Chapter 16: Greenhouse Gas Emissions and Climate Change

A. INTRODUCTION

This chapter evaluates the greenhouse gas (GHG) emissions that would be generated by the construction and operation of the proposed projects on the east end of Block 675 in Manhattan that would be allowed by the proposed actions, as well as the proposed actions' consistency with the citywide GHG reduction goals. As described in Chapter 1, "Project Description," and Chapter 2, "Analytical Framework," in the future with the proposed actions (the With Action condition), the Project Area would be redeveloped with two new mixed-use buildings on two project sites (project site A—601 West 29th Street and project site B—606 West 30th Street). The Project Area includes these two project sites as well as an intervening lot (Lot 38), which ~~is not~~may be part of ~~either~~ project site B and~~but~~ is assumed to be redeveloped for the purposes of environmental review. Since the sites are within the future potential flood hazard area, this chapter also evaluates the resilience of the developments that would result from the proposed actions to climate conditions throughout the lifetime of the projects.

As discussed in the 2014 *City Environmental Quality Review* (*CEQR) Technical Manual*, climate change is projected to have wide-ranging effects on the environment, including rising sea levels, increases in temperature, and changes in precipitation levels. Although this is occurring on a global scale, the environmental effects of climate change are also likely to be experienced at the local level. New York City's sustainable development policy, starting with PlaNYC, and continued and enhanced in OneNYC, established sustainability initiatives and goals for greatly reducing GHG emissions and for adapting to climate change in the City.

Per the *CEQR Technical Manual,* the citywide GHG reduction goal is currently the most appropriate standard by which to analyze a project under CEQR. The *CEQR Technical Manual* recommends that a GHG consistency assessment be undertaken for any project preparing an environmental impact statement expected to result in 350,000 square feet or more of development and other energy-intense projects. The proposed projects would result in approximately 1.3 million gross square feet (gsf) of developed floor area. Accordingly, a GHG consistency assessment is provided.

PRINCIPAL CONCLUSIONS

GREENHOUSE GAS EMISSIONS

The proposed projects would be consistent with the City's emissions reduction goals, as defined in the *CEQR Technical Manual.*

The building energy use and vehicle use associated with the proposed projects would result in up to approximately 13 thousand metric tons of carbon dioxide equivalent (CO_2e) emissions per year—approximately two thirds from building energy and one third from vehicular emissions. In

addition, total construction emissions throughout the construction period are estimated at 53 thousand metric tons CO_2e, equivalent to approximately 4 years of operational emissions.

The *CEQR Technical Manual* defines five goals by which a project's consistency with the City's emission reduction goal is evaluated: (1) efficient buildings; (2) clean power; (3) sustainable transportation; (4) construction operation emissions; and (5) building materials carbon intensity.

The applicants are required at a minimum to achieve the energy efficiency requirements of New York City's building code. The applicants are currently evaluating the specific energy efficiency measures and design elements that may be implemented. Energy efficiency measures that will be included and additional measures under consideration are described in this chapter. Both projects intend to exceed the minimum energy requirements of New York City's building code such that the developments would achieve energy consumption that is 10 percent lower as compared with a baseline development designed to meet the current minimum building code requirements, and the project may qualify for EPA's Energy Star Qualified Multifamily High Rise Buildings certification. Therefore, the proposed projects would support the goal identified in the *CEQR Technical Manual* of building efficient buildings.

Furthermore, in 2016, as part of the City's implementation of strategies aimed at achieving the OneNYC GHG reduction goals, the City adopted a more stringent building energy code, which substantially increased the energy efficiency required. In 2016, the City also published a pathway to achieving the GHG reduction goals in the building sector. Should the measures identified in the City's pathway or other measures not yet implemented be adopted by the City in the future, they may apply to the proposed projects similar to any new building (if prior to building approval) or existing building (after construction). The proposed projects would implement any measures required under such programs as legally applicable.

While the potential cogeneration system[1] under consideration for project site A could decrease net building energy consumption (electricity and fuel use combined), based on the current carbon intensity of electricity in New York City, the cogeneration could increase building energy GHG emissions and total potential GHG emissions by less than one percent.

The proposed projects would also support the other GHG goals by virtue of proximity to public transportation, reliance on natural gas, commitment to construction air quality controls, and the fact that as a matter of course, construction in New York City uses recycled steel and includes cement replacements. All of these factors demonstrate that the proposed development supports the GHG reduction goal.

Therefore, based on the commitment to energy efficiency, compliance with enhanced energy efficiency requirements of New York City's building code, and by virtue of location and nature, the proposed projects would be consistent with the City's emissions reduction goals, as defined in the *CEQR Technical Manual*.

[1] "Cogeneration" refers to a fossil fuel-fired electricity generation system (natural gas in this case) which uses the heat generated as a byproduct for heat and/or hot water, reducing the fuel consumption in those systems.

RESILIENCE

The proposed projects are located in part within the current "one-percent annual chance" floodplain.[2] The floodplain would be larger in the future, as sea-level rises, and would include both sites. Potential flood water elevations would be higher in the future as a consequence as well. Therefore, the proposed projects have accounted for these potential changes and would be designed to be resilient to potential projected flood elevations of 14.5 feet NAVD88, accounting for sea-level rise of up to 30 inches by the 2050s, with the potential for additional adaptive measures in the future so as to increase all flood protection up to 17 feet NAVD88 should that be necessary. Specifically:

1. All critical infrastructure elements in the proposed new construction would be either elevated above 17 feet NAVD88, or sealed or otherwise designed to be resistant to flood waters if located below that elevation. This would include all critical elements and connections such as electrical, communications, fire safety and pumps, fuel storage, emergency power generation, and elevators. This approach would provide resilience to one-percent annual chance flood elevations for all critical infrastructure through the end of the century.
2. All new residential units would be higher than 17 feet NAVD88, protecting residential units from potential one-percent annual chance flood events throughout the end of the century.
3. Commercial, parking, lobby, and other non-critical non-residential spaces would be either designed with deployable protective barriers so as to hold back flood waters up to an elevation of 14.5 feet NAVD88, or designed such that flood waters entering these areas could be rapidly removed after a severe flood event without substantial structural damage, allowing for rapid recovery. This would provide resilience from potential one-percent annual chance flood events through the 2050s. Note that all critical infrastructure would be protected as described above, and residents would be evacuated prior to severe flood events as required by emergency evacuation recommendations or orders.

   For project site A, bike storage and parking areas (which front on West 29th Street) would be designed to flood and recover (i.e., would be built with flood resistant materials, and may sustain some damage during flooding, but could be rapidly repaired after flooding). In the event that a Fire Department of the City of New York- Emergency Medical Services (FDNY-EMS) Station is located in the western portion of project site A, additional planning and resilience review would be necessary, and would be undertaken as part of the design and environmental review required for that use. Other areas would be protected by a combination of deployable flood barriers and internal flood protective walls and doors.

