tides and the type of vegetation.

Today wetlands are the focus of preservation, restoration, and enhancement projects. In particular, the city is investing in more monitoring and evaluation of wetlands to better manage climate change risks such as submergence from sea level rise.

New York City's largest remaining wetland complexes can be found in Jamaica Bay, on northwest Staten Island, and along the upper East River and western Long Island Sound.

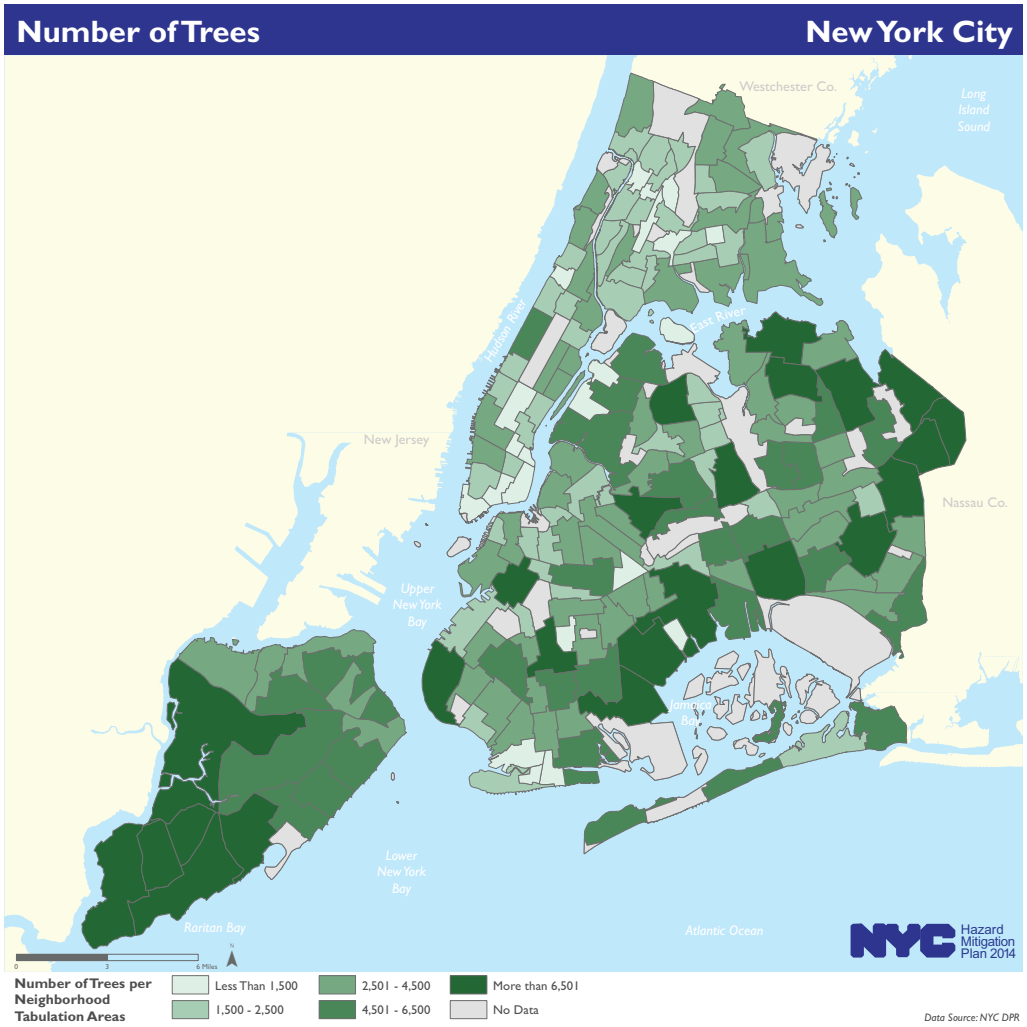
Table 3.4.5: Selected Wetlands in the New York City Region

Wetlands	Borough
Pelham Bay Park Wetlands	Bronx
Jamaica Bay	Brooklyn and Queens
Alley Pond Park	Queens
Udall's Cove	Queens
Lemon Creek	Staten Island
Fresh Kills	Staten Island
Sawmill Creek Marshes	Staten Island
Arlington Marsh	Staten Island

a) *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 (see Figure 3.4.7: New York City Street Tree Density). These trees moderate temperatures, remove carbon dioxide and pollutants from the air, enhance sidewalk environments and other settings, protect waterways by reducing stormwater runoff, and help reduce the urban heat island effect (see section 10. Extreme Temperatures). 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 3.4.7: New York City Street Tree Density



B. 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. Data on population growth and density, neighborhoods, and the economy can provide a powerful context for understanding New York City's social environment.

i. Demographics

Density

More people live in, work in, and visit New York City today than at any other time in the city's history. According to the 2011 American Community Survey (ACS), conducted by the U.S. Census Bureau, 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 densely populated borough, with approximately 12 people per acre (see Table 3.4.6 and Figure 3.4.8).

Age

New York City's population has historically been characterized by its high concentration of young adults. Today, as Table 3.4.7 shows, New York City's population is comprised of a growing number of both older adults and children.

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, followed by Manhattan (21%), the Bronx (15%), and Staten Island (6%) (see Table 3.4.7 and Figure 3.4.9). Given growth

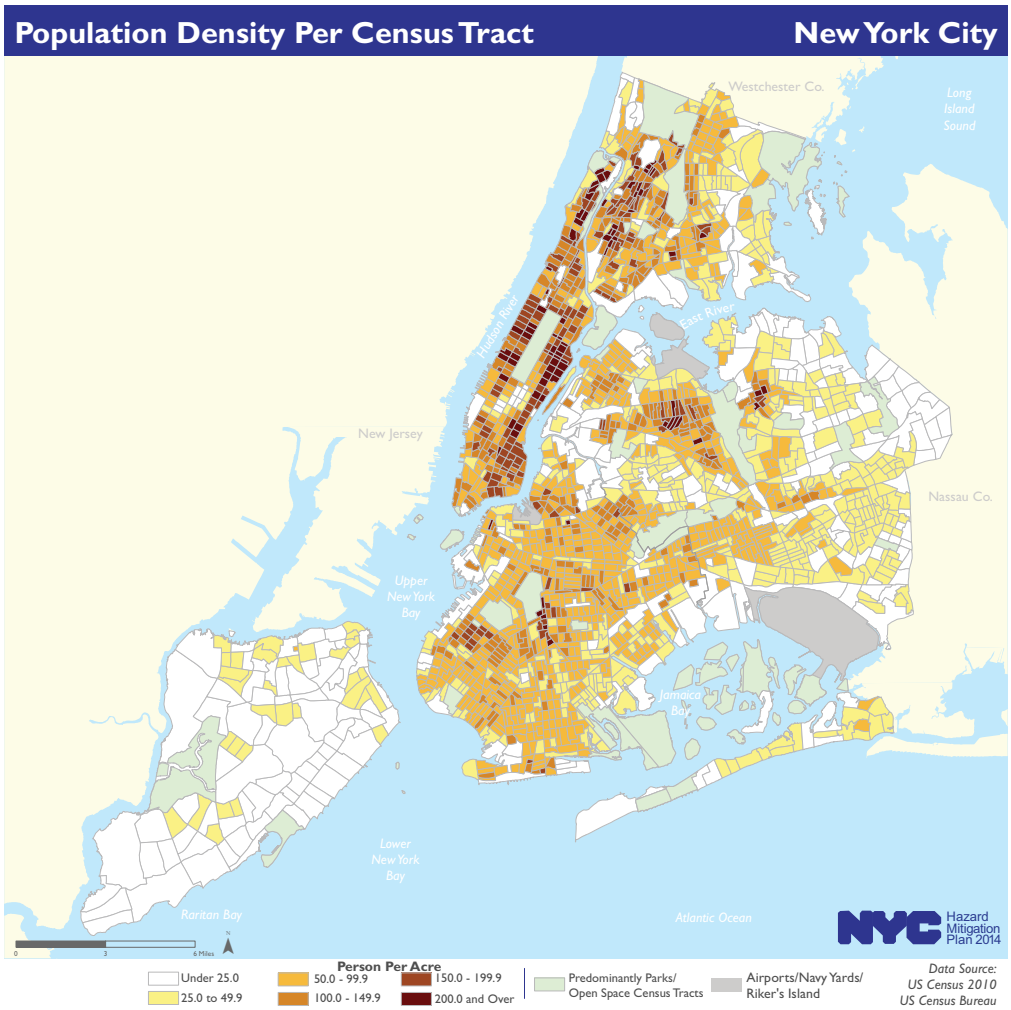
Table 3.4.6: New York City Population Density by Borough (Source: U.S. Census, American Community Survey 2011)

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

	New York City		Bronx		Brooklyn		Manhattan		Queens		Staten Island	
	Estimate	**%**	**Estimate**	**%**	**Estimate**	**%**	**Estimate**	**%**	**Estimate**	**%**	**Estimate**	**%**
Under 5	534,400	6.5	106,190	7.6	183,027	7.2	80,126	5	136,797	6.1	28,260	6
Under 18	1,775,171	21.5	368,276	26.5	598,160	23.6	237,292	14.8	463,568	20.6	107,875	22.9
Over 65	1,011,996	12.3	149,110	10.7	291,892	11.5	218,875	13.7	290,927	12.9	61,192	13

Figure 3.4.8: New York City Population Density by Census Tract



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. 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%. Data from the 2010 U.S. Census indicate that almost 50% of New York City's older residents are foreign-born. According to the Center for an Urban Future, 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, 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.

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 21.5% of the city's population is under the age of 18, and 6.5%, 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 (see Figure 3.4.10).

According to the Federal Emergency Management Agency (FEMA), children are particularly vulnerable to natural disasters. This is because 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 section, 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.

Figure 3.4.9: New York City Population over the Age of 65 by Census Tract

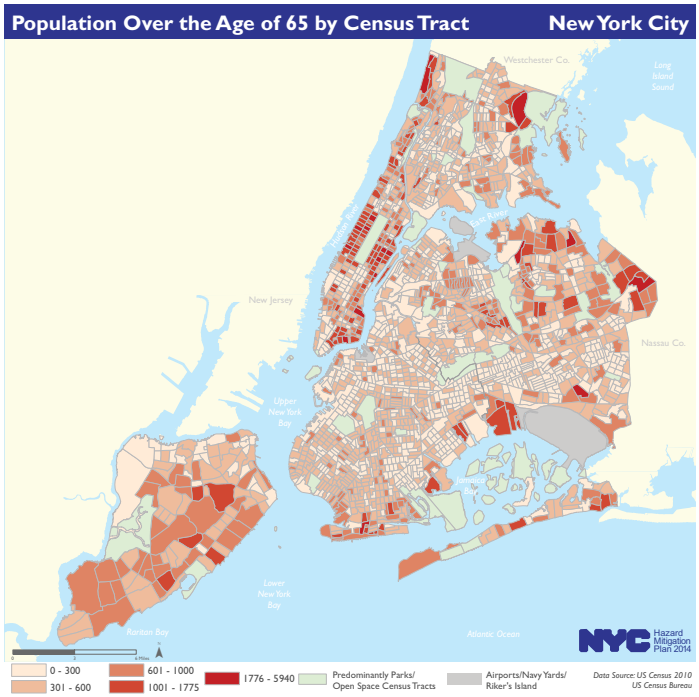
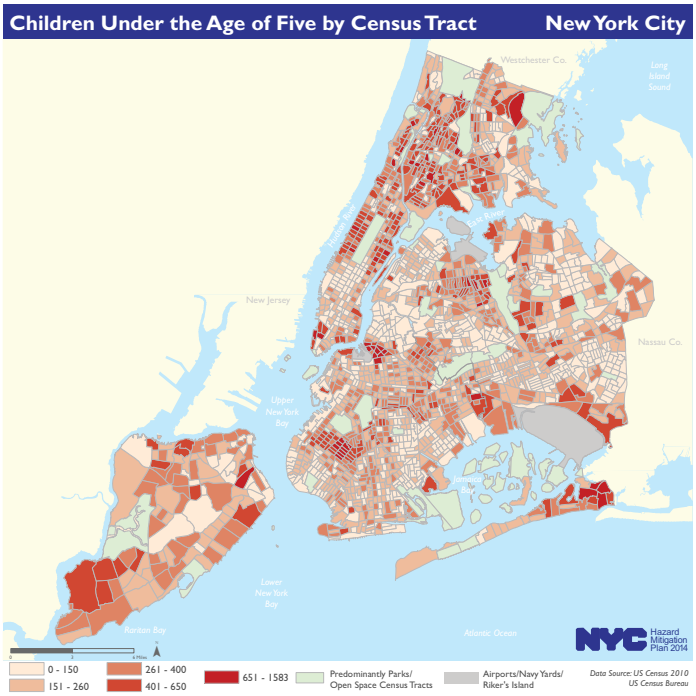


Figure 3.4.10: New York City Population under the Age of 5 by Census Tract



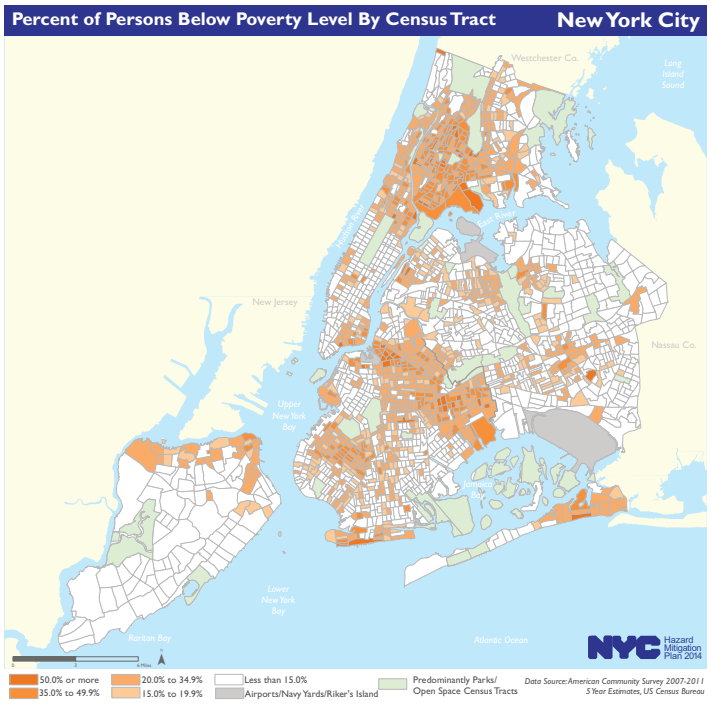
Income and Poverty

Federal poverty status is determined by annual income and therefore influenced by larger economic trends. 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.

