A. INTRODUCTION

This chapter evaluates the greenhouse gas (GHG) emissions associated with the construction and operation of the Proposed Project, and its consistency with the statewide GHG reduction goals.

As discussed in the Council on Environmental Quality's (CEQ) guidance[1] and New York State Department of Environmental Conservation's (DEC) policy,[2] 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. The United States and New York State have established sustainability initiatives and goals for greatly reducing GHG emissions and for adapting to climate change.

This analysis has been prepared following CEQ and DEC guidance to the extent practicable. Per the CEQ guidance, it is recommended that agencies quantify GHG emissions where appropriate data inputs are reasonably available, with the appropriate level of review to assess the broad-scale effects of GHG emissions to inform decisions. Potential changes in GHG emissions associated with the construction and operation of the Proposed Project are discussed qualitatively. Developing regional transportation model scenarios and emissions modeling in order to project potential GHG emissions solely for the purpose of this analysis would not be commensurate with the extent of the effects of the Proposed Project. It is widely demonstrated in academic literature as well as in the MTA's own models that commuter rail operations result in a net reduction of greenhouse gas emissions.[3] The CEQ and DEC guidance both state that agencies should consider reasonable measures to lower the level of the potential GHG emissions. Therefore, the analysis reviews and evaluates potential relevant measures aimed at reducing GHG emissions associated with the Proposed Project.

The climate change analysis also addresses resilience of the Proposed Project to projected future climate conditions. The assessments are presented in two sections: **Section B, "Greenhouse Gas Emissions"** presents the regulatory context, methodology, and analysis of GHG emission and consistency with applicable policies; and **Section C, "Adaptation to Climate Change,"** presents the regulatory context and analysis of the Proposed Project's resilience to future climate conditions.

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[1] Executive Office of the President, CEQ. *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews*. August 1, 2016.

[2] DEC. *DEC Policy: Assessing Energy Use and Greenhouse Gas Emissions in Environmental Impact Statements*. July 15, 2009.

[3] MTA. *Impact of Public Transportation on GHG in the MTA Area*. May 28, 2009.

PRINCIPAL CONCLUSIONS AND IMPACTS

GHG EMISSIONS

New York State, in large measure due to the availability and extensive use of public transportation, with the highest transit mode-share of any state, has the lowest per-capita energy use and GHG emissions.[4] Improving the overall reliability, attractiveness, and convenience of mass transit is an important part of maintaining and increasing transit use into the future and reducing traffic congestion, and thus reducing region-wide GHG emissions. It is important to note in this context that region-wide emissions are not driven solely by the transportation mode choice. Transit use reduces emissions relative to private vehicle use, but also reduces congestion and thus indirectly reduces emissions further. Moreover, the availability of well-connected transit systems facilitates a more compact and transit-oriented development land use pattern, resulting in further efficiency in travel, services, and utilities. Therefore, as part of the larger region-wide transit system, improving the overall reliability, attractiveness, and convenience of the LIRR supports New York State's long term GHG emission reduction policies.

The Proposed Project would result in some additional GHG emissions associated with operating electric locomotives (indirect emissions from power generation), and would reduce some emissions associated with on-road vehicular emissions due to the shift of trips in the off-peak direction from on-road to LIRR, with some increased emissions associated with local park-and-ride and taxi trips to and from stations. There would also be direct emissions associated with construction vehicles and indirect emissions associated with the extraction, production, and delivery of materials, which would be reduced to the extent practicable via measures described later in this chapter.

Therefore, based on the outlined sustainability commitments aimed at reducing construction and operational emissions, and since the Proposed Project is a transit enhancement project, the Proposed Project would be consistent with the State's GHG emissions reduction goals and policies.

ADAPTATION TO CLIMATE CHANGE

With respect to sea level rise, the Proposed Project is well above the current "100-year" and "500-year" flood elevations (the elevations that would potentially be inundated during a coastal storm of a magnitude with a 1-percent and 0.2-percent probability of occurring in any given year, respectively). Therefore, the Proposed Project area would not be flooded during either such future storm event, even when accounting for the highest projected sea level rise by the year 2100.

Average and extreme temperatures are projected to increase, and extreme temperature events ("heatwaves") are likely to increase in the future as a result of climate change. The same design, maintenance, and operational procedures to minimize track buckling that LIRR currently uses would also address the future condition when heatwaves may be more frequent or intense.

