Chapter 16: Greenhouse Gas Emissions and Climate Change

A. INTRODUCTION

This chapter evaluates the greenhouse gas (GHG) emissions and climate change that would be generated by the construction and operation of the proposed projects and their consistency with the citywide GHG reduction goals. Per the *CEQR Technical Manual,* evaluation of GHG emissions serves as a proxy for evaluating the proposed project's impact on climate change. This chapter also evaluates the resilience of the projects in the face of potential climate conditions as they are projected to change in the future through 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 over 2.5 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 21 to 22 thousand metric tons of carbon dioxide equivalent (CO_2e) emissions per year. Total GHG emissions associated with the construction, including direct emissions and upstream emissions associated with construction materials, would be approximately 250 thousand metric tons.

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 have stated that they are currently evaluating the specific energy efficiency measures and design elements that may be implemented, and are required at a minimum to achieve the energy efficiency requirements of the New York City Building Code. In 2016, as part of the City's implementation of strategies aimed at achieving the OneNYC GHG reduction goals, the

City substantially increased the stringency of the building energy efficiency requirements. In 2016, the City also published a pathway to achieving the GHG reduction goals in the building sector. Should the measures identified as part of that 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), and the proposed projects would implement any measures required under such programs. Therefore, the proposed projects would support the goal identified in the *CEQR Technical Manual* of building efficient buildings.

The inclusion of a cogeneration system is under consideration for Site 5. If included, the system would produce electricity on-site while providing heat as a byproduct, and would reduce the electricity demand from the grid while burning natural gas on-site. The heat produced would offset some or all of the natural gas required to provide heat and hot water for Site 5. Although the potential cogeneration system under consideration for Site 5 could decrease the 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 net building energy GHG emissions for Site 5 by approximately 10 percent, representing approximately 3 percent of the total potential GHG emissions for the proposed projects.

Overall, the proposed projects would support the goal identified in the *CEQR Technical Manual* of building efficient buildings. The proposed projects also would support the other GHG goals by virtue of their 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 projects would support the GHG reduction goal.

Therefore, based on the commitment to energy efficiency 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*.

RESILIENCE TO CLIMATE CHANGE

The new construction for the proposed projects would be designed to provide flood resilience to the potential conditions projected through the 2050s, and the designs 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. This would include protecting all critical infrastructure up to potential flood conditions projected out to the year 2100, elevating all residential units above those levels, and designing non-critical uses located below the potential flood elevations projected for 2050 to either be protected from flood waters via stand-alone deployable barriers or to flood and quickly recover from severe flooding events. Nothing in the projects' designs would structurally or otherwise preclude the introduction, at a later date, of additional flood protection measures (such as flood barriers) to protect project elements up to potential flood elevations projected for 2100.

B. GREENHOUSE GAS EMISSIONS

POLLUTANTS OF CONCERN

GHGs are those gaseous constituents of the atmosphere, both natural and anthropogenic, 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[1] 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**.

[1] *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.

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[2] 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.[3] On June 1st, 2017, The President of the U.S. announced that "the United States will withdraw from the Paris Climate Accord."[4]

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 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.

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

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

[4] 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.

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.[5] 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 also has 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").[6] The City also has announced a longer-term goal of reducing 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

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

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

building energy and water consumption annually, using an EPA online tool. By 2025, commercial buildings over 50,000 square feet also will 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. For example, the LEED system is a benchmark for the design, construction, and operation of high-performance green buildings that includes energy efficiency components. 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 proposed 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 developments. 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 2021 build year and lower still in future years as the fraction of electricity generated from renewable sources continues to increase. Vehicular emission factors also will 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 CO_2e emissions per year (see “Pollutants of Concern,” above).