   For project site B, a deployable flood barrier system would be designed to be deployed and protect façade elements and openings should flood levels rise above levels that the design can accommodate without a barrier.
4. The proposed projects would be designed to accommodate future enhancement (adaptive measures) of any deployable protections designed for commercial, parking,

[2] The one-percent annual probability floodplain, or the area that would potentially be flooded in a severe coastal storm with a probability of one percent of occurring in any given year.

lobby, and other non-critical non-residential spaces up to 17 feet NAVD88 should this be necessary in the future to accommodate increased flood elevations throughout the end of the century. This would include, for example, structural considerations for flood barriers with increased height and deeper flood waters.

B. GREENHOUSE GAS EMISSIONS

POLLUTANTS OF CONCERN

GHGs are those gaseous constituents of the atmosphere, both natural and anthropogenic (released due to human activity), that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. The general warming of the Earth's atmosphere caused by this phenomenon is known as the "greenhouse effect." Water vapor, carbon dioxide (CO_2), nitrous oxide (N_2O), methane, and ozone are the primary GHGs in the Earth's atmosphere.

There are also a number of entirely anthropogenic GHGs in the atmosphere, such as halocarbons and other chlorine- and bromine-containing substances, which also damage the stratospheric ozone layer (and contribute to the "ozone hole"). Since these compounds are being replaced and phased out due to the 1987 Montreal Protocol, there is no need to address them in GHG assessments for most projects. Although ozone itself is also a major GHG, it does not need to be assessed as such at the project level since it is a rapidly reacting chemical and efforts are ongoing to reduce ozone concentrations as a criteria pollutant (see Chapter 15, "Air Quality"). Similarly, water vapor is of great importance to global climate change, but is not directly of concern as an emitted pollutant since the negligible quantities emitted from anthropogenic sources are inconsequential.

CO_2 is the primary pollutant of concern from anthropogenic sources. Although not the GHG with the strongest effect per molecule, CO_2 is by far the most abundant and, therefore, the most influential GHG. CO_2 is emitted from any combustion process (both natural and anthropogenic); from some industrial processes such as the manufacture of cement, mineral production, metal production, and the use of petroleum-based products; from volcanic eruptions; and from the decay of organic matter. CO_2 is removed ("sequestered") from the lower atmosphere by natural processes such as photosynthesis and uptake by the oceans. CO_2 is included in any analysis of GHG emissions.

Methane and N_2O also play an important role since the removal processes for these compounds are limited and because they have a relatively high impact on global climate change as compared with an equal quantity of CO_2. Emissions of these compounds, therefore, are included in GHG emissions analyses when the potential for substantial emission of these gases exists.

The *CEQR Technical Manual* lists six GHGs that could potentially be included in the scope of a GHG analysis: CO_2, N_2O, methane, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). This analysis focuses mostly on CO_2, N_2O, and methane. There are no significant direct or indirect sources of HFCs, PFCs, or SF_6 associated with the proposed projects.

To present a complete inventory of all GHGs, component emissions are added together and presented as CO_2e emissions—a unit representing the quantity of each GHG weighted by its effectiveness using CO_2 as a reference. This is achieved by multiplying the quantity of each GHG emitted by a factor called global warming potential (GWP). GWPs account for the lifetime

and the radiative forcing[3] of each chemical over a period of 100 years (e.g., CO_2 has a much shorter atmospheric lifetime than SF_6, and therefore has a much lower GWP). The GWPs for the main GHGs discussed here are presented in **Table 16-1**.

Table 16-1
Global Warming Potential (GWP) for Major GHGs

Greenhouse Gas	100-year Horizon GWP
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140 to 11,700
Perfluorocarbons (PFCs)	6,500 to 9,200
Sulfur Hexafluoride (SF_6)	23,900

Note: The GWPs presented above are based on the Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report (SAR) to maintain consistency in GHG reporting. The IPCC has since published updated GWP values that reflect new information on atmospheric lifetimes of GHGs and an improved calculation of the radiative forcing of CO_2. In some instances, if combined emission factors were used from updated modeling tools, some slightly different GWP may have been used for this study. Since the emissions of GHGs other than CO_2 represent a very minor component of the emissions, these differences are negligible.
Source: 2014 *CEQR Technical Manual.*

POLICY, REGULATIONS, STANDARDS, AND BENCHMARKS FOR REDUCING GHG EMISSIONS

Because of the growing consensus that GHG emissions resulting from human activity have the potential to profoundly impact the Earth's climate, countries around the world have undertaken efforts to reduce emissions by implementing both global and local measures addressing energy consumption and production, land use, and other sectors. Although the U.S. has not ratified the international agreements that set emissions targets for GHGs, in December 2015, the U.S. signed the international Paris Agreement[4] that pledges deep cuts in emissions, with a stated goal of reducing annual emissions to a level that would be between 26 and 28 percent lower than 2005 emissions by 2025.[5] On June 1, 2017, the President announced that "the United States will withdraw from the Paris Climate Accord."[6]

Regardless of the Paris Agreement, the U.S. Environmental Protection Agency (EPA) is required to regulate GHGs under the Clean Air Act and has begun preparing and implementing regulations. In coordination with the National Highway Traffic Safety Administration (NHTSA), EPA currently regulates GHG emissions from newly manufactured on-road vehicles. In addition, EPA regulates transportation fuels via the Renewable Fuel Standard program, which will phase

[3] *Radiative forcing* is a measure of the influence a gas has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the importance of the gas as a GHG.

[4] Conference of the Parties, 21st Session. *Adoption of The Paris Agreement, decision -/CP.21*. Paris, December 12, 2015.

[5] United States of America. *Intended Nationally Determined Contributions (INDCs)* as submitted. March 31, 2015.

[6] Under the Agreement, countries are allowed to withdraw four years from the date the agreement entered into force—meaning the United States can officially withdraw on November 4, 2020. However, given the voluntary nature of the agreement, any action in the U.S. may or may not occur regardless of this status.

in a requirement for the inclusion of renewable fuels increasing annually up to 36.0 billion gallons in 2022. In 2015, EPA also finalized rules to address GHG emissions from both new and existing power plants that would, for the first time, set national limits on the amount of carbon pollution that power plants can emit. The Clean Power Plan sets carbon pollution emission guidelines and performance standards for existing, new, and modified and reconstructed electric utility generating units. On February 9, 2016, the Supreme Court stayed implementation of the Clean Power Plan pending judicial review. The President has signed an executive order which calls for a review of the Clean Power Plan.