Stormwater management practices for the Proposed Project have been designed for the current 100-year storm event. With the potential for substantial increases in the frequency and scale of downpour events it is possible that these systems may not be as resilient as possible. However, it would not be practicable to install stormwater management practices sized for a larger event given the space constraints of the right-of-way.

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[4] US Energy Information Administration, http://www.eia.gov/environment/emissions/state/analysis/

The Proposed Project would be designed to accommodate any reasonably foreseeable potential future changes in climate, and would, therefore, be consistent with state and federal policies requiring climate change resiliency.

B. GREENHOUSE GAS EMISSIONS

METHODOLOGY

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. This phenomenon causes the general warming of the Earth's atmosphere, or 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.

The primary GHGs of concern emitted from anthropogenic sources include CO_2, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. CO_2 is the primary pollutant of concern from anthropogenic sources, as it 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.

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

As a result of the growing consensus that human activity resulting in GHG emissions has 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 international agreements, which set emissions targets for GHGs, the U.S. signed the international Paris agreement[5] in December 2015 that pledges deep cuts in emissions, with a stated goal of reducing emissions to between 26 and 28 percent lower than 2005 levels by 2025[6] to be implemented via existing laws and regulations with executive authority of the President.

The U.S. Environmental Protection Agency (USEPA) 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), USEPA currently regulates GHG emissions from newly manufactured on-road vehicles. In addition, USEPA 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. The U.S. Department of Transportation (USDOT) is also involved in many activities,

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

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

programs, and partnerships, including collaborations with other federal agencies and international organizations, aimed at reducing GHG emission.[7,8] In 2015, USEPA 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. USEPA expects to expand this program in the future to limit emissions from additional stationary sources.

There are also regional and local efforts to reduce GHG emissions. In 2009, then-New York Governor David 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 climate action plan was published in 2010.[9] 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 a new target of reducing GHG emissions in New York State by 40 percent, compared with 1990 levels, by 2030. The plan also establishes a new target of providing 50 percent of electricity generation in the state from renewable sources by 2030, and 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.

In 2007, MTA convened a Blue Ribbon Commission on Sustainability. The Commission published a final report *Greening Mass Transit & Metro Regions*, recommending actions and approaches for enhancing the sustainability of MTA operations and the MTA region by addressing energy and GHG emissions, facilities, smart growth and transit oriented

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7 http://climate.dot.gov/policies-legislation-programs/federal-org-directory.html

8 http://climate.dot.gov/policies-legislation-programs/dot-partnerships/international-activities.html

9 New York State Climate Action Council. New York State Climate Action Plan Interim Report. November 2010.

development, material flows, water management, and climate adaptation.[10] MTA subsequently published two reports in 2011 and 2012 highlighting projects and activities that reduce the carbon footprint of MTA's operations and of transportation in the region overall.[11,12] LIRR applies the approach outlined in the above reports for planning purposes.

In addition, LIRR's *Environmental Management Corporate Policy and Procedure*[13] includes the following principles:

- *Review and continuously improve all activities to ensure consideration of environmental impacts, risks and costs in all planning, acquisition and operational decisions.*
- *Encourage and promote pollution prevention efforts through material substitution, waste minimization, recycling, and resource conservation and recovery.*

LIRR's *Station Design Guidelines*[14] recognized that the MTA Blue Ribbon Commission on Sustainability Report recommended that all building projects, new construction and major renovations achieve certification at a Silver level under the Leadership in Energy & Environmental Design (LEED) program. Strategies for achieving LEED Silver include enhanced energy efficiency and other measures that directly and indirectly reduce GHG emissions.

In accordance with NYSDEC Executive Order 4 (EO 4), LIRR has reported on progress in the areas of green procurement and agency sustainability annually since 2008. LIRR's sustainability coordinator, in conjunction with sister agencies, has monitored LIRR's progress with respect to the following sustainability initiatives: sustainability planning & outreach; waste prevention and reuse; recycling and composting; reducing the use of toxic chemicals; energy efficiency and renewable energy resources; conservation of water and natural resources; and green procurement.[15]

The MTA's annual "Greenhouse Gas Emissions Inventory" has been voluntarily reported to the Climate Registry since 2008. Energy usage and statistics have been compiled in accordance with the Greenhouse Gas Protocol developed by World Resources Institute and World Business Council on Sustainable Development.[16]

ASSESSMENT APPROACH

Although the contribution of any single project's emissions to climate change is infinitesimal, the combined GHG emissions from all human activity have been found to have significant effects on global climate. 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.

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[10] MTA. *Greening Mass Transit & Metro Regions: The Final Report of the Blue Ribbon Commission on Sustainability and the MTA*. January 8, 2009.