BUILDING OPERATIONAL EMISSIONS

Estimates of emissions from building electricity and fuel use were prepared using projections of energy consumption developed specifically for the proposed developments by the project engineers and the emission factors referenced in the 2015 GHG emissions inventory for New York City.[7] Sites 4 (4A/4B), 5, and 6A are estimated to require 5.0 gigawatt-hours per year (GWh/yr), 13.5 GWh/yr, and 6.7 GWh/yr of electricity for general building operations, respectively. A total of 33,000 million British thermal units per year (MMBtu/yr), 73,202 MMBtu/yr, and 39,500 MMBtu/yr of natural gas would be consumed for the heat and hot water systems of Sites 4 (4A/4B), 5, and 6A, respectively. Since the electricity emissions represent the latest data (2015) and not future build year (2021), future emissions are expected to be lower as efficiency and renewable energy use continue to increase with the objective of meeting State and City GHG reduction goals.

Site 5 also would include an increase of 5,319 gsf of retail in the existing buildings on that site. Projected fuel consumption and electricity usage for the retail usage were not available; therefore, estimates of emissions due to building electricity and fuel use 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 (2021). 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.

Additionally, the inclusion of a cogeneration system is under consideration for Site 5. If included, the system would produce electricity on-site while providing heat as a byproduct, and would

[7] 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.

reduce the electricity demand within the range of 1.93 to 9.02 GWh/yr. The system would require between 26,288 to 109,091 MMBtu/yr of natural gas. The heat produced would offset some or all of the natural gas required to provide heat and hot water. The system under consideration assumed a 55 percent heat recovery efficiency and would reduce natural gas consumption within the range of 18,073 to 51,810 MMBtu/yr. The range of implementation under consideration has been analyzed.

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. 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 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,[8] 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 developments, 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 total annual vehicle miles traveled by roadway type, forming the basis for the GHG emissions calculations from mobile sources, are summarized in **Table 16-2**.

Table 16-2
Vehicle Miles Traveled per Year

Roadway Type	Passenger	Taxi	Truck
Local	702,509	380.066	379,335
Arterial	1,532,746	826,236	827,641
Interstate/Expressway	957,966	518,272	517,276
Total	3,193,221	1,727,574	1,724,252
Source: AKRF, Inc., for the Two Bridges LSRD EIS, 2017.			

CONSTRUCTION EMISSIONS

A description of construction activities is provided in Chapter 19, "Construction." Construction emissions include emissions from on-road trips, on-site non-road engines, and materials extraction, production, and transport.

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

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 19, "Construction." The assumptions used in the calculation include average daily workers, the percentage of auto trips, and the average vehicle occupancy to develop annual vehicle miles traveled (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)[9] 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 vehicle miles traveled 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 4.3 million VMT. Additionally, the proposed projects would result in construction truck trips totaling 2.6 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 19, "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 2.0 million gallons of diesel equivalent throughout the duration of construction. The quantity of fuel was then multiplied by an emission factor of 10.30 kilograms CO_2e per gallon of diesel fuel.[10]

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 197,045 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.[11] The precise origin of cement for this project is unknown at this time.

The construction is estimated to require 27,118 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,[12] and 0.65 metric tons of CO_2e per metric ton of

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[9] 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.

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

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

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

steel product produced for process emissions associated with iron and steel production were applied.[13]

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

The fuel consumption and electricity use, emission factors, and resulting GHG emissions associated with building energy uses are presented in detail in **Table 16-3**. Building energy emissions are roughly proportional to the size of the buildings, with the highest emissions from Site 5, and the lowest from Site 4 (4A/4B). Site 5 may include a cogeneration system with a capacity in the range of 200 to 1,000 kW; therefore, emissions with the cogeneration options are presented as a range in **Table 16-4**. Within the range considered, the smaller 200 kW cogeneration system is estimated to reduce annual building energy emissions by less than one percent, while the largest system considered, 1,000 kW, would increase emissions by approximately 10 percent.