There are also regional and local efforts to reduce GHG emissions. In 2009, Governor Paterson issued Executive Order No. 24, establishing a goal of reducing GHG emissions in New York State by 80 percent, compared with 1990 levels, by 2050, and creating a Climate Action Council tasked with preparing a climate action plan outlining the policies required to attain the GHG reduction goal; an interim draft plan has been published.[7] The State is now seeking to achieve some of the emission reduction goals via local and regional planning and projects through its Cleaner Greener Communities and Climate Smart Communities programs. The State has also adopted California's GHG vehicle standards (which are at least as strict as the federal standards).

The New York State Energy Plan outlines the State's energy goals and provides strategies and recommendations for meeting those goals. The latest version of the plan was published in June 2015. The new plan outlines a vision for transforming the state's energy sector that would result in increased energy efficiency (both demand and supply), increased carbon-free power production, and cleaner transportation, in addition to achieving other goals not related to GHG emissions. The 2015 plan also establishes new targets: (1) reducing GHG emissions in New York State by 40 percent, compared with 1990 levels, by 2030; (2) providing 50 percent of electricity generation in the state from renewable sources by 2030; and (3) increasing building energy efficiency gains by 600 trillion British thermal units (Btu) by 2030.

New York State has also developed regulations to cap and reduce CO_2 emissions from power plants to meet its commitment to the Regional Greenhouse Gas Initiative (RGGI). Under the RGGI agreement, the governors of nine northeastern and Mid-Atlantic states have committed to regulate the amount of CO_2 that power plants are allowed to emit, gradually reducing annual emissions to half the 2009 levels by 2020. The RGGI states and Pennsylvania have also announced plans to reduce GHG emissions from transportation, through the use of biofuel, alternative fuel, and efficient vehicles.

Many local governments worldwide, including New York City, are participating in the Cities for Climate Protection™ campaign, and have committed to adopting policies and implementing quantifiable measures to reduce local GHG emissions, improve air quality, and enhance urban livability and sustainability. New York City's long-term comprehensive plan for a sustainable and resilient New York City, which began as PlaNYC 2030 in 2007, and continues to evolve today as OneNYC, includes GHG emissions reduction goals, many specific initiatives that can result in emission reductions, and initiatives aimed at adapting to future climate change impacts. The goal to reduce citywide GHG emissions to 30 percent below 2005 levels by 2030 ("30 by 30") was codified by Local Law 22 of 2008, known as the New York City Climate Protection Act (the "GHG reduction goal").[8] The City has also announced a longer-term goal of reducing

[7] New York State Climate Action Council. New York State Climate Action Plan Interim Report. November 2010.

[8] Administrative Code of the City of New York, §24-803.

emissions to 80 percent below 2005 levels by 2050 ("80 by 50"), which was codified by Local Law 66 of 2014, and has published a study evaluating the potential for achieving that goal. More recently, as part of OneNYC, the City has announced a more aggressive goal for reducing emissions from building energy down to 30 percent below 2005 levels by 2025.

In December 2009, the New York City Council enacted four laws addressing energy efficiency in large new and existing buildings, in accordance with PlaNYC. The laws require owners of existing buildings larger than 50,000 square feet to conduct energy efficiency audits and retro-commissioning every 10 years, to optimize building energy efficiency, and to "benchmark" the building energy and water consumption annually, using an EPA online tool. By 2025, commercial buildings over 50,000 square feet will also require lighting upgrades, including the installation of sensors and controls, more efficient light fixtures, and the installation of submeters, so that tenants can be provided with information on their electricity consumption. The legislation also creates a local New York City Energy Conservation Code, which along with the Energy Conservation Construction Code of New York State (as updated in 2016), requires equipment installed during a renovation to meet current efficiency standards.

To achieve the 80 by 50 goal, the City is convening Technical Working Groups to analyze the GHG reduction pathways from the building sector, power, transportation, and solid waste sectors to develop action plans for these sectors. The members of the Technical Working Groups will develop and recommend the data analysis, interim metrics and indicators, voluntary actions, and potential mandates to effectively achieve the City's emissions reduction goal. In 2016, the City published the building sector Technical Working Group report, which included commitments by the City to change to building energy code and take other measures aimed at substantially reducing GHG emissions.

For certain projects subject to CEQR (e.g., projects with 350,000 gsf or more of development or other energy intense projects), an analysis of the projects' contributions to GHG emissions is required to determine consistency with the City's reduction goal, which is currently the most appropriate standard by which to analyze a project under CEQR, and is therefore applied in this chapter.

A number of benchmarks for energy efficiency and green building design have also been developed (green building design considerations include factors such as material selection, which affects GHG emissions associated with materials extraction, production, delivery, and disposal.) For example, the LEED system is a benchmark for the design, construction, and operation of high-performance green buildings that includes energy efficiency components. Similarly, Envision is a voluntary system for benchmarking performance and resiliency of physical infrastructure projects. EPA's Energy Star is a voluntary labeling program designed to identify and promote the construction of new energy efficient buildings, facilities, and homes and the purchase of energy efficient appliances, heating and cooling systems, office equipment, lighting, home electronics, and building envelopes.

METHODOLOGY

Climate change is driven by the collective contributions of diverse individual sources of emissions to global atmospheric GHG concentrations. Identifying potential GHG emissions from a proposed action can help decision makers identify practicable opportunities to reduce GHG emissions and ensure consistency with policies aimed at reducing overall emissions. While the increments of criteria pollutants and toxic air emissions are assessed in the context of health-based standards and local impacts, there are no established thresholds for assessing the

significance of a project's contribution to climate change. Nonetheless, prudent planning dictates that all sectors address GHG emissions by identifying GHG sources and practicable means to reduce them. Therefore, this chapter presents the total GHG emissions potentially associated with the proposed projects and identifies measures that would be implemented and measures that are still under consideration to limit emissions. (Note that this differs from most other technical areas in that it does not account for only the increment between the condition with and without the Proposed Action. The reason for that different approach is that to truly account for the incremental emissions only would require speculation regarding where people would live in a No Action condition if residential units are not built at this location, what energy use and efficiency might be like for those alternatives and other related considerations, and similar assumptions regarding commercial and other uses. The focus is therefore on the total emissions associated with the uses, and on the effect of measures to reduce those emissions.)

Estimates of potential GHG emissions associated with the proposed projects are based on the methodology presented in the *CEQR Technical Manual*. Estimates of emissions of GHGs from the developments have been quantified, including off-site emissions associated with use of electricity, on-site emissions from heat and hot water systems, and emissions from vehicle use associated with the proposed development. GHG emissions that would result from construction are discussed as well. As per the guidance, analysis of building energy is based on the average carbon intensity of electricity in 2008 and in some cases more recent data (see below), which will likely be lower in the 2022 build year and lower still in future years as the fraction of electricity generated from renewable sources continues to increase. Vehicular emission factors will also continue to decrease in future years as vehicle engine efficiency increases and emissions standards continue to decrease, resulting in lower emissions in future years. Since the methodology does not account for future years and other changes described above, it also does not explicitly address potential changes in future consumption associated with climate change, such as increased electricity for cooling, or decreased on-site fuel for heating. Overall, this analysis results in conservatively high estimates of potential GHG emissions.