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 was unemployed increased between 2008 and 2010 (as compared to the previous two-year period), resulting in 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. Of those people living below poverty, almost 30% are children under the age of 18, and just under 20% are adults over the age of 65 (see Table 3.4.8). The greatest concentration of low-income populations can be found in the south Bronx, upper Manhattan, and scattered throughout Brooklyn. See Figure 3.4.11 for a spatial distribution of people living below the poverty line.

Figure 3.4.11: Percentage of New York City Population below the Federal Poverty Level by Census Tract



Many low-income New Yorkers depend on some form of public assistance. 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.

Low-income households in New York City tend to be renters, a fact that is relevant in a post-disaster context. Investment in post-disaster repairs is typically made by property owners, 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 alter-

Table 3.4.8: New York City Population below Federal Poverty Level by Age (Source: U.S. Census, American Community Survey 2011)

	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%

native 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—exposing them to hazardous materials, for instance. 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.

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, or are "linguistically isolated" are of special concern during an emergency as they might not become aware of warnings and evacuation orders or know about critical city services and resources. According to the 2011 ACS, an estimated 23% of the city's population speaks English less than "very well" and is therefore considered "linguistically isolated" (see Table 3.4.9 and Figure 3.4.12).

Figure 3.4.12: Concentrations of Linguistically Isolated New Yorkers by Census Tract

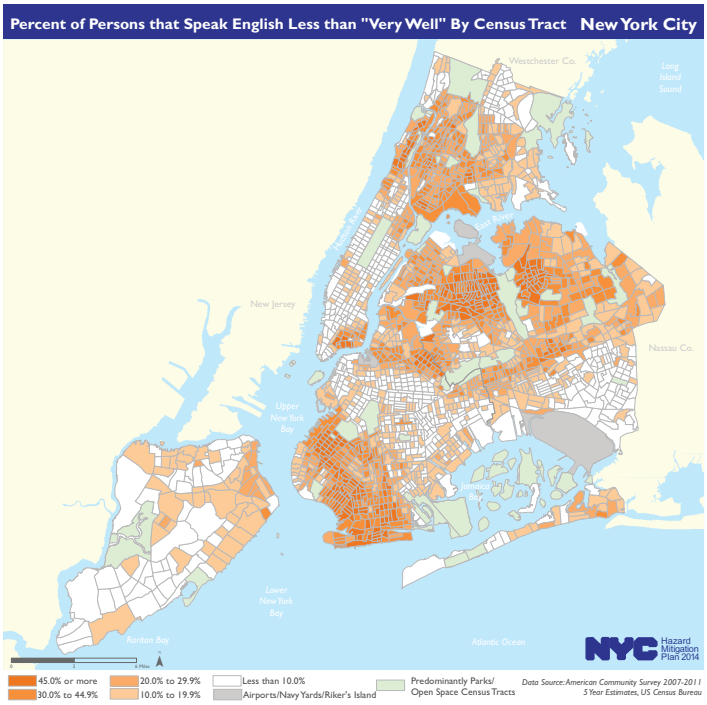


Table 3.4.9: New Yorkers Who Speak English Less than "Very Well" by Borough (Source: U.S. Census, American Community Survey 2011)

	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%

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. See Table 3.4.10 for numbers and percentages of New Yorkers with disabilities by age and borough.

Table 3.4.10: New Yorkers with Disabilities by Age and Borough (Source: U.S. Census, American Community Survey

	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%

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 with 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.

ii. Neighborhoods

New York City has a wide variety of neighborhoods. It encompasses five boroughs, 59 community districts (CDs), 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 3.4.13 through Figure 3.4.17 show the diverse neighborhoods throughout New York City.

The Bronx

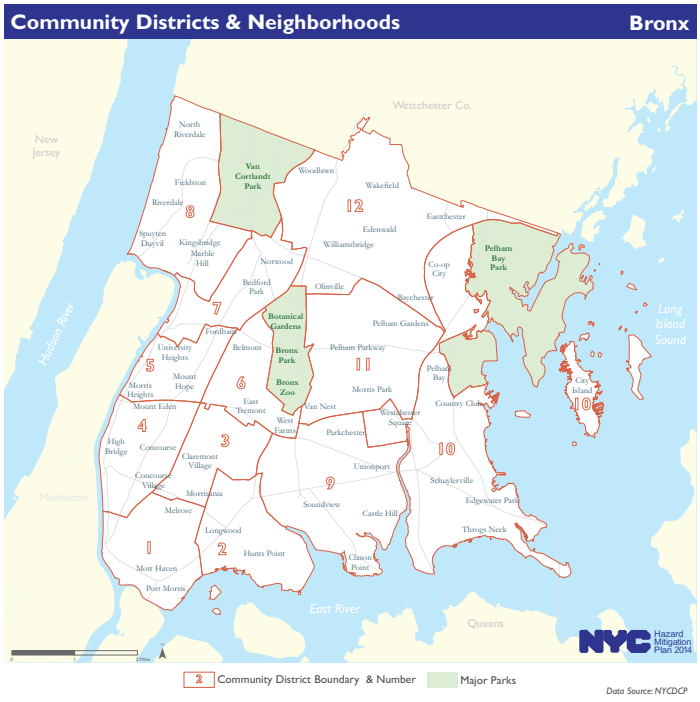
There are twelve community districts in the Bronx. The northernmost borough of New York City, the Bronx is the only borough that is not an island or part of one. It is home to Yankee Stadium, the Bronx Zoo, and the New York Botanical Garden. Almost 30% of the land use in the Bronx is dedicated to parks and open space uses, the most in New York City. This includes Van Cortlandt Park, Bronx Park, and Pelham Park, the largest park in New York City.

Its housing stock ranges from dense urban neighborhoods located throughout the borough to small bungalows in Edgewater Park. The southern portion of Community Districts 1 and 2 are mainly occupied with manufacturing and industrial uses. This includes Hunts Point Cooperative Market, New York City's largest food distribution center. There are other pockets of significant manufacturing and industrial uses such as in Eastchester, Bathgate, and along Westchester Creek. Commercial activity, much like the rest of New York City, is scattered throughout the Bronx serving local neighborhoods. However, the Hub, which is the district anchored by the intersection of 3rd Ave and East 149th Street, and the corridor along West and East Fordham Road are the borough's most well-known and visited regional commercial destinations.

As of 2011, the Bronx had a population of approxi-

mately 1.4 million and its household median income was $32,058, which was the lowest of the five boroughs. Nearly 78% of the borough's total private employment is concentrated within the Services and Trade sectors. The Health Care and Social Assistance sector alone makes up 39.0% of total private sector employment in the Bronx.

Figure 3.4.13: Bronx Community Districts and Neighborhoods



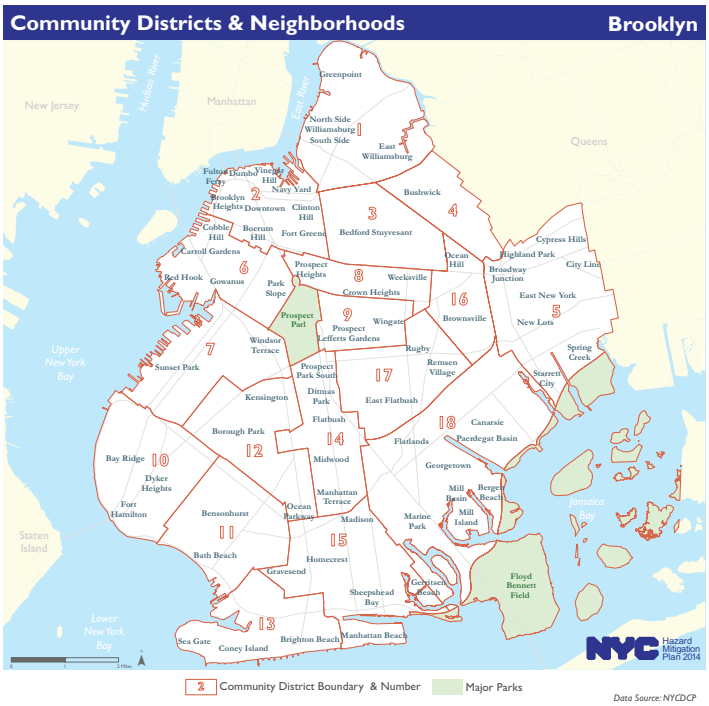
Brooklyn

Brooklyn consists of 18 community districts, the most in any borough. It is known, among many characteristics, for its stretches of neighborhood streets lined with buildings of brownstone architecture. Brooklyn can be accessed through some of the nation's most well-known crossings including the Brooklyn Bridge and Verrazano-Narrows Bridge. Coney Island and its 2.5-mile boardwalk and sandy beach have been an amusement destination for over a century. It is home to the historic Cyclone rollercoaster, New York Aquarium, and the Luna Park amusement area; amongst other local and regional attractions. Prospect Park, located in the center of the borough, is a 526-acre park that contains the Prospect Park Zoo and Brooklyn Botanical Gardens. The Barclays Center, completed in 2012 and home to the Brooklyn Nets, is located along Atlantic Avenue near Downtown Brooklyn.

Aside from brownstone residences, Brooklyn has a wide variety in building type and density. Generally neighborhoods closer to Manhattan are denser and were developed earlier than more auto-dependent neighborhoods at the outer reaches of the borough. Former industrial sections of Brooklyn along the East River such as Williamsburg, Greenpoint, and DUMBO have slowly been transforming into mixed-use districts. However, a significant amount of manufacturing and industrial uses remain in Brooklyn. They range from less intensive manufacturing uses that take place in the warehouses of Red Hook, Gowanus, and Sunset Park to heavier and more intensive uses found along Newtown Creek in the northern parts of the borough. Downtown Brooklyn serves as the borough's major central business and commercial district though commercial corridors that serve local residents are scattered throughout along borough arterials.

Brooklyn had a population of over 2.5 million according to the 2011 ACS, making it the most populous borough in the City. Its households had a median income of nearly $43,000. Like the Bronx, private sector employment in Brooklyn is predominantly made up of the Services and Trade sectors as they constitute 74% of total employment. The Health Care and Social Assistance sector make up one-third of overall private employment in Brooklyn.

Figure 3.4.14: Brooklyn Community Districts and Neighborhoods



Manhattan

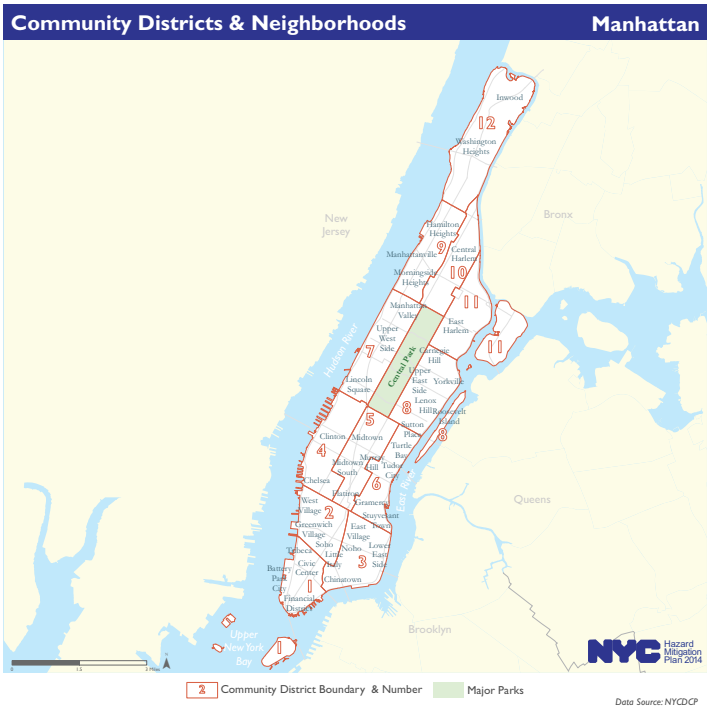
Manhattan, the smallest borough in terms of geographic area, is comprised of twelve community districts. Several culturally, politically, and economically significant institutions are located in New York City's central borough. The Metropolitan Museum of Art, the American Museum of Natural History, Lincoln Center for the Performing Arts, Ellis Island Immigration Museum, Times Square and the Theatre District are just a few examples of cultural institutions that can be found in found in Manhattan. The United Nations with its satellite embassies and consulates; and the New York Stock Exchange, NASDAQ, and other major global financial institutions of Wall Street are just a few of the politically and economically significant institutions centered in Manhattan.

In the middle of the island is Central Park, an 843-acre parkland that takes up six percent of Manhattan's total landmass. It is considered the first public park built in America and is visited by 25 million people annually.

Manhattan is the most densely populated county in the nation. Its iconic skyline is made up of buildings that house or provide a place of work for millions of Americans. However, not all parts of Manhattan have skyscrapers. Greenwich Village, Lower East Side, Harlem, and many of the residential streets of the borough have retained their medium density characteristics, while SoHo and Chelsea serve as examples of former manufacturing districts whose warehouse structures have been converted to residential and mixed-use. Lower Manhattan and Midtown Manhattan are the primary central business districts of New York City and serve as global centers for finance and economic activity.

Approximately 1.6 million residents call Manhattan home and the median household income for the borough is $66,299. Approximately 15% of private employment sector jobs in Manhattan are within the Finance, Insurance, and Real Estate (FIRE) sector. This is a much higher concentration in comparison to the other four boroughs where it makes up about five percent of the entire private employment sector. The Services Sector makes up 45.1% of such jobs, which is significantly less than elsewhere in New York City.

Figure 3.4.15: Manhattan Community Districts and Neighborhoods



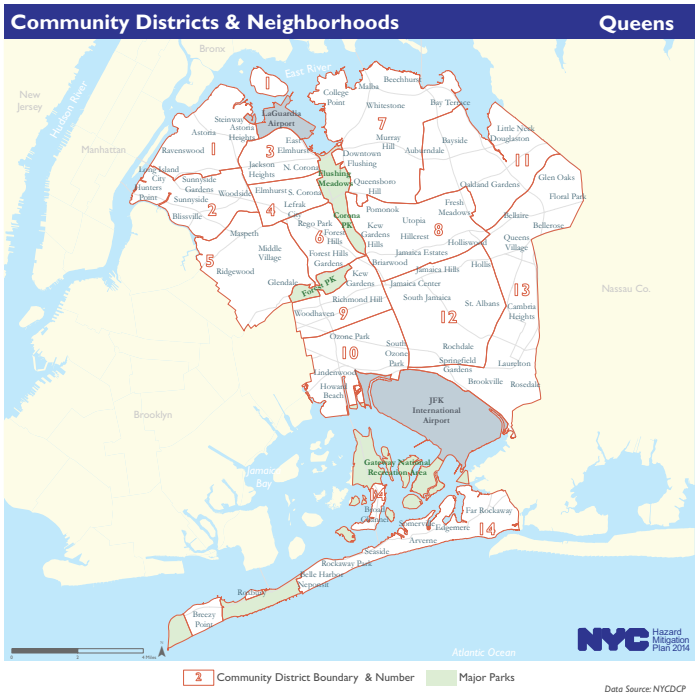
Queens

Queens is the largest borough in terms of geographic area and is made up of 14 community districts. It is known for its diversity as nearly half its residents are foreign born. Queens holds the largest amount of park and open space out of the five boroughs. The larger parks include Gateway National Recreational Area in Jamaica Bay, Forest Park, and Flushing Meadows/Corona Park. The latter is home to the annual US Open Tennis Championship and had been the site for both the 1939 and 1964 World Fair. Citifield, home of the New York Mets major league baseball team, is nearby. The sandy beaches along the southern edges of the Rockaway Peninsula are a popular recreational destination for New York residents.