Table 16-3
Annual Building Operational GHG Emissions
(metric tons CO_2e, No Cogeneration)

Site	Natural Gas	Grid Electricity	Total Emissions
	53.196 Kg CO_2e/MMBtu(1)	257.0 metric tons/GWh(2)	
Site 4 (4A/4B)	33,000 MMBtu	5.0 GWh	3,041
Site 5	73,202 MMBtu	13.5 GWh	7,426†
Site 6A	39,500 MMBtu	6.7 GWh	3,832
		Total:	**14,298**

Notes:
Totals may not sum due to rounding.
Per *CEQR Technical Manual* guidance, electricity emissions represent the latest data (2015) and not the future build year (2021). Future emissions are expected to be lower.
† Site 5 includes the additional emission of 50 metric tons CO_2e for new retail square footage in the existing 265-275 Cherry Street building, 5,319 gsf. Fuel usage estimates were unavailable; therefore emissions were estimated using the CEQR annual emission factor for commercial land use, 9.43 kg CO_2e per gsf.
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*. September 2016. Note that this factor represents a correction of the factor presented in the 2014 *CEQR Technical Manual*.

[13] 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 16-4
Site 5 Cogeneration Options—Total Annual Building Operational GHG Emissions (metric tons CO_2e)

Cogeneration Option	Natural Gas 53.196 Kg CO_2e/MMBtu(1)	Grid Electricity 257.0 metric tons/GWh(2)	Total Emissions
No Cogeneration	73,202 MMBtu	13.5 GWh	7,426
200 kW Cogeneration	81,417 MMBtu	11.6 GWh	7,368
1,000 kW Cogeneration	130,483 MMBtu	4.5 GWh	8,156

Notes:
Totals may not sum due to rounding.
Per 2014 *CEQR Technical Manual* guidance, electricity emissions represent the latest data (2015) and not the future build year (2021). Future emissions are expected to be lower.
Site 5 includes the additional emission of 50 metric tons CO_2e for new retail square footage in the existing 265-275 Cherry Street building, 5,319 gsf. Fuel usage estimates were unavailable; therefore emissions were estimated using the CEQR annual emission factor for commercial land use, 9.43 kg CO_2e per gsf.
Sources:
(1) 2014 *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*. September 2016.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 proposed projects 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 16-5
Annual Mobile Source Emissions (metric tons CO_2e, 2021)

Site	Use	Passenger Vehicle	Taxi	Truck	Total
Site 4 (4A/4B)	Residential	452	212	848	*1,511*
	Retail	3	11	23	*38*
	Subtotal	*454*	*223*	*872*	*1,549*
Site 5	Residential	924	433	1,735	*3,092*
	Retail	5	19	39	*63*
	Community Facility*	17	4	76	*97*
	Subtotal	*945*	*457*	*1,850*	*3,252*
Site 6A	Residential	524	245	983	*1,752*
	Retail	2	9	19	*30*
	Subtotal	*526*	*255*	*1,002*	*1,782*
Total		**1,926**	**934**	**3,723**	***6,583***

Note:
*The proposed community facility space on Site 5 is as yet unprogrammed; however, for the purposes of a conservative analysis, it is assumed that this space could be utilized as an accessory early childhood educational facility
Source: AKRF, Inc., for the Two Bridges LSRD EIS, 2017.

CONSTRUCTION EMISSIONS

The estimated GHG emissions from construction of the proposed projects are presented in **Table 16-6**. Total construction emissions, 249,794 metric tons CO_2e, would be equivalent to approximately 10-years of operational emissions. Emissions for the three project sites are approximately proportional to the size of their respective development areas.

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

Use	Site 4 (4A/4B)	Site 5	Site 6A	Total
Nonroad	793	1,347	1,805	3,945
Transportation	2,861	2,719	1,468	7,048
Materials	43,011	176,042	19,749	238,802
Total	**46,665**	**180,108**	**23,022**	**249,794**

Source: AKRF, Inc., for the Two Bridges LSRD EIS, 2017.

SUMMARY

A summary of GHG emissions by source type 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 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)

Site	Building Operations	Mobile	Total
Site 4 (4A/4B)	3,041	1,549	4,590
Site 5	7,368 to 8,156	3,252	10,620 to 11,408
Site 6A	3,832	1,782	5,614
Total	**14,240 to 15,028**	**6,583**	**20,824 to 21,611**

Note: The range of results for Site 5 and totals represent the range of emission associated with the various cogeneration options. See **Table 16-3**.
Source: AKRF, Inc., for the Two Bridges LSRD EIS, 2017.