CO_2 is the primary pollutant of concern from anthropogenic emission sources and is accounted for in the analysis of emissions from all development projects. GHG emissions for gases other than CO_2 are included where practicable or in cases where they comprise a substantial portion of overall emissions. The various GHG emissions are added together and presented as metric tons of carbon dioxide equivalent (CO_2e) emissions per year (see "Pollutants of Concern," above).

BUILDING ENERGY EMISSIONS

Estimates of emissions from building electricity and fuel use for project site A were prepared using projections of energy consumption developed specifically for the proposed development by the project engineers and the emission factors referenced in the 2015 GHG emissions inventory for New York City.[9] This approach was necessary due to the potential inclusion of a cogeneration system. Project site A is estimated to require 12.927 gigawatt-hours per year (GWh/yr) of electricity for general building use and a total of 60,207 million British thermal units per year (MMBtu/yr) of natural gas for heat and hot water. Since the electricity emissions represent the latest data (2015) and not future build year (2022), future emissions are expected to be lower as efficiency and renewable energy use continue to increase with the objective of

[9] The City of New York Mayor's Office of Long-Term Planning and Sustainability. *Inventory of New York City Greenhouse Gas Emissions in 2015*. September 2016.

meeting State and City GHG reduction goals. An option including on-site electricity and heat cogeneration for project site A is under consideration, which would reduce the electricity demand to 11.175 GWh/yr, using a natural gas-fired system, requiring 69,480 MMBtu/yr of natural gas. Both options have been analyzed.

Projected fuel consumption and electricity usage for project site B were not available; therefore, estimates of emissions due to building electricity and fuel use for those sites were prepared using building carbon intensity by use type as detailed in the *CEQR Technical Manual*. Per *CEQR Technical Manual* guidance, the building carbon intensity data represents 2008 citywide averages by use type and not projections for the future build year (2022). Estimates of emissions due to parking/mechanical space electricity use were prepared using the parking facility carbon intensity provided in the 2001 *CEQR Technical Manual* (carbon intensity for parking facilities is not available in the subsequent versions) Future emissions are expected to be lower as efficiency and renewable energy use for grid-supplied electric power continue to increase with the objective of meeting State and City future GHG reduction goals.

MOBILE SOURCE EMISSIONS

The number of annual weekday vehicle trips by mode (cars, taxis, and trucks) that would be generated by the proposed projects was calculated using the transportation planning assumptions developed for the analysis and presented in Chapter 14, "Transportation." The assumptions used in the calculation include average daily weekday person trips and delivery trips by proposed use, the percentage of vehicle trips by mode, and the average vehicle occupancy. To calculate annual totals, the number of trips on Saturdays was calculated using similar trip-generation assumptions based on the same sources cited in Chapter 14, "Transportation," and the number of trips on Sundays was assumed to be the same as on Saturday. Travel distances shown in Table 18-6 and 18-7 and associated text of the *CEQR Technical Manual* were used in the calculations of annual vehicle miles traveled (VMT) by cars, taxis, and trucks. Table 18-8 of the *CEQR Technical Manual* was used to determine the percentage of vehicle miles traveled by road type and the mobile GHG emissions calculator provided with the manual was used to estimate GHG emissions from car, taxi, and truck trips attributable to the proposed projects.

Based on the latest fuel lifecycle model from Argonne National Laboratory,[10] emissions from producing and delivering fuel ("well-to-pump") are estimated to add an additional 25 percent to the GHG emissions from gasoline and 27 percent from diesel. Although upstream emissions (emissions associated with production, processing, and transportation) of all fuels can be substantial and are important to consider when comparing the emissions associated with the consumption of different fuels, fuel alternatives are not being considered for the proposed development, and as per the *CEQR Technical Manual* guidance, the well-to-pump emissions are not considered in the analysis. The assessment of tailpipe emissions only is in accordance with the *CEQR Technical Manual* guidance on assessing GHG emissions and the methodology used in developing the New York City GHG inventory, which is the basis of the GHG reduction goal.

The projected annual VMT, forming the basis for the GHG emissions calculations from mobile sources, are summarized in **Table 16-2**.

[10] Based on GREET1_2016 model from Argonne National Laboratory.

Table 16-2
Vehicle Miles Traveled per Year

Use by Site	Passenger	Taxi	Truck
Project Site A—EMS	32,193~~64,386~~	1,660	638,020
Project Site A—Local Retail	40,169~~80,337~~	7,322	54,441
Project Site A—Residential	711,385~~1,422,769~~	305,734	667,379
Project Site B, Lot 39—Local Retail	56,914~~113,827~~	10,375	77,135
Project Site B, Lot 39—Residential	155,930~~311,860~~	67,015	146,284
Project Site B, Lot 38—Local Retail	10,109~~20,218~~	1,843	13,701
Project Site B, Lot 38—Residential	25,150~~50,300~~	10,809	23,594
Total	**1,031,849~~2,063,697~~**	**404,757**	**1,620,554**

CONSTRUCTION EMISSIONS

A description of construction activities is provided in Chapter 20, "Construction." Construction emissions include emissions from on-road trips, on-site non-road engines, and materials extraction, production, and transport.

The number of vehicle trips by mode (worker cars, delivery trucks) that would be generated by the proposed projects' construction was calculated using the assumptions developed for the analysis and presented in Chapter 20, "Construction." The assumptions used in the calculation include average daily workers, the percentage of auto trips, and the average vehicle occupancy to develop annual VMT associated with commuting workers. An average round-trip commute distance for construction workers in the New York City Region of 25.3 miles (based on the average trip to work distance for the New York Metropolitan Area area)[11] was used. Similarly, the numbers of trucks (concrete trucks, dump trucks, and tractor trailers) for each phase of construction activity were used to estimate truck VMT. Distances for truck deliveries were developed based on estimates of the origin and destination of materials for the proposed projects. Table 18-8 of the *CEQR Technical Manual* was used to determine the percentage of VMT by road type and the most recent version of the EPA MOVES model was used to obtain an estimate of car and truck GHG emission factors used to produce the associated emissions attributable to the proposed actions.

The proposed projects would result in construction worker travel of 3.3 million VMT. Additionally, the proposed projects would result in construction truck trips totaling 0.3 million VMT. These data were used as the basis for the GHG emissions calculations from mobile sources, applying emission factors as described above for operational mobile source emissions.