The built environment of Queens takes on several characteristics; from newly constructed residential towers along the East River in Long Island City and Hunter's Point to suburban-style, auto-dependent neighborhoods with one-family homes that are found throughout the eastern section of the borough. Downtown Flushing and Jamaica are emerging regional commercial districts and provide office space and retail establishments serving local residents. There is significant manufacturing and industrial use activity in Queens. This is primarily found in Long Island City, Maspeth along Newtown Creek, and College Point. Both major New York City airports, LaGuardia Airport and John F. Kennedy International Airport, are located in Queens.

The population of Queens exceeded 2.2 million in 2011, second to only Brooklyn. The median household income was $53,572. Approximately 40% of all private sector employment is concentrated in the Services sector with Health Care and Social Assistance jobs making up about one-fifth of overall employment. The Retail sector is a significant factor in the overall economy of Queens due to the presence of Queens Center Mall and other shopping areas in the vicinity of Corona and Elmhurst. The borough is also home to approximately 37% of Construction sector jobs in New York City.

Figure 3.4.16: Queens Community Districts and Neighborhoods



Staten Island

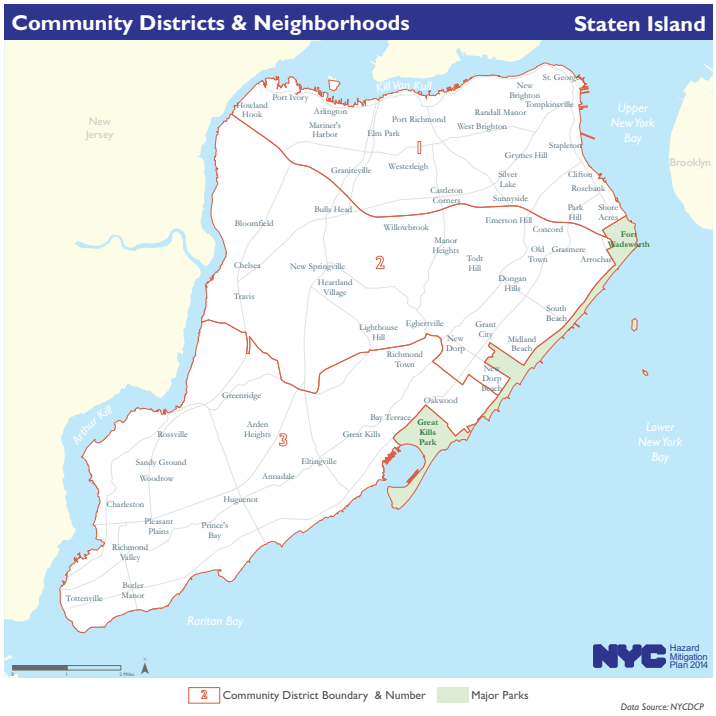
Staten Island, the southernmost borough of New York City, has three community districts. Staten Island can be accessed from the rest of New York City via the Verrazano-Narrows Bridge from Brooklyn and the Staten Island Ferry which travels between the southern tip of Lower Manhattan and St. George on the North Shore of Staten Island. The borough can also be accessed from New Jersey from the Bayonne Bridge, Goethals Bridge, and Outerbridge Crossings. In recent years, Staten Island has become an environmental and recreational destination with the introduction of a new parks system that transformed the Fresh Kills landfill into a 2,200 acre park with various active and passive recreational opportunities.

Historically, Staten Island developed as town villages which were connected by railway. With the opening of the Verrazano-Narrows Bridge in 1964, Staten Island began to transform into a more suburban, auto-oriented community. The majority of Staten Island neighborhoods are low density in character consisting of one- and two-family homes. Key commercial corridors include Hylan Boulevard in the vicinity of New Dorp

and Grant City, Forest Avenue and Victory Boulevard on the north shore, and Richmond Avenue in Heartland Village and New Springville. Portions of the north and west shore of Staten Island are dedicated to manufacturing and industrial uses with several water-dependant industries occupying these areas.

Staten Island is the least populated with 470,467 residents according to the ACS, yet it has been the fastest growing borough over the past three decades. Its median household income is $70,578, which is the highest of the five boroughs of New York City. Much like the Bronx, Brooklyn, and Queens, the Services sector plays an important role in the Staten Island economy as it accounts for 57.2% of private sector jobs in the borough.

Figure 3.4.17: Staten Island Community Districts and Neighborhoods



The Health Care and Social Assistance Services alone account for nearly 30% of such jobs. Retail and Wholesale-related jobs, which are part of the Trade Sector, collectively account for 20% and are the next largest source for private sector jobs in Staten Island.

iii. Economy

New York City is one of the world's financial capitals and serves as the hotspot for both national and regional economic activity. It is home to a broad spectrum of industries–from finance and real estate, high-tech to tourism and manufacturing to service sector–and millions of regional jobs (see Table 3.4.11).

Table 3.4.11: New York City Employment by Industry August 2013 (Source: New York City Economic Development Corporation)

Industry	Number of Employees
Finance, Insurance, Real Estate	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 and government)	3,979,460

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 country and the world. 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.

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 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 revenue, 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 rooms.

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 event can cause direct damage to local inventory, equipment, and interior spaces, not to mention structural damage to New York City's buildings, transportation and communication networks – all of which can result in bottlenecks in business in places like New Jersey, San Francisco and even London and Tokyo.

C. The Built Environment

No other American city can match New York City 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. 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.

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.

While millions of physical assets exist throughout New York 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 disaster, the city will need these critical assets to continue operating and sustain daily activities for its residents.

i. Land Use

New York City's land area covers approximately 305 square miles (approximately 195,000 acres or 8.5 billion square feet). Excluding streets and major bodies of water, approximately 145,000 acres (about 6.3 billion square feet) of land, or lot area, is available for use.

Table 3.4.12 provides a summary of land use in New York City. Figure 3.4.18 shows the spatial distribution of land uses in New York City. Table 3.4.13 through Table 3.4.17 provide summaries of land use by borough and Figure 3.4.19 through Figure 3.4.23 show the spatial distribution of land use by borough.

Table 3.4.12: Summary of New York City Land Use (Source: MapPluto 13V1)

Land Use	Lots		Total Lot Area		Total Building Area	
	#	%	Sq. Feet	%	Sq. Feet	%
Residential	706,448	82.3%	2,670,789,776	42.3%	2,945,754,292	54.5%
Mixed use	48,598	5.7%	210,278,605	3.3%	710,919,018	13.2%
Commercial	24,415	2.8%	273,798,156	4.3%	768,821,829	14.2%
Industrial	11,894	1.4%	235,574,986	3.7%	253,099,490	4.7%
Transportation/utility	6,618	0.8%	572,328,288	9.1%	77,765,685	1.4%
Public facilities	12,145	1.4%	453,401,868	7.2%	564,756,051	10.5%
Open space	4,942	0.6%	1,439,258,407	22.8%	38,664,041	0.7%
Parking	11,310	1.3%	87,700,962	1.4%	36,250,028	0.7%
Vacant land	27,962	3.3%	316,745,985	5.0%	309,190	0.0%
All others or no data	3,547	0.4%	61,346,674	1.0%	5,170,025	0.1%
Total	857,879	100.0%	6,321,223,705	100.0%	5,401,509,649	100.0%

Figure 3.4.18: Land Use in New York City

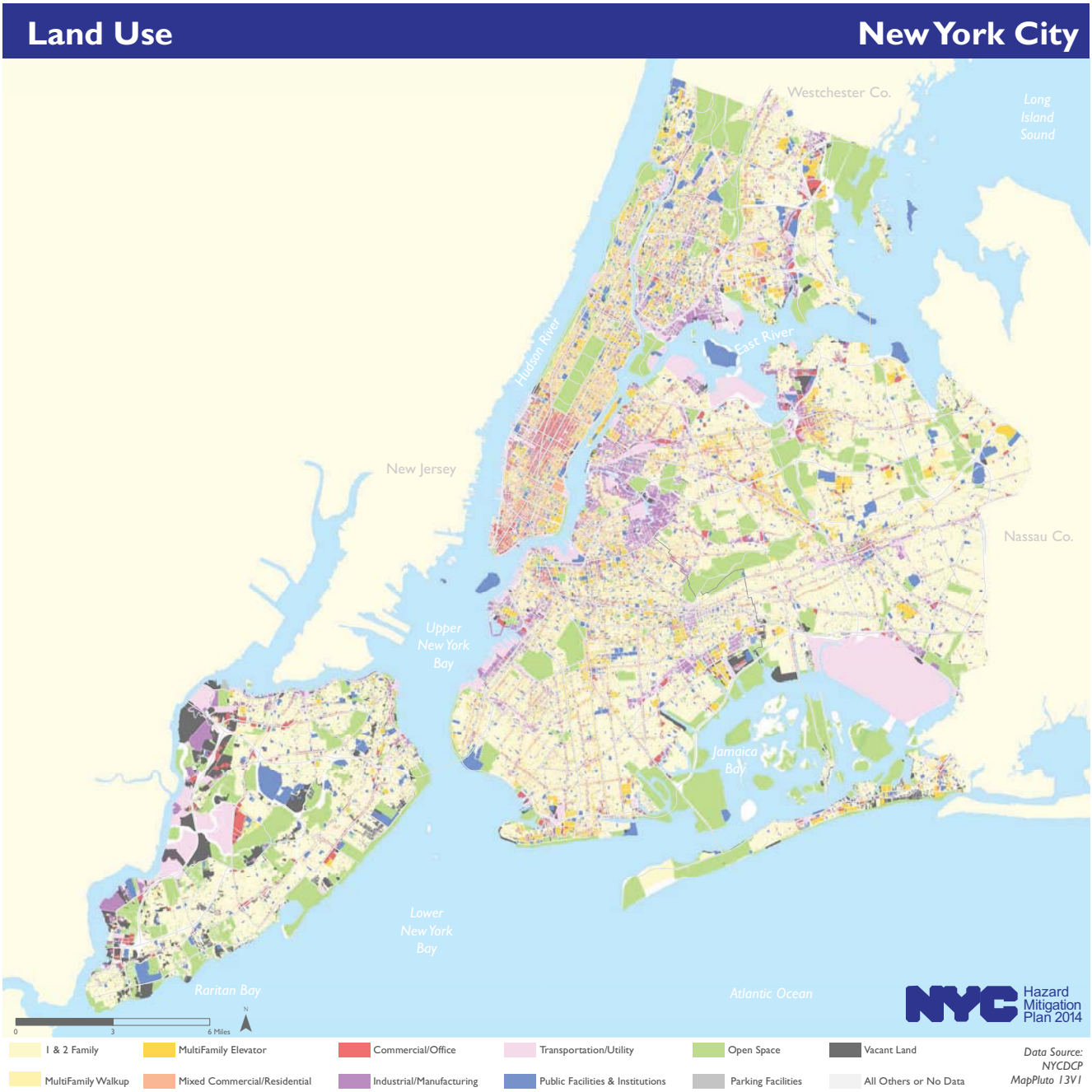


Table 3.4.13: Land Use in the Bronx

Land Use	Lots		Total Lot Area		Total Building Area	
	#	%	Sq. Feet	%	Sq. Feet	%
Residential	71,134	79.2%	304,776,816	34.8%	438,820,942	62.0%
Mixed use	3,713	4.1%	28,483,111	3.3%	89,278,981	12.6%
Commercial	3,094	3.4%	40,728,881	4.7%	39,503,688	5.6%
Industrial	1,391	1.5%	33,224,900	3.8%	29,575,150	4.2%
Transportation/utility	1,078	1.2%	49,234,393	5.6%	5,921,865	0.8%
Public facilities	1,872	2.1%	97,205,716	11.1%	87,666,684	12.4%
Open space	678	0.8%	259,228,999	29.6%	5,244,881	0.7%
Parking	2,149	2.4%	18,565,420	2.1%	9,349,936	1.3%
Vacant land	4,140	4.6%	27,606,562	3.2%	5,840	0.0%
All others or no data	556	0.6%	16,753,289	1.9%	2,247,933	0.3%
Total	89,805	100.0%	875,808,086	100.0%	707,615,900	100.0%