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.

In addition, total GHG emissions associated with the construction, including direct emissions and upstream emissions associated with construction materials (excluding fuel), would be approximately 250 thousand metric tons.

ELEMENTS THAT WOULD REDUCE 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

The applicants have stated that they are currently evaluating the specific energy efficiency measures and design elements that may be implemented, and are required at a minimum to achieve the energy efficiency requirements of the New York City Building code. 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 (NYCECCC) 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 the Buildings Technical Working Group (TWG) convened by the City to identify the pathway to achieving the GHG reduction goals in the building sector;[14] 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.

Therefore, the proposed projects would support the goal identified in the *CEQR Technical Manual* of building efficient buildings.

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 cogeneration system.

TRANSIT-ORIENTED DEVELOPMENT AND SUSTAINABLE TRANSPORTATION

The proposed projects are located in an area well supported by many transit options: a five minute-walk from the East Broadway F subway station, a 15 minute walk from the Essex J/M/Z station and the Grand Street B/D station, approximately one block from the M22 and M15 buses, and approximately 9 minute walk from the X14, X38, and X37 express buses. In addition, three Citi Bike stations are located within several blocks from the project sites, and a major bike route is located near the project sites along the East River Esplanade.

REDUCE CONSTRUCTION OPERATION EMISSIONS

Construction specifications would include an extensive diesel emissions reduction program, as described in detail in Chapter 19, "Construction," 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.

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[14] 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. Some cement replacements such as fly ash and/or slag may also be used, and concrete content would be optimized to the extent feasible.

Additional measures are being considered. For example, Sites 5 and 6A may include building materials with recycled content, materials that are extracted and/or manufactured within the region, rapidly renewable building materials, and/or 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.

C. RESILIENCE TO CLIMATE CHANGE

The Waterfront Revitalization Program (WRP)[15] 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 sites are 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 (DCP) and other city agencies when conducting environmental review. The proposed projects' consistency with WRP policies is described in Chapter 2, "Land Use, Zoning, and Public Policy," and **Appendix C**.

Since the project sites are near the East River waterfront, the potential effects of global climate change on the proposed projects have been considered and measures that would be implemented as part of the projects to improve their resilience to climate change have been 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.[16] 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 information infrastructure, and transportation.[17] New York State's Community Risk and Resiliency Act (CRRA)[18] 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

[15] 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.

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

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

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

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 fostering collaboration and cooperation between public and private organizations working to build the resilience of the city's critical infrastructure against rising seas, higher temperatures, and changing precipitation patterns. The Task Force is composed of over 57 New York City and State agencies, public authorities, and companies that operate, regulate, or maintain critical infrastructure in New York City. Led by the Mayor's office of Resilience and Recovery, the Task Force works together 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[19] which was subsequently updated,[20,21] 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 1-in-100 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.

The New York City Green Code Task Force also has recommended strategies for addressing climate change resilience in buildings and for improving storm water management.[22] 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 "100-year" floodplain (the area that would potentially be flooded in a

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[19] 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.

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

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

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

severe coastal storm with a probability of 1-in-100 of occurring in any given year) to meet the same standards as buildings in the current "100-year" 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[23] 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 2, "Land Use, Zoning, and Public Policy," and **Appendix C**.

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,[24] the current 1-in-100 coastal storm surge could reach elevations of 11 feet NAVD88 at Sites 4 (4A/4B) and 6A (and the existing uses on Site 5), and 12 feet NAVD88 for the proposed building on Site 5. Therefore, the official design flood elevation per the New York City 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 projected 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 1-in-100 flood levels could reach 30 inches higher due to sea-level rise (per NPCC "High" scenario), to approximately 13.5 feet NAVD88 at Sites 4 (4A/4B) and 6A, and 14.5 feet NAVD88 for the proposed building on Site 5. By the end of the century, the 1-in-100 flood levels could reach 75 inches higher (per NPCC "High" scenario), to approximately 17 feet NAVD88 at Sites 4 (4A/4B) and 6A, and 18 feet NAVD88 for the proposed building on Site 5.