On-site emissions were calculated for non-road construction engines based on specific estimates of construction activity and fuel consumption data from EPA's NONROAD emissions model. A detailed schedule for the use of non-road construction engines was developed, as described in Chapter 20, "Construction." The detailed data, including the number, type, power rating, and hours of operation for all construction engines was coupled with fuel consumption rate data from EPA's NONROAD model to estimate total fuel consumption throughout the duration of the construction activities. Non-road construction engines are estimated to require approximately 76 thousand gallons of diesel equivalent throughout the duration of construction. The quantity of

[11] NYSDOT. *2009 NHTS, New York State Add-On*. Key Tables. Table 3: Average Travel Day Person-Trip Length By Mode and Purpose, trip-to work distance for SOV in NYMTC 10-county area. 2011.

fuel was then multiplied by an emission factor of 10.30 kilograms CO_2e per gallon of diesel fuel.[12]

Upstream emissions related to the production of construction materials were estimated based on the expected quantity of iron or steel and cement. Although other materials will be used, cement and metals have the largest embodied energy and direct GHG emissions associated with their production, and substantial quantities would be used for the proposed actions.

The construction is estimated to require 35,247 metric tons of cement. An emission factor of 0.928 metric tons of CO_2e per metric ton of cement produced was applied to estimate emissions associated with energy consumption and process emissions for cement production.[13] The precise origin of cement for this project is unknown at this time.

The construction is estimated to require 14,121 metric tons of steel. An emission factor of 0.6 metric tons of CO_2e per metric ton of steel product produced was applied to estimate emissions associated with production energy consumption,[14] and 0.65 metric tons of CO_2e per metric ton of steel product produced for process emissions associated with iron and steel production were applied.[15]

EMISSIONS FROM SOLID WASTE MANAGEMENT

The proposed projects would not fundamentally change the City's solid waste management system. Therefore, as per the *CEQR Technical Manual*, the GHG emissions from solid waste generation, transportation, treatment, and disposal are not quantified.

PROJECTED GHG EMISSIONS

BUILDING OPERATIONAL EMISSIONS

Since project site A may include a cogeneration system, building operational emissions were estimated using estimates of electricity and fuel consumption. The fuel consumption, electricity use, emission factors, and resulting GHG emissions are presented in **Table 16-3**. The building floor area, emission intensity, and resulting GHG emissions from each of the project site B land uses are presented in detail in **Table 16-4**.

[12] EPA. Emission Factors for Greenhouse Gas Inventories. 19 November 2015.

[13] The Portland Cement Association. Life Cycle Inventory of Portland Cement Manufacture. 2006.

[14] Arpad Horvath et al. Pavement Life-cycle Assessment Tool for Environmental and Economic Effects, Consortium on Green Design and Manufacturing. UC Berkeley. 2007.

[15] Based on 42.3 teragrams of CO_2e emitted and 65,460 thousand tons produced; Source: EPA. *Inventory of U.S. Climate Change and Sinks: 1990–2009*. April 15, 2011.

Table 16-3
Annual Building Energy Emissions, Project Site A

Option	Source	Annual Consumption	Emission Factor	GHG Emissions (metric tons CO_2e)
No Cogeneration	Natural Gas	60,207 MMBtu	53.196 Kg CO_2e/MMBtu[(1)]	3,203
	Grid Electricity	12.927 GWh	257.0 metric tons/GWh[(2)]	3,322
				Total: 6,525
200 kW Cogeneration	Natural Gas	69,480 MMBtu	53.196 Kg CO_2e/MMBtu[(1)]	3,696
	Grid Electricity	11.175 GWh	257.0 metric tons/GWh[(2)]	2,872
				Total: 6,568

Notes:
Totals may not sum due to rounding.
Per *CEQR Technical Manual* guidance, electricity emissions represent the latest data (2012) and not the future build year (2022). Future emissions are expected to be lower.
Sources:
(1) *CEQR Technical Manual*
(2) The City of New York Mayor's Office of Long-Term Planning and Sustainability. *Inventory of New York City Greenhouse Gas Emissions in 2015*. Note that this factor represents a correction of the factor presented in the 2014 *CEQR Technical Manual*.

MOBILE SOURCE EMISSIONS

The mobile-source-related GHG emissions from the various proposed projects' land uses are presented in detail in **Table 16-5**. In addition to the direct emissions included in the analysis, an additional approximately 25 percent would be emitted upstream, associated with fuel extraction, production, and delivery.

Table 16-4
Annual Building Energy Emissions, Project Site B

Source Use	Building Area (gsf)	GHG Intensity[(1)] (kg CO_2e/gsf/year)	Annual GHG Emissions (metric tons CO_2e)
Lot 39 Residential	198,843	6.59	1,310
Lot 39 Commercial	21,253	9.43	200
Lot 39 Parking/Mechanical	37,045	2.06[(2)]	76
Lot 38 Residential	31,793	6.59	210
Lot 38 Commercial	3,775	9.43	36
Lot 38 Parking/Mechanical	3,131	2.06[(2)]	6
			Total: 1,839

Notes:
Totals may not sum due to rounding.
Per *CEQR Technical Manual* guidance, electricity emissions are representative of existing conditions in 2012 and not the future build year (2022). Future emissions are expected to be lower.
Representative emission intensity for existing buildings are higher than new and future construction, and do not include the expected energy efficiency measures.
Sources:
(1) *CEQR Technical Manual*
(2) Based on 27,400 Btu/sq.ft./yr., 2001 *CEQR Technical Manual*.

Table 16-5
Annual Mobile Source Emissions
(metric tons CO_2e, 2022)

Use	Passenger Vehicle	Taxi	Truck	Total
Project Site A—EMS	1938	1	1,369	1,3881,407
Project Site A—Local Retail	2447	4	117	144168
Project Site A—Residential	418836	161	1,431	2,0102,428
Project Site B Lot 39—Local Retail	3367	5	165	204238
Project Site B Lot 39—Residential	92183	35	314	441532
Project Site B Lot 38—Local Retail	612	1	29	3642
Project Site B Lot 38—Residential	1530	6	51	7186
Total	**6061,212**	**213**	**3,476**	**4,2954,901**

CONSTRUCTION EMISSIONS

The estimated GHG emissions from construction of the proposed projects are presented in **Table 16-6**.

Table 16-6
Total Construction GHG Emissions (metric tons CO_2e)

Use	Project Site A	Project Site B	Total
Nonroad	848	263	848
Transportation	1,291	522	1,813
Materials	24,606	25,718	50,325
Total	**26,482**	**26,503**	**52,985**

SUMMARY

A summary of operational GHG emissions by site is presented in **Table 16-7**. Note that if new buildings were to be constructed elsewhere to accommodate the same number of units and space for other uses, the emissions from the use of electricity, energy for heating and hot water, and vehicle use could equal or exceed those estimated for the proposed projects, depending on their location, access to transit, building type, and energy efficiency measures. The cogeneration system, if included, would reduce grid electricity consumption and heat load, but increase total natural gas consumption, resulting in negligible change in GHG emissions. The proposed projects are not expected to fundamentally change the City's solid waste management system, and therefore emissions associated with solid waste are not presented.