Figure 3.4.19: Primary Land Use in the Bronx

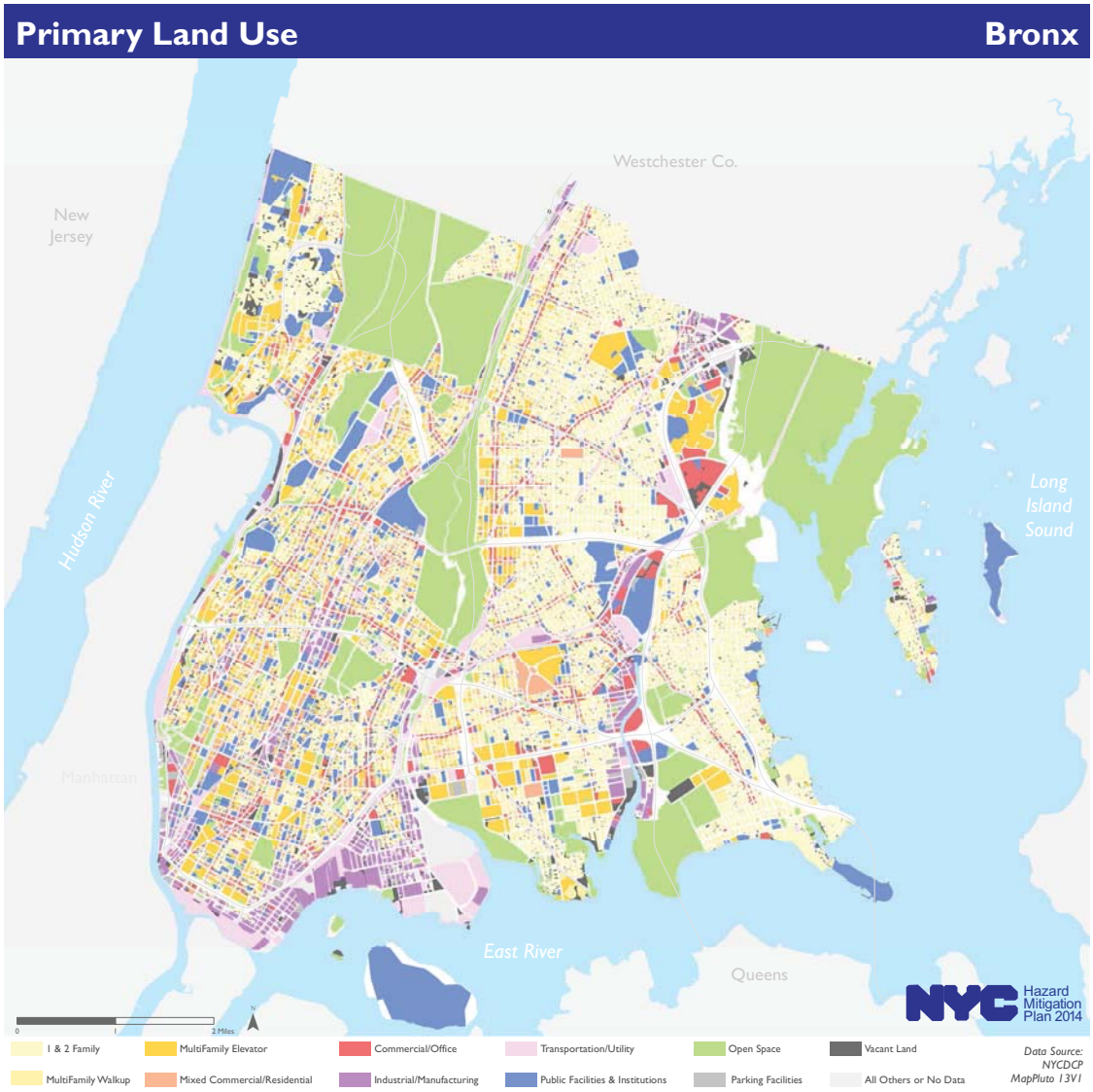


Table 3.4.14: Land Use in Brooklyn

Land Use	Lots		Total Lot Area		Total Building Area	
	#	%	Sq. Feet	%	Sq. Feet	%
Residential	223,627	80.6%	661,319,515	46.7%	909,807,601	63.7%
Mixed use	21,947	7.9%	67,760,668	4.8%	154,272,703	10.8%
Commercial	6,981	2.5%	56,233,060	4.0%	79,447,276	5.6%
Industrial	4,927	1.8%	75,478,979	5.3%	87,279,742	6.1%
Transportation/utility	2,042	0.7%	78,897,991	5.6%	30,398,414	2.1%
Public facilities	4,294	1.5%	101,755,643	7.2%	152,837,003	10.7%
Open space	901	0.3%	296,985,642	21.0%	5,645,328	0.4%
Parking	3,992	1.4%	26,692,757	1.9%	8,494,343	0.6%
Vacant land	7,231	2.6%	37,761,387	2.7%	90,422	0.0%
All others or no data	1,585	0.6%	13,539,583	1.0%	1,113,913	0.1%
Total	277,527	100.0%	1,416,425,227	100.0%	1,429,386,745	100.0%

Figure 3.4.20: Primary Land Use in Brooklyn

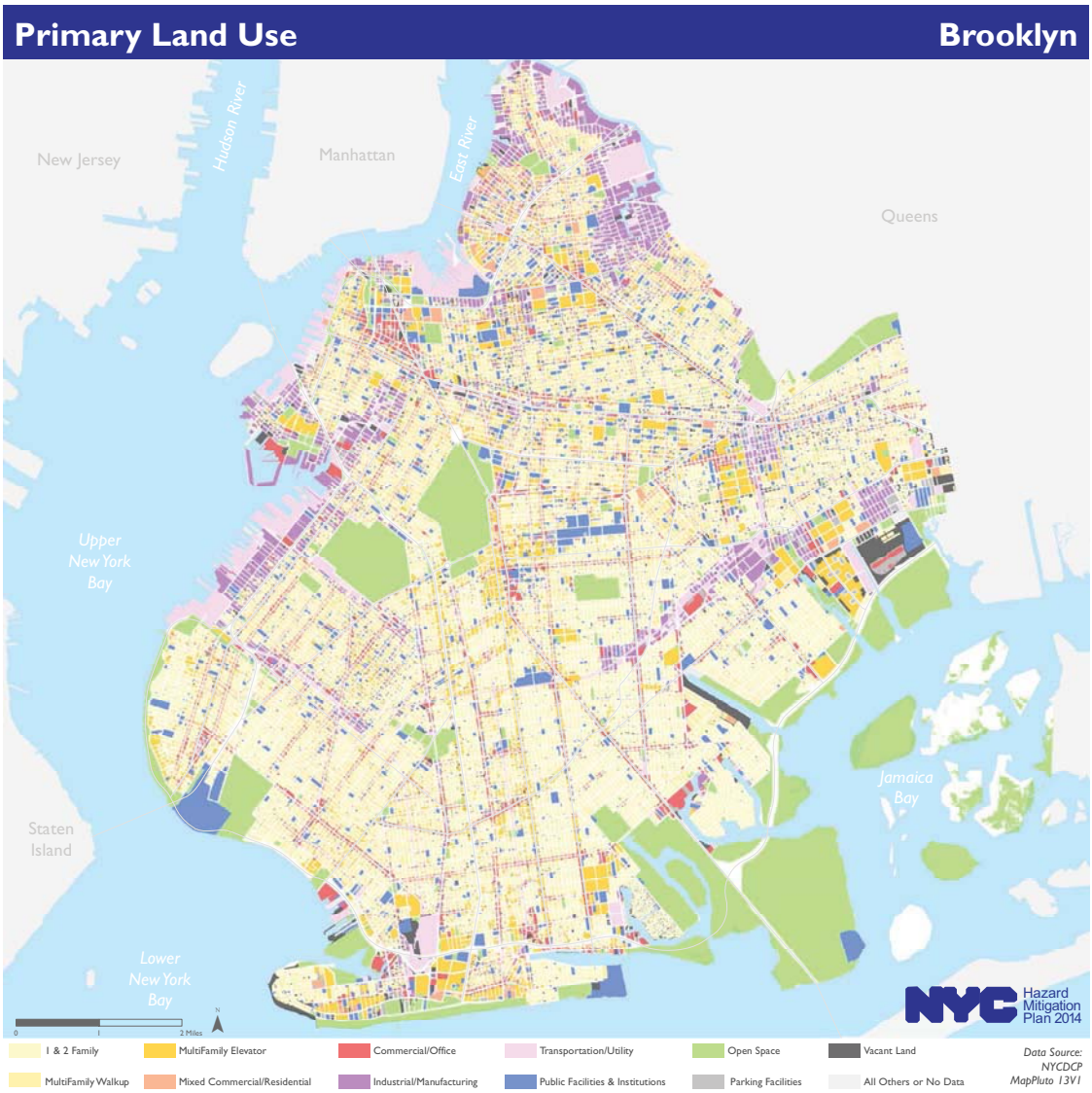


Table 3.4.15: Land Use in Manhattan

Land Use	Lots		Total Lot Area		Total Building Area	
	#	%	Sq. Feet	%	Sq. Feet	%
Residential	20,751	48.2%	118,618,032	26.1%	547,869,319	31.7%
Mixed use	10,230	23.8%	65,584,904	14.4%	382,099,796	22.1%
Commercial	5,222	12.1%	51,142,279	11.3%	543,694,466	31.4%
Industrial	1,368	3.2%	8,785,415	1.9%	53,848,942	3.1%
Transportation/utility	465	1.1%	26,610,097	5.9%	12,277,771	0.7%
Public facilities	2,470	5.7%	55,172,864	12.1%	175,799,142	10.2%
Open space	375	0.9%	107,563,333	23.7%	2,558,288	0.1%
Parking	787	1.8%	7,005,522	1.5%	9,934,116	0.6%
Vacant land	1,222	2.8%	8,146,293	1.8%	65,466	0.0%
All others or no data	178	0.4%	5,601,020	1.2%	1,193,753	0.1%
Total	43,068	100.0%	454,229,759	100.0%	1,729,341,059	100.0%

Figure 3.4.21: Primary Land Use in Manhattan

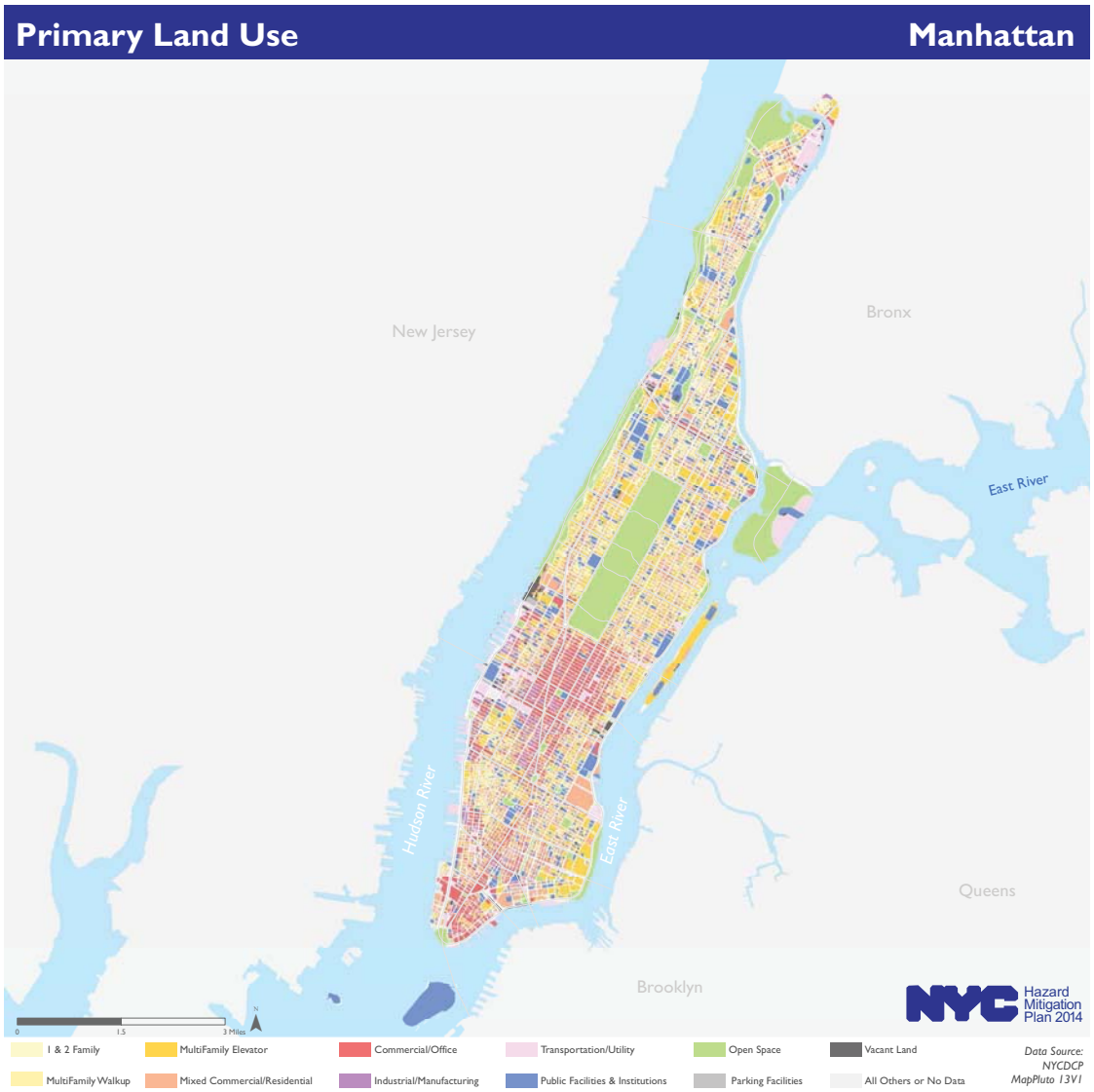


Table 3.4.16: Land Use in Queens

Land Use	Lots		Total Lot Area		Total Building Area	
	#	%	Sq. Feet	%	Sq. Feet	%
Residential	283,320	87.4%	1,091,534,788	47.9%	817,198,316	67.4%
Mixed use	11,242	3.5%	40,568,446	1.8%	79,491,910	6.6%
Commercial	6,936	2.1%	79,129,747	3.5%	86,426,240	7.1%
Industrial	3,776	1.2%	80,264,714	3.5%	75,403,381	6.2%
Transportation/utility	2,255	0.7%	312,714,375	13.7%	26,093,616	2.2%
Public facilities	2,819	0.9%	112,680,780	4.9%	96,416,810	8.0%
Open space	1,101	0.3%	459,623,438	20.2%	23,330,687	1.9%
Parking	3,629	1.1%	27,312,525	1.2%	7,672,391	0.6%
Vacant land	8,358	2.6%	62,420,571	2.7%	146,362	0.0%
All others or no data	820	0.3%	14,453,785	0.6%	547,666	0.0%
Total	324,256	100.0%	2,280,703,169	100.0%	1,212,727,379	100.0%