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.

In the project area, New York City is currently in the process of planning and approving the Lower Manhattan Coastal Resiliency (LMCR) Project, a flood-proofing and park-building measure that extends from Montgomery Street, one block north of the proposed projects, around Lower Manhattan to the north of Battery Park City. The City received funding through the U.S. Department of Housing and Urban Development's (HUD) National Disaster Resilience Competition (NDRC) to initiate LMCR and has begun working on the design and environmental

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

[24] FEMA. *Preliminary Flood Insurance Rate Map*. Panel 3604970203G. Release Date: 12/05/2013.

review. In addition, the City is currently designing the East Side Coastal Resiliency (ESCR) project, a similar effort starting at Montgomery Street northward to East 25th Street, and is currently in the preliminary design phase and undergoing environmental review. The City and the HUD have committed $760 million to ESCR. Through these projects the City is proposing to install a flood protection system within City parkland and streets. The flood protection system would include a combination of berms, floodwalls, and possibly deployable systems with other infrastructure improvements to reduce flooding, and is being designed to accommodate the 1-in-100 flood elevation with 30 inches of sea-level rise—equivalent to the NPCC 2050s "High" scenario.[25]

The new construction for 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. To that end, the following measures would be implemented:

- All critical infrastructure elements in the proposed developments would be either elevated above 17 feet NAVD88 at Sites 4 (4A/4B) and 6A and 18 feet NAVD88 for the proposed building on Site 5, or sealed or otherwise designed to be resistant to flood waters if located below those elevations. 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 1-in-100 flood elevations for all critical infrastructure through the end of the century.
- All new residential units would be located higher than17 feet NAVD88 at Sites 4 (4A/4B) and 6A and 18 feet NAVD88 for the proposed building on Site 5, protecting residential units from potential 1-in-100 flood events throughout the end of the century (the lowest residential units are designed currently at elevations of approximately 205, 126, and 82 feet NAVD88 on Site 4 [4A/4B], Site 5, and Site 6A, respectively).
- Commercial, parking, lobby, and other non-critical non-residential spaces would be either designed with deployable stand-alone protective barriers so as to hold back flood waters up to an elevation of 14.5 feet NAVD88 at Sites 4 (4A/4B) and 6A and 15.5 feet NAVD88 for the proposed building on Site 5, 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. For the South Street façade of the proposed Site 5 building, given the large difference between the street level and potential flood levels and the limited space available, deployable stand-alone barriers would likely not be practicable; the proposed Site 5 building's south façade would be protected by structurally integrated flood resistant building materials and deployable barriers for the doorways. This would provide resilience from potential 1-in-100 flood events through the 2050s (including one foot of freeboard). 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. If the LMCR and ESCR projects are finalized, providing resilience to 2050s-projected conditions at the projects' sites, deployable stand-alone flood barriers may not be necessary and may then

[25] The City of New York. *ESCR: Project Area One—Conceptual Design Update.* Presentation, December 1 and 7, 2016.

not be included. All critical systems and residential units, however, would remain elevated above or otherwise protected up to the 2100 1-in-100 flood elevation.

- The project sites would be located in Zone AE, beyond the current Limit of Moderate Wave Action (LMWA). Note that the LMWA may move somewhat inland as sea level rises in the future which could affect Site 5. While this would not affect flood depth (as wave height is included in the BFE), southern façades of the proposed Site 5 building would need to be designed to structurally withstand moderate wave action.

The projects would be designed to accommodate future enhancement (adaptive measures) of any protections designed for commercial, parking, lobby, and other non-critical non-residential spaces up to 17 feet NAVD88 at Sites 4 (4A/4B) and 6A and 18 feet NAVD88 for the proposed building on Site 5 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 stand-alone flood barriers or façades designed to be structurally resistant to flooding (such as the South Street façade of the proposed Site 5 building) with increased height and deeper flood waters. ✷