Table 16-7
Summary of Annual GHG Emissions, 2021
(metric tons CO_2e, excluding construction)

Site	Building Energy	Mobile	*Total*
Project Site A	6,525 to 6,568	3,5434,003	*10,068 to 10,11110,528 to 10,571*
Project Site B, Lot 39	1,587	645770	*2,2322,357*
Project Site B, Lot 38	252	107128	*359380*
Total	**8,364 to 8,407**	**4,2954,901**	***12,659 to 12,70213,265 to 13,308***

Notes:
Totals may not sum due to rounding.
The range of building energy emissions for project site A and total emissions represent the possible range based on the cogeneration options presented above.

The operational emissions from building energy use include on-site emissions from fuel consumption as well as emissions associated with the production and delivery of the electricity to be used on-site. The applicants are currently evaluating the specific energy efficiency measures and design elements that would be implemented (see the following section). Both projects intend to exceed the minimum energy requirements of New York City's building code such that the developments would achieve energy consumption that is 10 percent lower as compared with a baseline development designed to meet the current minimum building code requirements—the full benefits of these additional measures under consideration are not necessarily reflected in the above estimates.

In addition, total construction emissions throughout the construction period are estimated at 52,985 metric tons CO_2e, equivalent to approximately four years of operational emissions.

ELEMENTS THAT WOULD REDUCE GHG EMISSIONS

The proposed projects would include a number of sustainable design features, which would, among other benefits, result in lower GHG emissions. In general, dense, mixed-use development with access to transit and existing roadways is consistent with sustainable land use planning and smart growth strategies to reduce the carbon footprint of new development. These features and other measures currently under consideration are discussed in this section, addressing the PlaNYC/OneNYC goals as outlined in the *CEQR Technical Manual*. The implementation of the various design measures and features described would result in development that is consistent with the City's emissions reduction goal, as defined in the *CEQR Technical Manual*.

BUILD EFFICIENT BUILDINGS

All project site A roofs would combine green roof elements and pavers with high albedo roofing materials to reduce energy consumption and reduce the building's contribution to the urban heat-island effect. Efficient lighting in all common areas, daylight harvesting in areas where practicable, and Energy Star elevators and appliances, where applicable, would be installed to reduce electricity consumption. Exterior lighting would be energy efficient and directed. Third-party fundamental building energy systems commissioning would be undertaken upon completion of construction to ensure energy performance. The project site A applicant would also provide sustainable design guidelines to commercial tenants for build-out.

Other measures are under consideration. For example, project site A would likely include energy-efficient glazing designed to reduce heat loss and facilitate daylight harvesting by admitting more daylight than solar heat, and the energy systems would likely utilize high-efficiency heating, ventilation, and air conditioning (HVAC) systems. Some of project site B's design would also include elements that would reduce GHG emissions. ~~Lot 39~~Project site B would implement energy-efficient glazing designed to reduce heat loss and facilitate daylight harvesting by admitting more daylight than solar heat, high-albedo roofing materials to reduce energy consumption and reduce the buildings contribution to the urban heat-island effect, incorporate motion sensor lighting control in common spaces, maximize interior daylighting, install efficient, directed exterior lighting, and efficient lighting and elevators exceeding requirements and/or Energy Star appliances where applicable. ~~A building is not being designed for~~If Lot 38 is included as part of the project site B development, ~~but it is anticipated that a building at this site would be~~ it would be incorporated into the overall project site B building with the same measures described above.~~designed using an approach similar to that used for Lot 39.~~

The applicants are required at a minimum to achieve the energy efficiency requirements of New York City's building code. Overall, both projects intend to exceed the minimum energy requirements of New York City's building code such that the developments would achieve energy consumption that is 10 percent lower as compared with a baseline development designed to meet the current minimum building code requirements, and the projects may qualify for EPA's Energy Star Qualified Multifamily High Rise Buildings certification. Therefore, the proposed projects would support the goal identified in the *CEQR Technical Manual* of building efficient buildings.

Furthermore, in 2016, as part of the City's implementation of strategies aimed at achieving the OneNYC GHG reduction goals, the City adopted the 2016 New York City Energy Conservation Construction Code, which substantially increased the stringency of the building energy efficiency requirements and adopted the ASHRAE 90.1-2013 standard as a benchmark. In 2016, the City also published the findings of a the Buildings Technical Working Group (TWG) convened by the City to identify the pathway to achieving the GHG reduction goals in the building sector;[16] should the measures identified by the Buildings TWG or other measures not yet implemented be adopted by the City in the future, they may apply to the proposed projects similar to any new building (if prior to building approval) or existing building (after construction) and the proposed projects' would implement any measures required under such programs.

USE CLEAN POWER

The proposed projects would use natural gas, a lower carbon fuel, for the normal operation of the heat and hot water systems and, if implemented, for the project site A cogeneration system.

TRANSIT-ORIENTED DEVELOPMENT AND SUSTAINABLE TRANSPORTATION

The proposed projects are located near several transit options, at approximately a 5-minute walk from the 34th Street 7 subway station and the cross-town M34-SBS bus stop, with M12 uptown and downtown bus stops located on Twelfth Avenue one block to the north and on Eleventh Avenue adjacent to the projects, respectively. In addition, the proposed projects are adjacent to the 29th and 30th Street crosstown bike routes and the Hudson River Greenway bike route, and located near a Citi Bike station at West 27th Street and Eleventh Avenue with a few more stations within walking distance.

REDUCE CONSTRUCTION OPERATION EMISSIONS

Construction specifications would include an extensive diesel emissions reduction program, as described in detail in Chapter 20, "Construction Impacts," including diesel particle filters for large construction engines and other measures. These measures would reduce particulate matter emissions; while particulate matter is not included in the list of standard GHGs ("Kyoto gases"), recent studies have shown that black carbon—a constituent of particulate matter—may play an important role in climate change.

[16] The City of New York. Technical Working Group Report: Transforming New York City Buildings for a Low-Carbon Future. 2016.

USE BUILDING MATERIALS WITH LOW CARBON INTENSITY

Recycled steel would most likely be used for most structural steel since the steel available in the region is mostly recycled. Project site A would set a minimum target of 25 percent recycled steel. Some cement replacements such as fly ash and/or slag may also be used, and concrete content would be optimized to the extent feasible.

Project site A would use wood that is locally produced and/or certified in accordance with the Sustainable Forestry Initiative or the Forestry Stewardship Council's Principles and Criteria. Additional opportunities for sustainable building materials would be associated with commercial tenant build out, and details are unknown at this time. The project site A applicant would provide sustainable guidelines addressing these to the extent practicable depending on the specific uses and tenants. Project site A construction waste would be diverted from landfills to the extent practicable by separating out materials for reuse and recycling, with a diversion target of minimum 75 percent.