Figure 3.4.22: Primary Land Use in Queens

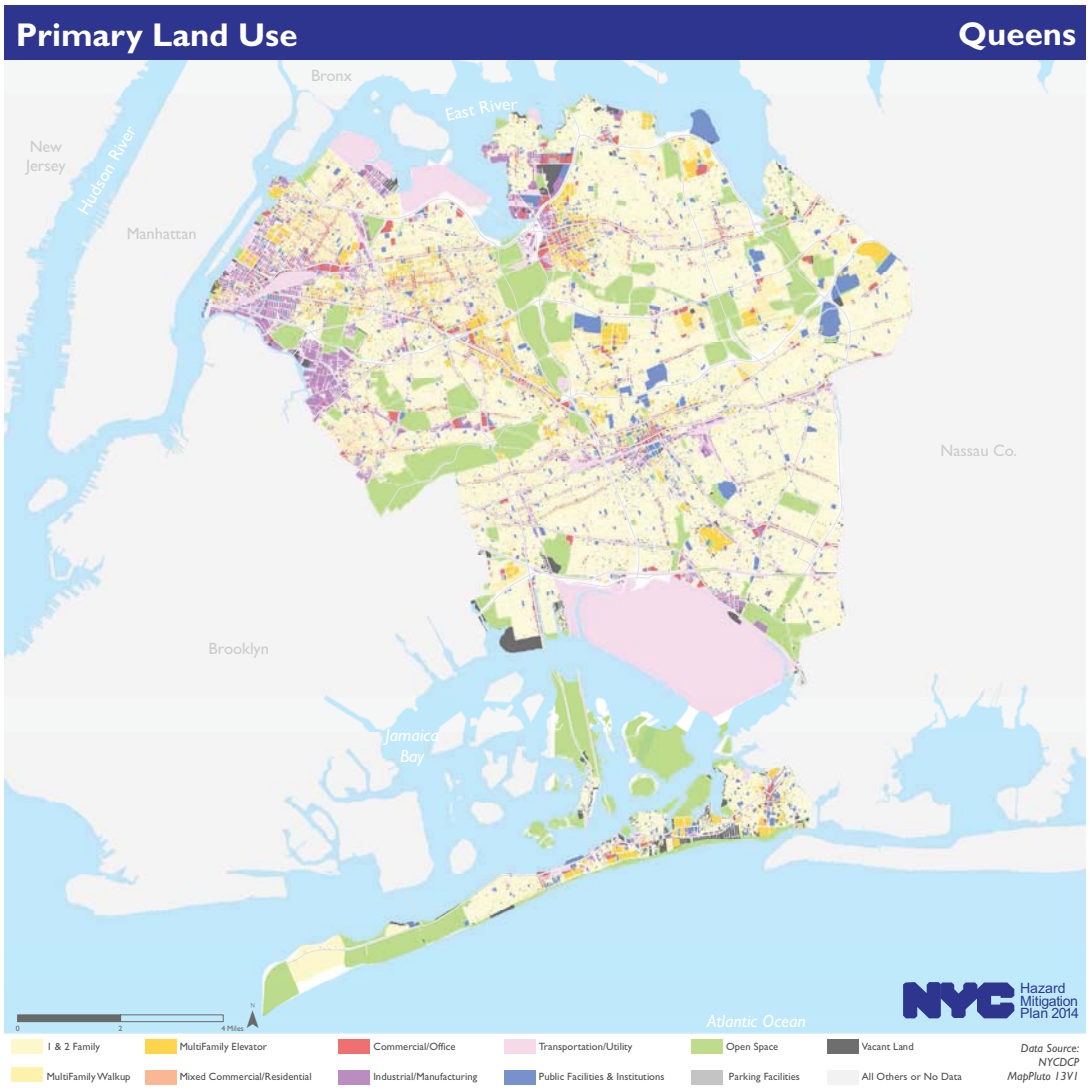
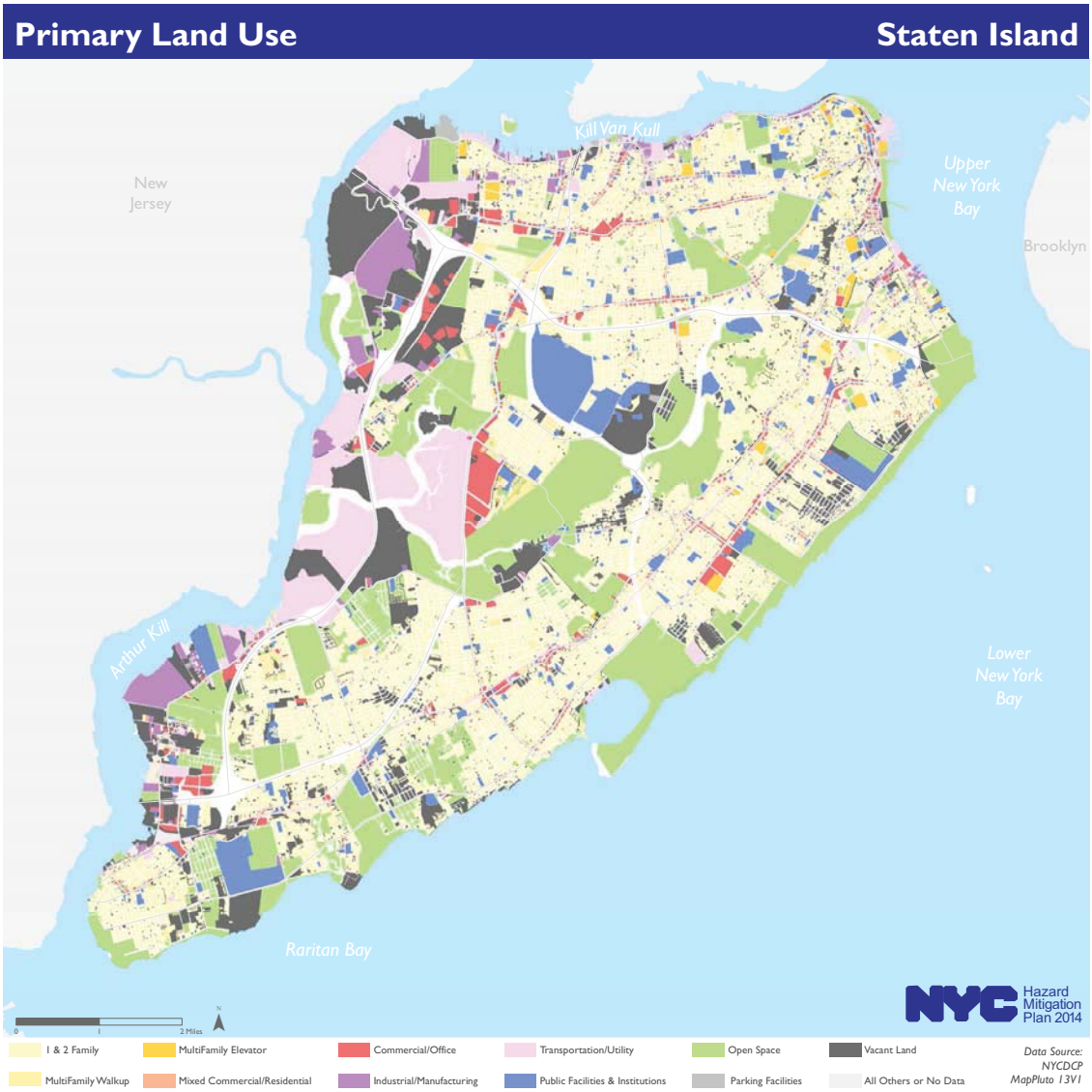


Table 3.4.17: Land Use in Staten Island

Land Use	Lots		Total Lot Area		Total Building Area	
	#	%	Sq. Feet	%	Sq. Feet	%
Residential	107,616	87.3%	494,540,625	38.2%	494,540,625	38.2%
Mixed use	1,466	1.2%	7,881,476	0.6%	7,881,476	0.6%
Commercial	2,182	1.8%	46,564,191	3.6%	46,564,191	3.6%
Industrial	432	0.4%	37,820,978	2.9%	37,820,978	2.9%
Transportation/utility	778	0.6%	104,871,432	8.1%	104,871,432	8.1%
Public facilities	690	0.6%	86,586,864	6.7%	86,586,864	6.7%
Open space	1,887	1.5%	315,856,994	24.4%	315,856,994	24.4%
Parking	753	0.6%	8,124,738	0.6%	8,124,738	0.6%
Vacant land	7,011	5.7%	180,811,171	14.0%	180,811,171	14.0%
All others or no data	408	0.3%	10,998,997	0.8%	10,998,997	0.8%
Total	123,223	100.0%	1,294,057,465	100.0%	1,294,057,465	100.0%

Figure 3.4.23: Primary Land Use in Staten Island



ii. 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 3.4.18). 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 across the city.

Table 3.4.18: New York City Number of Buildings by Borough Summary Data (Source: MapPluto 13V1 2013)

Borough	Number of Buildings	% of city
Brooklyn	316,287	31.7
Bronx	102,580	10.3
Manhattan	46,301	4.6
Queens	397,286	39.8
Staten Island	135,269	13.6
Total	997,723	100.0

Note: Table 3.4.9 uses New York City Department of Finance's (DOF) parcel data to determine the number of buildings in NYC. Due to different methodologies and variations in the data sets, these numbers will differ from the number of buildings modeled in HAZUS.

Buildings can be categorized by their construction type. In New York City, materials used in building construction are often referred to as "combustible" or "non-combustible." Combustible buildings use lighter stud-frame construction or wood joists on masonry bearing walls. Heavier non-combustible buildings have steel or masonry and concrete frames.

Construction type is an important determinant of structural vulnerability to the effects of some hazards. For example, low-rise buildings 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 characteristic of more recent and denser building types.

As shown in Table 3.4.19, roughly half the buildings in NYC are combustible and half are non-combustible. Table 3.4.19 uses 2013 New York City parcels data to show a summary of New York City's building stock based on Hazards U.S. 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 Figure 3.4.24 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.

Table 3.4.19: New York City Building Stock Summary Data (Source: MapPluto 13V1 2013)

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**

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

b. Building Age

Buildings in New York City can also be categorized by their age (see Figure 3.4.25). The vast majority of the city's building stock—approximately 80%—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, which are 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. In 2008, the New York City Construction Code was adopted 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.

Figure 3.4.24: New York City Buildings by Construction Type

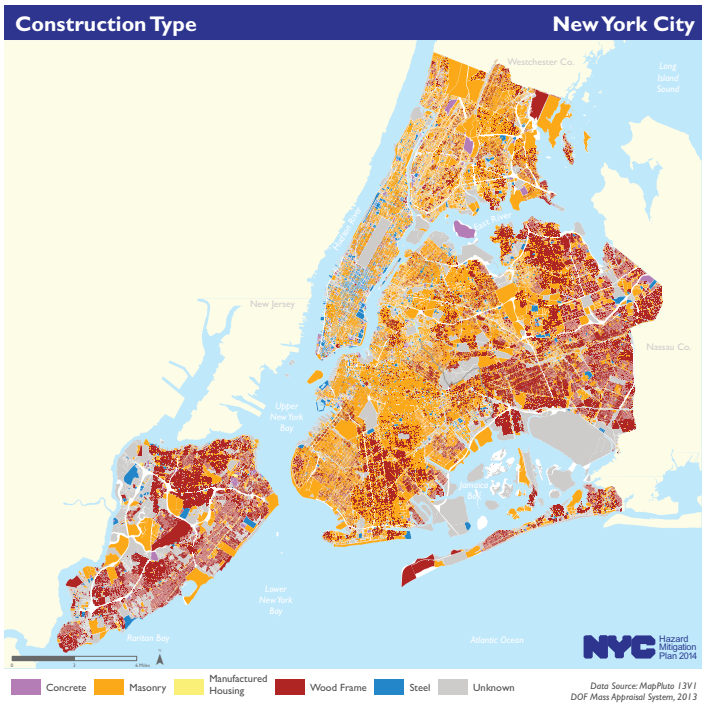
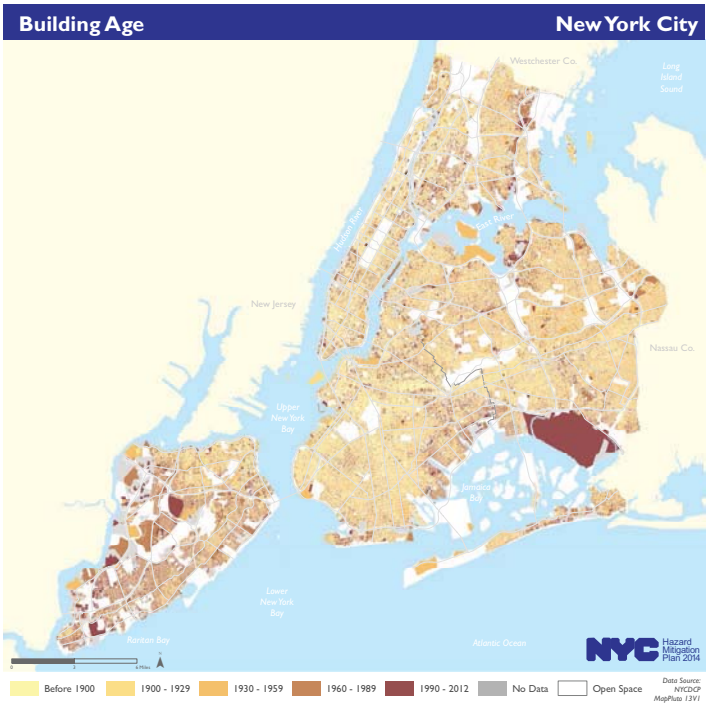


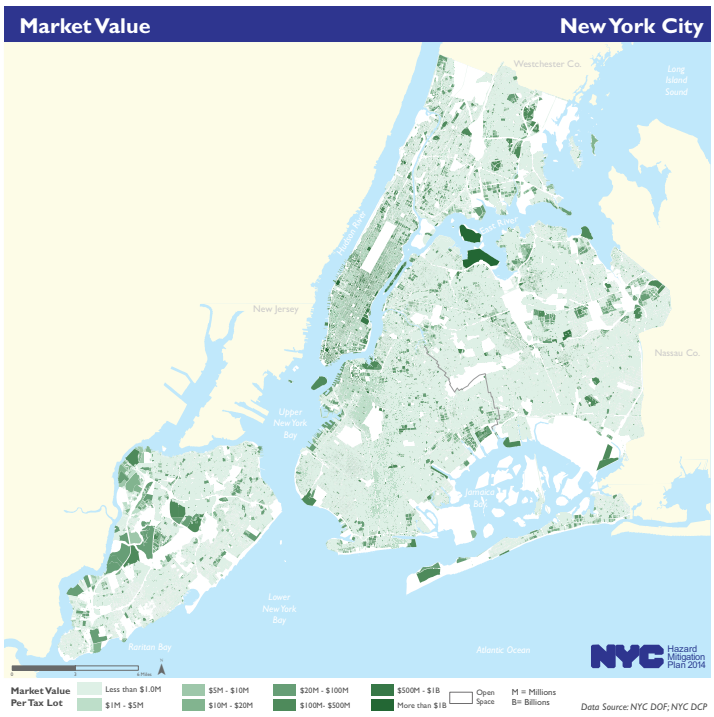
Figure 3.4.25: New York City Buildings by Age



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 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 (see Figure 3.4.26).

Figure 3.4.26: Market Value of Buildings in New York City



However, overall value exceeds the sum of building and contents value. The businesses and industries housed in many of these buildings, especially in Manhattan's financial district and midtown, are sometimes worth billions more.

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 2008, after several years of revisions, the city adopted the New York City Construction Code to ensure an up-to-date and comprehensive building code to meet the present and future challenges of

New York City's dense urban environment. The revised code helped address natural hazard mitigation, including new standards that applied to all new construction within the city to protect buildings from drought, earthquakes, extreme temperatures, flooding, wind, and winter weather.

- **Drought**

The Construction Code encourages 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, energy efficient, sustainable buildings.

- **Earthquakes**

The NYC 1995 building code update (Local Law 17/19) contained the first seismic provisions in the New York City Building Code which considered soil and foundation conditions for new construction. The Department of Buildings has further addressed structural vulnerability to earthquakes in the 2008 Construction Codes, which are based on the 2003 International Building Code requirements (with local modifications for buildings constructed after July 1, 2009). Additionally, the 2014 NYC Building Code (BC) will provide a new seismic standard that presents risk-based requirements, and enhanced design requirements for liquefaction.

- **Extreme Temperatures**

The Construction Code promotes 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 heavy 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.

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 flood zones.

- **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.

iii. Energy Systems

New York City's energy infrastructure–comprised of electric, 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; transmission, which transports electricity at high voltages to large substations; and distribution, 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.

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 system is owned, operated, and regulated by a wide array of private and public entities. 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 Generating Co (US Power Gen Co)
- Con Edison
- Riverbay Corp
- Calpine
- NextEra Energy Resources
- Brooklyn Navy Yard Cogeneration

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)

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—and 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.

iv. Telecommunication Systems

New York City's telecommunications–made up of services such as internet, information services, phone services, and cable television–is an essential component of the city's basic infrastructure. Telecommunications not only serve 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, telecommunications 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—which includes parts of all five boroughs. 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 provid-

ing 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 (DOT) 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 telecommunications sector, none currently has comprehensive responsibility for the entire system, and none is charged with ensuring that required service is available during emergencies. While the FCC has a Communications Security, Reliability, and Interoperability Council that 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.

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.

Multiple companies provide voice, data, and video services (see Table 3.4.20). 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.

Table 3.4.20: Telecommunications Companies in New York City

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

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.

v. Transportation Systems

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

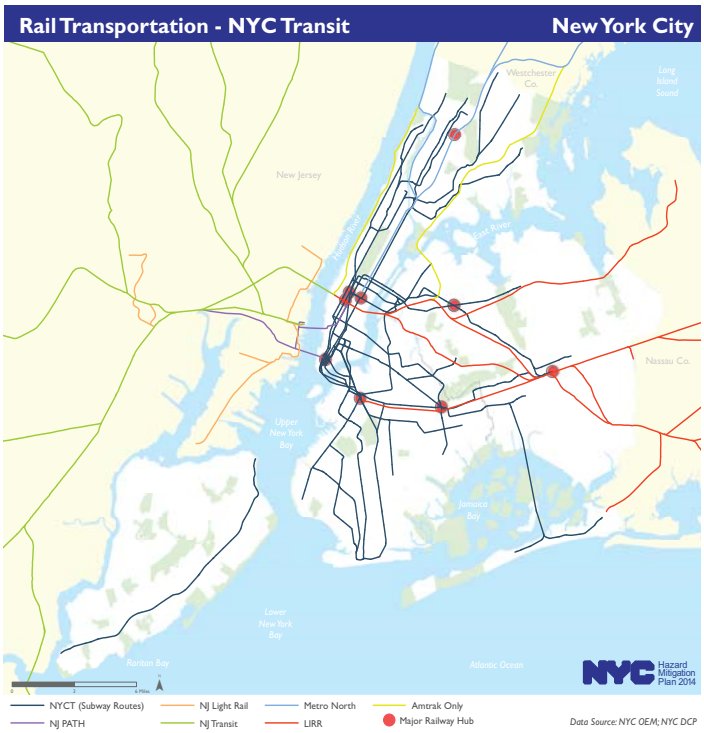
a. Rail Network

New York City has one of the most complex rail systems in the country. It is made up of interconnected 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 (see Table 3.4.21). 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) (see Figure 3.4.27). 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. Amtrak's rail system helps connect New York City to other major cities around the nation. Not surprisingly, Penn Station is the busiest station in the Amtrak rail system.

The city's rail transportation is dependent on electricity for power. For example the subway system alone consumes 1.8 billion kilowatt hours each year.

Rail infrastructure is located both underground and above-ground. 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 risks.

Figure 3.4.27: New York City Rail Network



b. Roadway Network

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 (see Figure 3.4.28). Bridges and tunnels are vital components of roadway transportation, providing inter-borough connections for vehicles and public transit as well as ac-

Table 3.14.21: New York City Rail Ridership (Source: MTA, NJ Transit, and Port Authority 2013

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
Amtrak Penn Station	N/A	9,493,414

**** Reflects average weekday boarding at Penn Station and ridership information for fiscal year 2012***

cess 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 3.4.28 represents the major roads, bridges, tunnels, and bus stations in New York City.

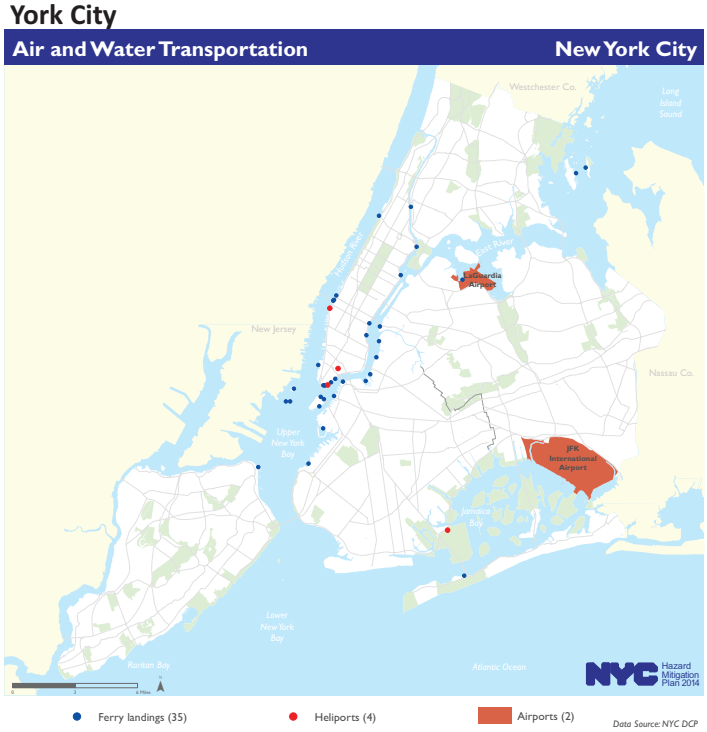
Figure 3.4.28: Major Elements of the New York City Road Network

c. Air and Maritime Transportation

Airports, port facilities, and ferry landings are located throughout the New York City region (see Figure 3.4.29). 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 and public 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 the third 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 The Department of Parks & Recreation (DPR), DOT, and the New York City Economic Development Corporation (EDC).

Figure 3.4.29: Air and Water Transportation Assets in New York City



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. There are 47 active ferry landings in New York City providing services for the city and region. Ferries 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.

vi. Water Systems

a. 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 watersheds—some more than 125 miles from the city—through a complex network of aqueducts and tunnels to in-city reservoirs (see Figure 3.4.30).

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 the 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% 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% 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 a water supply system that has various interconnections, permitting exchange of water from one to another, to increase flexibility and resiliency.

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 carries between 500 and 600 million gallons of water each day. Water tunnel 2, completed in 1936, is 20 miles long carries between 700 and 800 million gallons of water each day. Both tunnels have been in continuous service since they were originally built. In 1970, the city began construction a third tunnel, which will be completed in 2020, to increase redundancy and enable inspection and repair of Tunnels 1 and 2 as needed.

Additionally, to ensure a redundant and reliable supply of water to Staten Island the city is replacing the two existing water siphons that provide backup water supply for Tunnel 2, with one siphon that will be positioned approximately 50 feet deeper than the existing ones. Positioning the new water siphon at a lower depth will protect it from the New York Harbor deepening project.

Within the city, 7,000 miles of water mains and pipes distribute water throughout the five boroughs. These mains and pipes 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.

b. 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. While sanitary waste enters the sewer system through direct connections from buildings, stormwater enters the system from catch basins that direct flow to the city's sewer system.

Figure 3.4.30: New York City's Water Supply System

All of the city's 14 wastewater treatment plants are located along the waterfront at relatively low elevations (see Figure 3.4.31). 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). Secondly, 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).

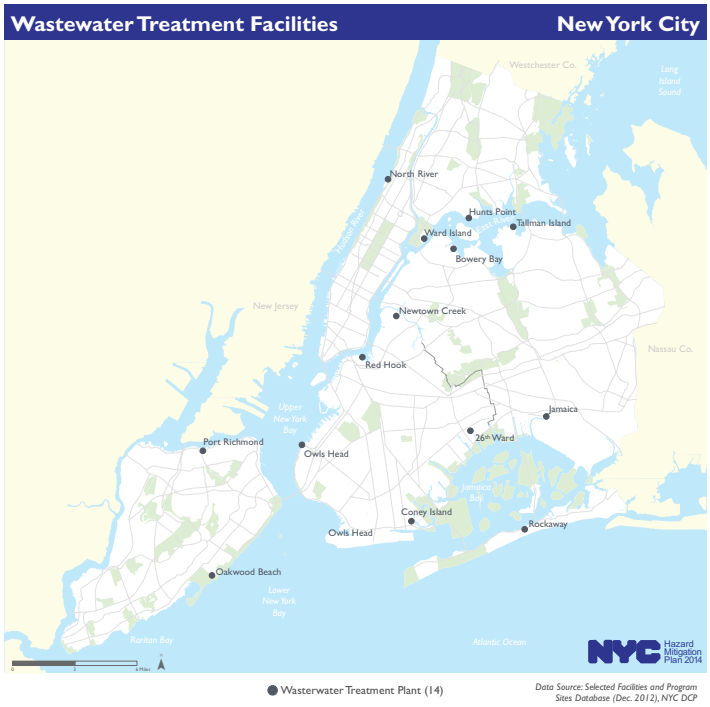
Under normal conditions, the system is adequate to perform full treatment on the combined volume of sewage and stormwater. During periods of heavy rain or snow, however, when flow exceeds two times dry-weather capacity, the volume of sewage and stormwater can quickly exceed the capacity of the wastewater 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, the City released the *NYC Green Infrastructure Plan*, a blueprint for 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. The 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.

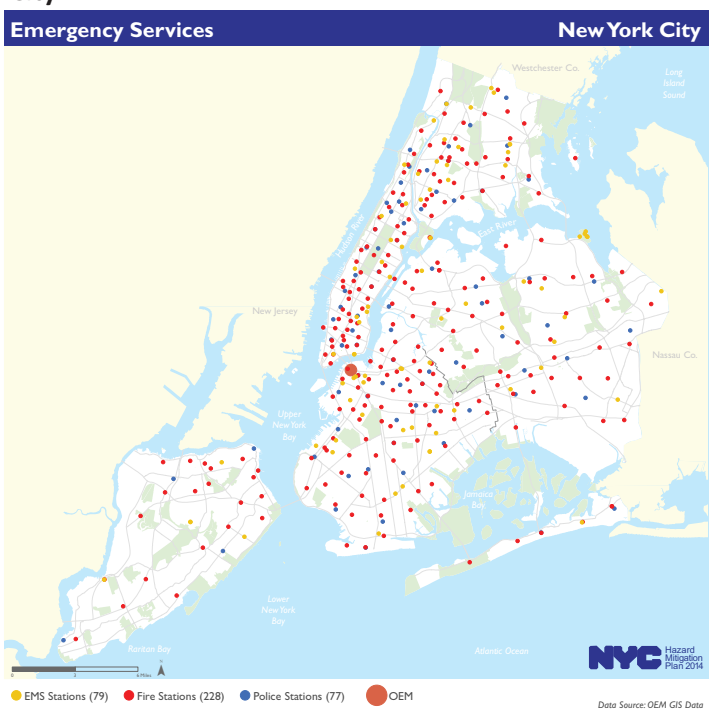
Figure 3.4.31: Wastewater Treatment Plants in New York City



vii. Emergency Facilities

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 3.4.32 shows the locations of police and fire stations as well as OEM's headquarters.

Figure 3.4.32: Emergency Service Providers in New York City



viii. Healthcare Facilities

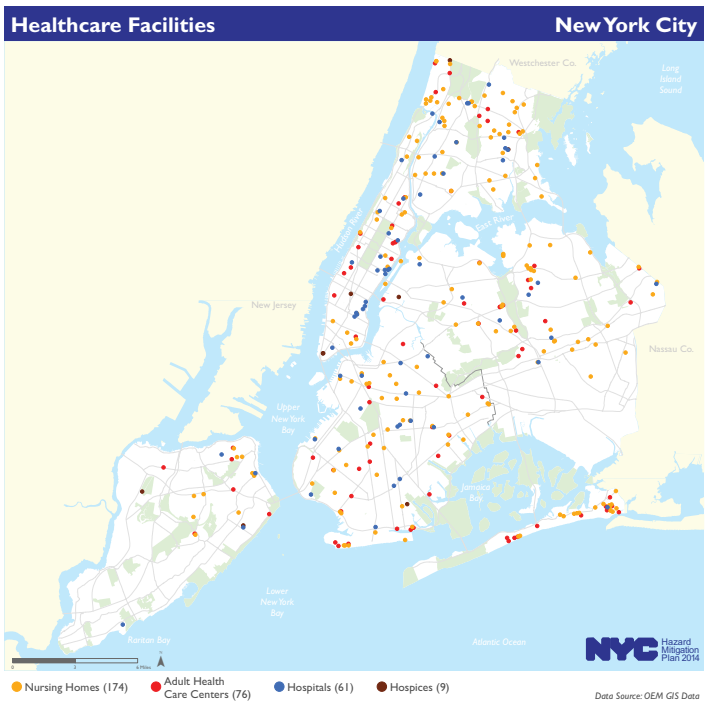
New York City has one of the greatest concentrations of healthcare facilities in the country. There are 61 hospitals, 174 nursing homes, 76 adult day care centers, and nine hospices citywide (see Figure 3.4.33). Additionally, 1,400 residential-based providers care for more than 80,000 patients at any 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.