C. RESILIENCE TO CLIMATE CHANGE

The Waterfront Revitalization Program (WRP)[17] addresses climate change and sea-level rise. The WRP requires consideration of climate change and sea-level rise in planning and design of development within the defined Coastal Zone Boundary (the Project Area is within that zone). As set forth in more detail in the *CEQR Technical Manual*, the provisions of the WRP are also applied by the New York City Department of City Planning and other city agencies when conducting environmental review. The proposed projects' consistency with WRP policies is described in Chapter 3, "Land Use, Zoning, and Public Policy," and evaluated in **Appendix B**.

Since the Project Area is near the waterfront, the potential effects of global climate change on the Project Area are considered and measures that would be implemented as part of the project to improve its resilience to climate change are identified.

DEVELOPMENT OF POLICY TO IMPROVE CLIMATE CHANGE RESILIENCE

The New York State Sea Level Rise Task Force was created to assess potential impacts on the state's coastlines from rising seas and increased storm surge. The Task Force prepared a report of its findings and recommendations including protective and adaptive measures.[18] The recommendations are to provide more protective standards for coastal development, wetlands protection, shoreline armoring, and post-storm recovery; to implement adaptive measures for habitats; integrate climate change adaptation strategies into state environmental plans; and amend local and state regulations or statutes to respond to climate change. The Task Force also recommended the formal adoption of projections of sea-level rise.

The New York State Climate Action Plan Interim Report identified a number of policy options and actions that could increase the climate change resilience of natural systems, the built environment, and key economic sectors—focusing on agriculture, vulnerable coastal zones, ecosystems, water resources, energy infrastructure, public health, telecommunications and

[17] City of New York Department of City Planning. *The New York City Waterfront Revitalization Program*. October 30, 2013. Approved by NY State Department of State, February 3, 2016.

[18] New York State Sea Level Rise Task Force. *Report to the Legislature*. December 2010.

information infrastructure, and transportation.[19] New York State's Community Risk and Resiliency Act (CRRA)[20] requires that applicants for certain State programs demonstrate that they have taken into account future physical climate risks from storm surges, sea-level rise and flooding, and required the New York State Department of Environmental Conservation (DEC) to establish official State sea-level rise projections. In February 2017, DEC adopted a rule (6 NYCRR Part 490) defining the existing projections for use. These projections provide the basis for State adaptation decisions and are available for use by all decision makers. CRRA applies to specific State permitting, funding and regulatory decisions, including smart growth assessments; funding for wastewater treatment plants; siting of hazardous waste facilities; design and construction of petroleum and chemical bulk storage facilities; oil and gas drilling, and State acquisition of open space. CRRA requires DEC to publish implementation guidance by 2017.

In New York City, the Climate Change Adaptation Task Force is tasked with securing the city's critical infrastructure against rising seas, higher temperatures, and fluctuating water supplies projected to result from climate change. The Task Force is composed of over 35 New York City and State agencies, public authorities, and companies that operate, regulate, or maintain critical infrastructure in New York City. The approaches suggested for the City to create a city-wide adaptation program include ways to assess risks, prioritize strategies, and examine how standards and regulations may need to be adjusted in response to a changing climate.

To assist the task force, the New York City Panel on Climate Change (NPCC) has prepared a set of climate change projections for the New York City region,[21] which was subsequently updated,[22,23] and has suggested approaches to create an effective adaptation program for critical infrastructure. The NPCC includes leading climatologists, sea-level rise specialists, adaptation experts, and engineers, as well as representatives from the insurance and legal sectors. The climate change projections include a summary of baseline and projected climate conditions throughout the 21st century including heat waves and cold events, intense precipitation and droughts, sea-level rise, and coastal storm levels and frequency. NPCC projected that sea levels are likely to increase by up to 30 inches by the 2050s and up to 75 inches by the end of the century (more detailed ranges and timescales are available). In general, the probability of increased sea levels is characterized as "extremely likely," but there is uncertainty regarding the probability the various levels projected and timescale. Intense hurricanes are characterized as "more likely than not" to increase in intensity and/or frequency, and the likelihood of changes in other large storms ("Nor'easters") are characterized as unknown. Therefore, the projections for future coastal storm surge levels for New York City include only sea-level rise at this time, and do not account for changes in storm frequency.

---

[19] NYSERDA. New York State Climate Action Plan Interim Report. November, 2010.

[20] *Community Risk and Resiliency Act.* Chapter 355, NY Laws of 2014. April 9, 2013. Signed September 22, 2014.

[21] New York City Panel on Climate Change. *Climate Change Adaptation in New York City: Building a Risk Management Response*. Annals of the New York Academy of Sciences, May 2010.

[22] New York City Panel on Climate Change. Climate Risk Information 2013: Observations, Climate Change Projections, and Maps. June 2013.

[23] New York City Panel on Climate Change. *New York City Panel on Climate Change 2015 Report*. Ann. N.Y. Acad. Sci. 1336. 2015.

The New York City Green Code Task force has also recommended strategies for addressing climate change resilience in buildings and for improving storm water management.[24] Some of the recommendations call for further study, while others could serve as the basis for revisions to building code requirements. Notably, one recommendation was to require new developments within the projected future one-percent annual chance floodplain (the area that would potentially be flooded in a severe coastal storm with a probability of one percent of occurring in any given year) to meet the same standards as buildings in the current one-percent annual chance flood hazard zone.

While strategies and guidelines for addressing the effects of climate change are being developed on all levels of government, there are currently no specific requirements or accepted recommendations for development projects in New York City. However, the revisions to the WRP and accompanying guidance[25] require consideration of climate change and sea-level rise in planning and design of waterfront development. As set forth in more detail in the City's *CEQR Technical Manual*, the provisions of the WRP are applied by city agencies when conducting environmental review, and are described in detail in Chapter 3, "Land Use, Zoning, and Public Policy."

Climate change considerations and measures that would be implemented to increase climate resilience are discussed below. Additional climate change considerations may be incorporated into state and/or local laws prior to the development of the proposed projects, and any development would be constructed to meet or exceed the codes in effect at the time of construction.

RESILIENCE OF THE PROPOSED PROJECTS TO CLIMATE CHANGE

According to current flood hazard projections,[26] the current one-percent annual chance coastal storm surge could reach elevations of 11 feet NAVD88 at in the western portion of project site A and a very small area of Lot 39. Therefore, the official design flood elevation per New York City's building code would be one foot above these elevations at each site. Resilience considerations are accounted for throughout the lifetime of the use being evaluated. Residential buildings have a lifetime of 80 years or more, and therefore the furthest available projections (end of century) are considered here. According to the above cited NPCC data, by the 2050s, the one-percent annual chance flood levels could reach 30 inches higher due to sea-level rise (per NPCC "High" scenario), to approximately 13.5 feet NAVD88. By the end of the century, the one-percent annual chance flood levels could reach 75 inches higher (per NPCC "High" scenario), to approximately 17 feet NAVD88.[27]

---

[24] New York City Green Codes Task Force. *Recommendations to New York City Building Code*. February 2010.