Community-based providers deliver the healthcare services that keep most New Yorkers well on a day-to-day basis. 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. During and after emergencies, health care facilities function as the city's most critical assets.

ix. Educational Institutions

New York City has 2,753 educational facilities. As Figure 3.4.34 through Figure 3.4.36 show, there are 102

Figure 3.4.33: Healthcare Facilities in New York City



colleges, 848 private schools, and 1,803 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% have children 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 3.4.34: Colleges in New York City

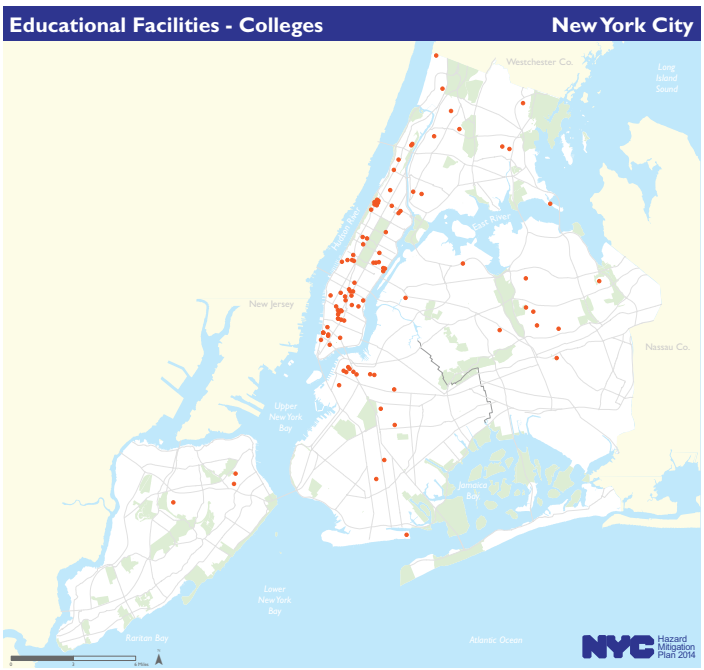


Figure 3.4.35: Private Schools in New York City

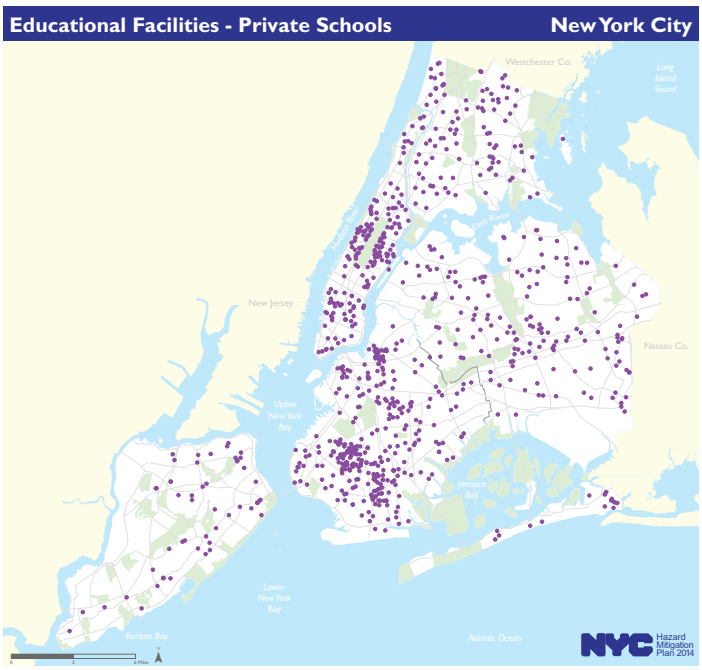
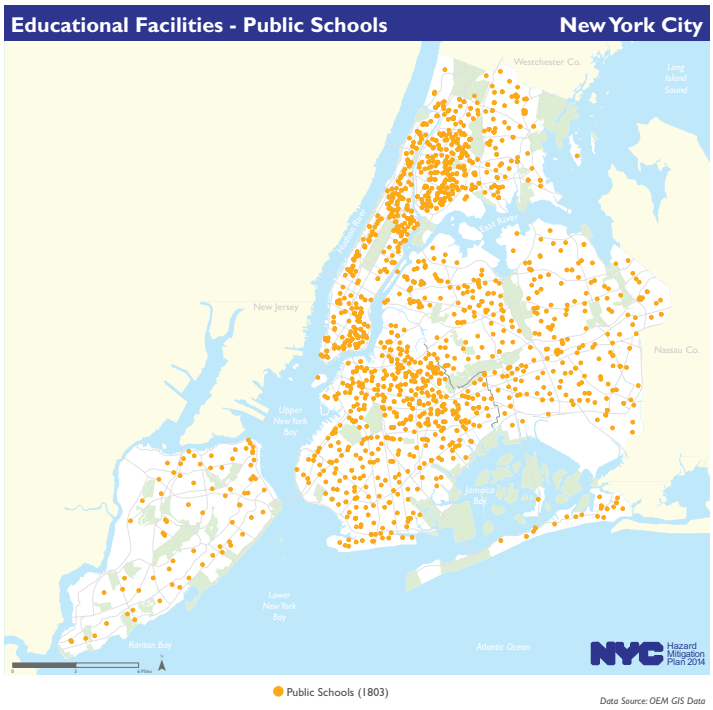


Figure 3.4.36: Public Schools in New York City



x. Cultural Facilities

New York City has one of the greatest concentrations of cultural institutions in the world. The map below (Figure 3.4.37) displays some of New York City's most visited museums, zoos, stadiums, iconic buildings, theaters, and concert halls.

Figure 3.4.37: Major Cultural Facilities in New York City

D. The Future Environment

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

1. 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, in part related to climate change, increased the extent and magnitude of flooding from the storm.

In 2008, to help respond to climate change in New York City and accomplish the goals outlined in PlaNYC, the City's long-term sustainability plan, the City convened the New York City Panel on Climate Change (NPCC). 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* (see end of section 4 for website link) for sea level rise, heat waves, and precipitation, summarized below.

Sea Level Rise

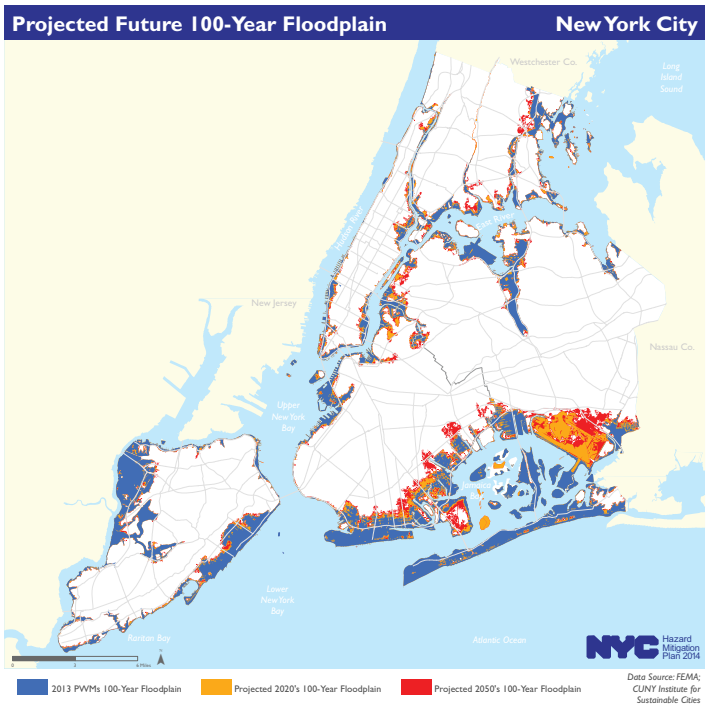
New York City's sea levels are rising, and, according to the NPCC, this trend is expected to continue in the coming decades (see Table 3.4.22). Middle-range projections for the 2020s indicate a 4- to 8-inch rise in sea levels, while high-end sea level rise projections show sea levels rising as much as 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 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. For example, by the 2020s, 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.

Table 3.4.22: NPCC Sea Level Rise Projections 2013

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

FEMA's Flood Insurance Rate Maps (FIRMs) show flood-prone land areas called floodplains, geographic areas classified according to levels of flood risk and/or type of flooding. 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 on FIRMS is the area where there is a 1% or greater chance of a flood—the so-called 100-year flood—in any given year. This is also referred to as the Special Flood Hazard Area (SFHA). Structures located

Figure 3.4.38: Future Flood Maps for the 2020s and 2050s



within this area are required to carry flood insurance if they have a federally backed mortgage. The 500-year floodplain is the area with a 0.2% or greater chance of flooding in any given year.

Future Flood Maps

The City worked with the NPCC to develop a series of "future flood maps" for New York City that will help guide the city's resiliency and mitigation efforts (see Figure 3.4.38). 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 FIRMs. 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.

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 Prelim-

Table 3.4.23: NPCC Projections for Heat Waves and Cold Events 2013

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

inary FIRMs) 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 Preliminary FIRMs). 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 (see Table 3.4.23).

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 mid-century, according to the NPCC (see Table 3.4.24).

2. Population Projections

New York City has a dynamic population, with several hundred thousand people coming and going each year. Beginning with the 1990 Census, there has been a net increase in population for every decennial Census (see Figure 3.4.39). This pattern is anticipated to continue well into the future based on the latest projections released by New York City Department of City Planning (see Figure 3.4.40 and Figure 3.4.41). By 2040, it is projected that New York City's population will increase by almost 10% and surpass 9 million for the first time in history. The Boroughs of the Bronx, Brooklyn, Queens, and Staten Island are anticipated to be home to more residents than at any point in their respective histories. Only Manhattan's estimated population is not expected to surpass its historical high which was established in 1910. The population increase is not expected to be distributed equally throughout the five boroughs. Approximately 62% of the total net increase in population is expected to take place in the boroughs of Brooklyn and the Bronx, while Staten Island will have the lowest share at four percent.

Table 3.4.24: NPCC Projections for Precipitation and Intense Precipitation 2013

		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

Figure 3.4.39: Percent Change in Population per Census Tract 2000 to 2010

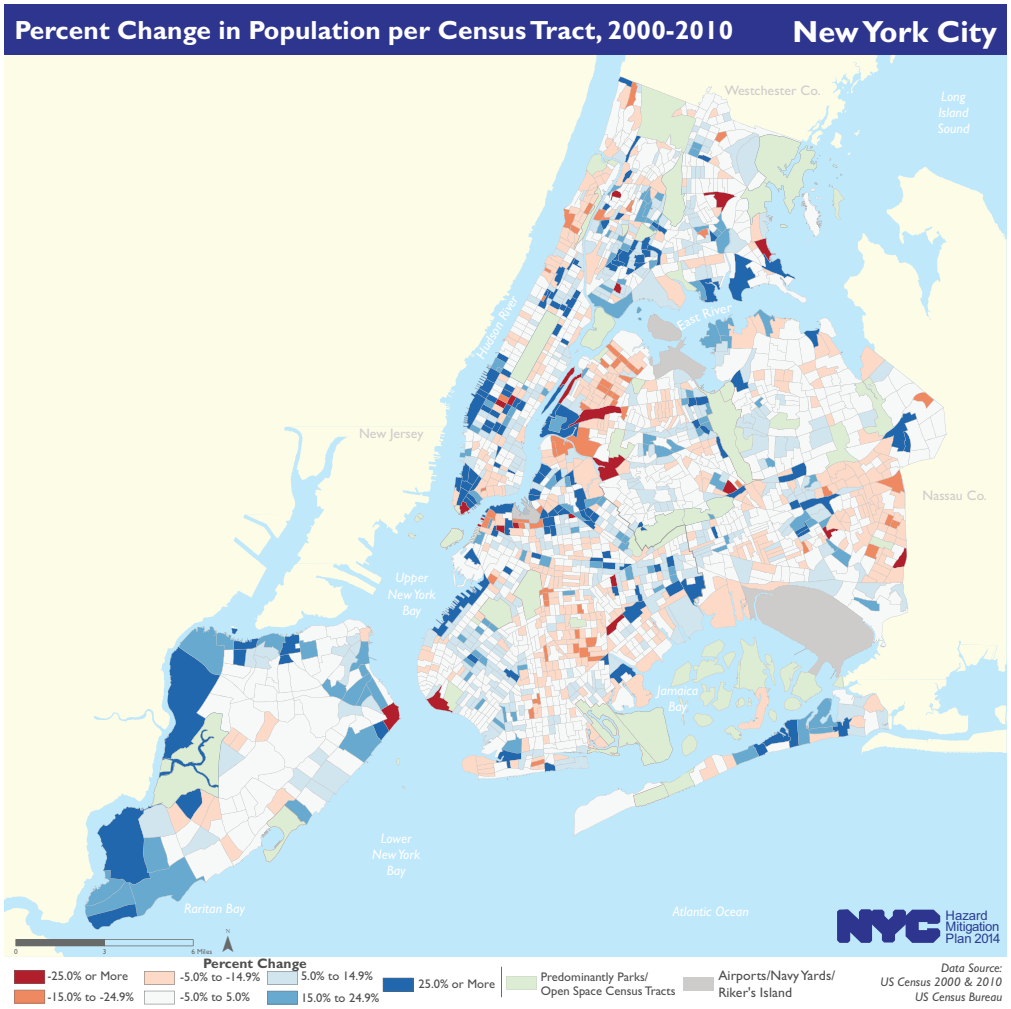
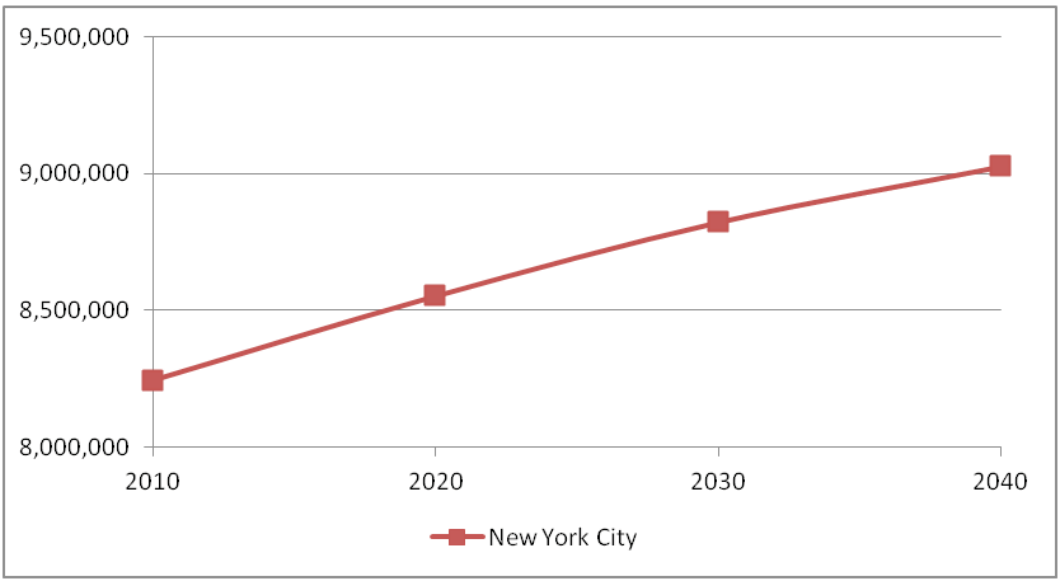


Figure 3.4.40: New York City Population, 2010-2040



By 2040, the age composition of New York City will be different than it has been in recent history. The most dramatic change is projected to take place amongst the population that will be 65 years or older. Between now and 2040, this age group will increase by approximately 40%. This is mainly due to the aging of the large baby boomer cohort, who will all be at least 75 years by this date, as well as an expected lower fertility rate and improvements in life expectancy. Currently, this age group makes up approximately 12 percent of New York City's population. In 2040, it is expected to increase to over 15%. Between 2010 and 2040, residents who are 65 and older in Staten Island will increase by 65%, which is the largest percentage increase in the five boroughs. By 2040, nearly 20% of the population in Staten Island will be 65 or older. This figure today stands at slightly less than 13% (see Figure 3.4.42).