[25] NYC Planning. The New York City Waterfront Revitalization Program: Climate Change Adaptation Guidance. March 2017.

[26] FEMA. *Preliminary Flood Insurance Rate Map*. Panel 3604970069G. Release Date: 12/05/2013.

[27] The area on the westernmost end of the block (outside of the projects' boundaries) has a current 1-in-100 flood elevation of 12' NAVD88—one foot higher than in the projects' sites. While sea level rise may in some cases push deeper flood areas further inland in the future, the boundary of the deeper flood zone may also be narrower in the future due to the development of the Western Rail Yard and other developments in the area. The current large open subgrade rail yards currently allow for deeper waters resulting in deeper flood zones further inland due to hydraulic dynamics. Therefore, it is unlikely that this effect will last for the long term, and the current 11' NAVD88 flood depth was applied for all estimates here.

Note that these flood areas and elevations are likely conservatively high, and may be revised in the near future. On October 17, 2016, the Federal Emergency Management Agency (FEMA) and New York City Mayor De Blasio announced plans to revise the FEMA flood maps based on a 2015 New York City appeal of FEMA's flood risk calculations for New York City and the region. While revised flood maps have not yet been produced, the appeal generally identified potential reductions of 1.5 to 2.0 feet in the area of the proposed projects. Therefore, it is possible that the revised FEMA current flood elevations would be lower, and the resulting future flood elevations, including sea-level rise, may also be lower than those presented here.

The design teams have taken great care in ensuring the long term resiliency of the projects, carefully planning in response to site constraints. For project site A, the main building components would be located outside of the current flood plain. The bulk of the tower has been located as far east as possible in order to avoid placing critical program elements or residential units in the current flood zone. The building in general has been designed to protect against critical damage during a storm event. Ground floor elevation has been set above the current flood elevation, key building systems are located well above the future projected flood elevations, and the main mechanical rooms are located on the second floor or higher, ensuring that critical systems and connections would be protected during flooding events. Habitable spaces are also located well above the future projected flood elevations to protect individual residences.

In addition to these measures, project site A may include a gas-fired cogeneration system that will be used at all times to power common areas and, during power outages, to provide standby power to areas of refuge (the amenity areas), where residents will have access to communal kitchens, showers, and heating and cooling. In addition, the cogeneration system will provide standby power to the potable water pumps, so each unit will have access to water during emergencies. All these resiliency features will be integrated in to the mechanical/electrical/plumbing systems and run through the Building Management System to ensure seamless operations. All items will also be included in the building operations and maintenance plan to ensure its long-term operation.

The project site A point of entry for all systems will be below grade and encased in flood proof construction until connection to main rooms above grade. Electrical switchgear, micro-turbine, and fire pump rooms will be located at the lobby mezzanine. Boilers and all other major equipment would be located at an elevation higher than 17 feet NAVD88 (second floor or higher).

A critical item for future resiliency of project site A would be entrances and façades that while higher than the current design flood elevation, will be below the projected future levels. Therefore, the design team minimized street level openings to reduce exposure and carefully designed entrances to make them both pedestrian friendly with the ability to flood proof during severe flooding events. The building façade piers become the armature that would organize a deployable flood barrier system that would protect façade elements and openings should flood levels rise above levels that the design can accommodate without a barrier.

A similar design approach will be taken for project site B. The building on Lot 39 in general has been designed to protect against critical damage during a storm event. Ground floor elevation has been set above the current flood elevation, and all building systems are located well above the future projected flood elevations. The point of entry for all systems will be below grade and encased in flood proof construction until connection to main rooms above grade. Habitable spaces are also located well above the future projected flood elevations to protect individual

residences. If Lot 38 is included as part of the project site B development, it would be incorporated into the overall project site B building with the same measures described above.~~While a building is not being designed for Lot 38, it is anticipated that a building at this site would be designed using an approach similar to that used for Lot 39.~~

A critical item for future resiliency of project site B would be entrances and façades that while outside of the current one-percent annual chance flood zone, will be below the projected future flood levels. Therefore, the team designed entrances to make them both pedestrian friendly with the ability to flood proof during severe flooding events. A deployable flood barrier system would be designed to be deployed and protect façade elements and openings should flood levels rise above levels that the design can accommodate without a barrier.

Overall, the proposed projects would be designed to provide resilience to the potential conditions projected through the 2050s, and the design would be adaptive such that enhancements could be implemented in the future to further protect uses up to the potential flooding conditions projected for the end of the century if necessary, based on future adjustments to end-of-century potential flood elevations estimates. However, should the "High" sea-level rise projections for 2100 occur (by 2100 or at some later date), and neighborhood-wide protections are not provided by that time, additional protections may be necessary since at those levels mean-high high tide could reach mid-block on West 29th Street, resulting in more frequent flooding for which the use of deployable solutions may not be practicable.

The following measures would be included in the proposed projects' designs:

1. All critical infrastructure elements in the proposed new construction would be either elevated above 17 feet NAVD88, or sealed or otherwise designed to be resistant to flood waters if located below that elevation. This would include all critical elements and connections such as electrical, communications, fire safety and pumps, fuel storage, emergency power generation, and elevators. This approach would provide resilience to one-percent annual chance flood elevations for all critical infrastructure through the end of the century.
2. All new residential units would be higher than 17 feet NAVD88, protecting residential units from potential one-percent annual chance flood events throughout the end of the century.
3. Commercial, parking, lobby, and other non-critical non-residential spaces would be either designed with deployable protective barriers so as to hold back flood waters up to an elevation of 14.5 feet NAVD88, or designed such that flood waters entering these areas could be rapidly removed after a severe flood event without substantial structural damage, allowing for rapid recovery. This would provide resilience from potential one-percent annual chance flood events through the 2050s. Note that all critical infrastructure would be protected as described above, and residents would be evacuated prior to severe flood events as required by emergency evacuation recommendations or orders.

   For project site A, bike storage and parking areas (with fronts on West 29th Street) would be designed to flood and recover. In the event that a FDNY-EMS Station is located in the western portion of project site A, additional planning and resilience review would be necessary and would be undertaken as part of the design and environmental review required for that use. Other areas would be protected by a combination of flood barriers and internal flood protective walls and doors.

For project site B, a deployable flood barrier system would be designed to be deployed and protect façade elements and openings should flood levels rise above levels that the design can accommodate without a barrier.

4. The projects would be designed to accommodate future enhancement (adaptive measures) of any deployable protections designed for commercial, parking, lobby, and other non-critical non-residential spaces up to 17 feet NAVD88 should this be necessary in the future to accommodate increased flood elevations throughout the end of the century. This would include, for example, structural considerations for flood barriers with increased height and deeper flood waters.

✷