Overall, the school-age population (ages 5-7) of New York City is projected to increase by approximately six percent by 2040. However, given the general increase in population, the share of school-age

Figure 3.4.41: New York City Population by Borough, 2010-2040

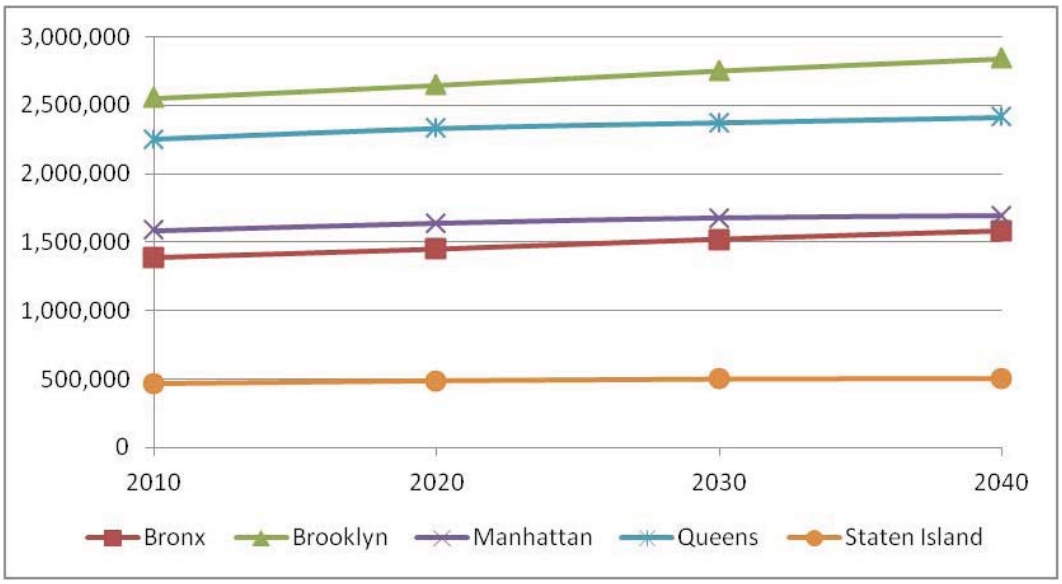


Figure 3.4.42: New York City 65 and Over Population by Borough, 2010-2040

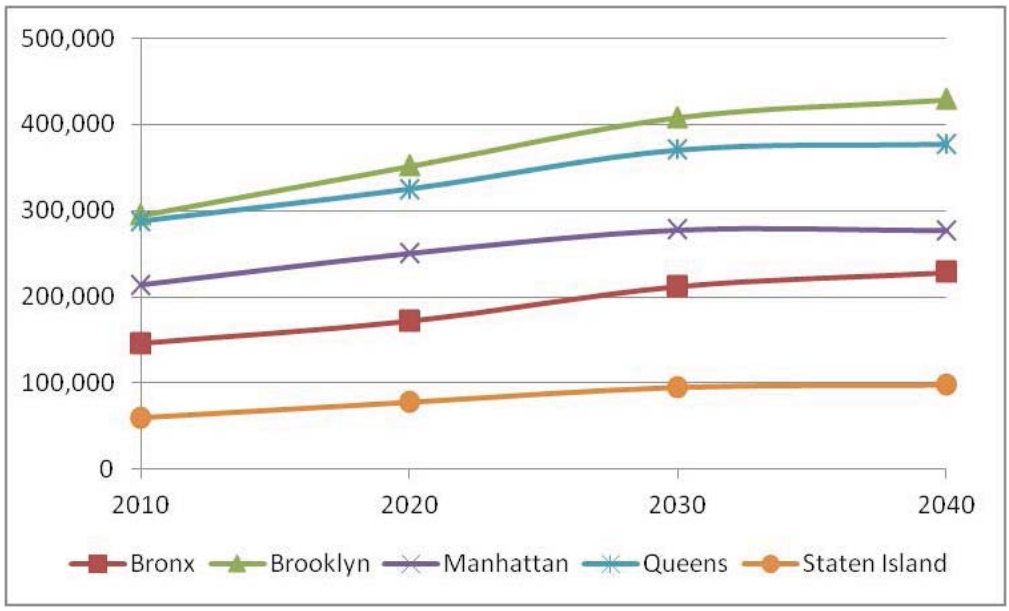
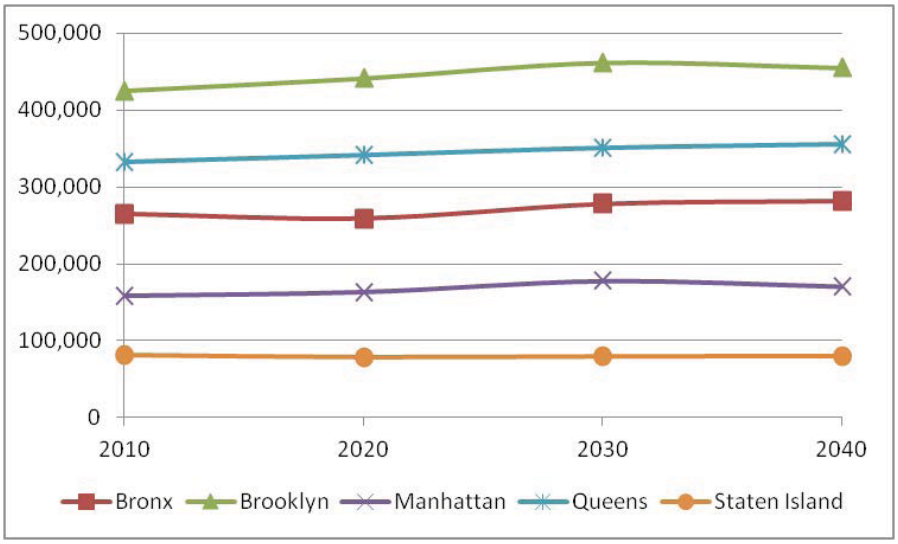


Figure 3.4.43: New York City School-Age Population (ages 5 to 17) by Borough, 2010-2040



population in New York City will slightly decrease by 2040. At the borough level, the share of this age group in the Bronx, Brooklyn, and Staten Island is expected to decline, while Queens and Manhattan will remain largely unchanged (see Figure 3.4.43).

3. Development Trends

New York City's land use and development trends are influenced by changes in the economy and the population, as well as the changing climate, and are guided by strategic planning initiatives designed to accommodate future growth and climate change challenges.

In the decades to come, New York City will be home to approximately nine million residents. To accommodate anticipated growth while addressing both the causes and implications of climate change, the City in 2007 released *A Greener, Greater New York*. The report launched a long-term strategy, known as PlaNYC, for how the City will address the physical challenges of population growth, aging infrastructure, and climate change.

PlaNYC contains over 100 initiatives designed to achieve sustainability goals for areas including land, water, transportation, energy, and air quality. With regard to land use planning and development, PlaNYC aims to guide housing and commercial development to transit-accessible areas; discourage further development of areas with limited transit access; redevelop vacant, underutilized, and brownfield sites; and preserve and create affordable housing.

Since the 2009 HMP, the City has continued to further these development goals and through more than 120 area-wide and targeted rezonings spanning almost 40% of the city's landmass, excluding parks and open space.

In neighborhoods well-served by transit, balanced rezonings tailored zoning regulations to protect and preserve existing character of neighborhoods while allowing for growth opportunities along major transit corridors (see Figure 3.4.44). Since the issuance of PlaNYC, over 87% of all new units constructed were located within a half-mile of transit and, as of 2013, rezoning initiatives have produced 27,000 new housing units. These contextual rezonings included neighborhoods such as the East Village, Lower East Side, and East Harlem in Manhattan; Bedford Stuyvesant, Flatbush, and Park Slope in Brooklyn; Morris Park, Williamsbridge, and Baychester in the Bronx; Astoria, Sunnyside/Woodside, and Maspeth in 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, South-

ern Brooklyn, northern Bronx, and much of Staten Island.

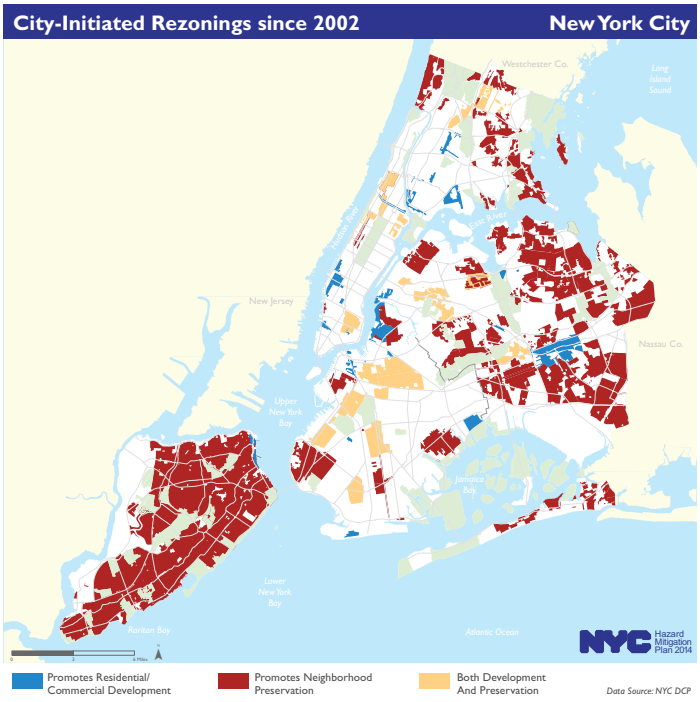
Other land use and development plans were targeted on the creation and enhancement of central and regional business districts near transit throughout the five boroughs, and encouraging mixed-use development there. These plans include Hudson Yards and Harlem's 125th Street in Manhattan, Downtown Brooklyn and Greenpoint-Williamsburg in Brooklyn, Jamaica and Long Island City in Queens, and the Lower Concourse in the South Bronx. Early results of these plans have transformed vacant and underutilized land areas into vibrant, mixed-use neighborhoods.

The recent revitalizations along the waterfront are part of a longer history of waterfront planning in New York City. Since the early 1990s, New York City's waterfront areas, notably in Manhattan and western Queens and Brooklyn, have been of particular strategic importance for the City's development vision. Rezonings in Greenpoint-Williamsburg, Long Island City/Hunter's Point, and Coney Island, for instance, have created opportunities for new housing, retail, and publicly accessible parks and open space on waterfront property, helping the city accommodate growth, create economic opportunities, and improve quality of life for visitors and residents alike.

With 520 miles of coastline, bordering the ocean, as well as rivers, inlets and bays, it is no surprise that the City's waterfront is among its greatest assets.

Many of PlaNYC initiatives have helped to enliven the waterfront by opening up access to miles of the shoreline that had been closed off to the public for decades, building new waterfront parks in all five boroughs and cleaning the City's waterways after years of decline and disuse. These strategies have enabled redevelopment to take place along the waterfront, creating much needed employment and housing opportunities for the City. Yet, waterfront neighborhoods face risks from coastal hazards today. With anticipated sea level rise and greater frequency of the most intense coastal storms, these risks are likely to increase in the future. For further information regarding the vulnerability of coastal development please see the vulnerability assessment sections of the following risk profiles: coastal erosion, coastal storms, and flooding.

Figure 3.4.44: City-Initiated Rezonings since 2002



The City has taken steps to reduce climate change risks and initiated numerous projects and initiatives to increase the resilience of the city's built environment, infrastructure and natural resources, particularly along the waterfront.

In June 2013, following Hurricane Sandy, the City's Special Initiative for Rebuilding and Resiliency report, *A Stronger, More Resilient New York,* made a series of recommendations to enhance coastal protection by increasing coastal edge elevations, protecting against storm surge, and improving coastal design and governance. The *Stronger, More Resilient* report drew upon the work carried out by the Department of City Planning's own coastal vulnerabilities and resiliency measures which was contained in *Urban Waterfront Adaptive Strategies* (UWAS) study, also released in 2013.

The *Stronger, More Resilient New York* and *UWAS* build on the accomplishments of 2011 *Vision 2020 New York City Comprehensive Plan,* the City's blueprint for revitalization of the waterfront. Crafted in collaboration with the City, state and federal agencies as well as non-governmental advisory groups and members of the general public, *Vision 2020* puts forth broad strategies and hundreds of specific recommendations for improving the waterfront and waterways both at the citywide and neighborhood scale. These strategies ensure the integration of public access in new commercial and residential developments, while simultaneously addressing the challenges of climate change and sea level rise.

These recent studies build on a strong tradition of waterfront planning in New York City. The first comprehensive waterfront plan, released in 1992, proposed ways to reclaim the shoreline for public access and productive uses. The 1992 Comprehensive Waterfront Plan built on the successful examples that existed at the time, including: Battery Park City, Roosevelt Island, and Pier 17 at the South Street Seaport. The 1992 plan proposed many important projects and recommended regulatory changes that have provided a foundation for contemporary waterfront planning and policies and laid the groundwork for the City's Waterfront Revitalization Program (WRP).

The WRP is the city's formal statement of policies for balancing economic development, natural resource protection, and public access on the shoreline. When a proposed project in a coastal zone requires a local, state, or federal discretionary action, a determination of the project's consistency with the policies and intent of the WRP must be made before the project can move forward. Revisions to the WRP in 2013 require proposed projects to analyze the risks associated with climate change and sea level rise and encourage applicants to minimize these risks through strategies that will enhance their ability to withstand and quickly recover from storm-related events.

The most recent example of resilient waterfront planning policy followed Hurricane Sandy, when the City adopted the Flood Resiliency Zoning Text Amendment to increase the city's resilience to climate-related events including coastal flooding and storm surge. The zoning text amendment encourages flood-resilient building construction throughout designated flood zones by enabling new and existing buildings to comply with new, higher flood elevations issued by the Federal Emergency Management Agency (FEMA) as well as new requirements in the New York City Building Code. Building to these new standards will reduce vulnerability to future floods as well as help avoid higher flood insurance premiums.

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