[11] MTA. *2011 MTA Sustainability Report: More MTA = Less CO_2*. April 2011.

[12] MTA. *2012 Sustainability Report: An Average MTA Trip Saves Over 10 Pounds of Greenhouse Gas Emissions*. April 2012.

[13] MTA LIRR. *Corporate Policy & Procedure: Environmental Management*. SAFE-003 (F.K.A. 5503). December 2009.

[14] MTA LIRR. *Station Design Guidelines.* Revised December 2014.

[15] http://www.ogs.state.ny.us/EO/4/

[16] http://www.cris4.org

Nonetheless, prudent planning dictates that all sectors address GHG emissions by identifying GHG sources and practicable means to reduce them.

Construction of the Proposed Project – as opposed to its operation – would result in direct and indirect GHG emissions. Operationally, once the project is constructed, additional passenger train service (as well as non-revenue train movements) would be provided. The increase in passenger service would be primarily in the off-peak direction, but would nonetheless likely reduce vehicular round trips by providing an option for commuters and others traveling in the off-peak direction. Some additional local short trips via taxi and/or park-and-ride would increase for those trips shifted from passenger vehicle to passenger rail. Some additional changes in emissions may occur as a result of new or upgraded station and parking garage systems such as lighting, ticketing, and platform deicing; these would represent increased emissions where adding components and potentially decreased emissions where introducing new more efficient systems. The Proposed Project will support on-going and existing development in the Project Corridor that is associated with livable, walkable communities, thereby encouraging network emissions avoidance. The Proposed Project would not affect freight traffic along the corridor. Some vegetation, including trees, would be cleared from the right-of-way, potentially reducing carbon storage and future sequestration capacity.

The impact of the construction and the operational changes on GHG emissions are discussed and evaluated. The precise effect of the Proposed Project on shift of trip mode from on-road to rail, locomotive emissions (indirect, from electricity production), and detailed estimates of materials and fuels needed for construction would require the development of regional transportation model scenarios and extensive emissions modeling in order to project potential GHG emissions solely for the purpose of disclosure, but are not necessary for the evaluation of the Proposed Project in the context of policies aimed at reducing GHG emissions, and would not be commensurate with the extent of the effects of the Proposed Project per CEQ and DEC guidance. Therefore, this chapter presents a qualitative analysis of changes in GHG emissions potentially associated with the Proposed Project and evaluates emission reduction measures that may be relevant for the Proposed Project. The assessment of consistency with relevant policies is based on that qualitative analysis.

POTENTIAL IMPACTS OF THE PROPOSED PROJECT

PROJECTED GHG EMISSIONS

The following sections describe the potential GHG emissions sources related to the Proposed Project, and potential measures that could reduce emissions.

Construction Emissions

GHG emissions associated with construction of the Proposed Project would result from several sources:

- fuel combusted on-site by non-road construction engines;
- fuel combusted off-site by trucks and worker vehicles;
- fuel combusted for the production of electricity used during construction; and
- fuel combusted in the extraction, production or recycling, and delivery of materials, especially energy intensive materials such as cement and steel, and direct emissions of CO_2 related to chemical processes in the production of cement, iron, and steel.

Operational Emissions

By improving the reliability of transit service through addition of a third track and removal of grade crossings, the Proposed Project would make transit use a more attractive mode choice to the automobile for NYC-bound commutes and intra-island travel. An efficient and reliable transit system would reduce regional GHG emissions by minimizing on-road travel. Given the volume of train traffic along this Main Line segment, it frequently becomes congested during a normal rush hour. Moreover, in the event of a bottleneck caused by an emergency repair or disabled train, conditions can range from severely constrained to immobilized, creating significant delays. Also, due to the heavy train volumes and the two-track configuration, the LIRR has very few options to route service around a disabled train or track outage, compounding delays and affecting thousands of train riders. The risk of delays will increase as volume increases in the future due to the completion of the East Side Access project and projected annual growth. Increasing the reliability of the service and reducing delays is likely to maintain transit use into the future, and support growth in ridership expected with the completion of the East Side Access project. The increase in ridership would shift trips from automobiles to passenger rail, which would reduce GHG emissions.

The changes to grade crossings would result in reductions in emissions from idling vehicles as a result of eliminating delays associated with the current at-grade crossings. ^ At South 12th Street in New Hyde Park and Main Street in Mineola, where grade crossings would be closed^ , traffic ^ would be diverted to alternative routes. Overall, the change in route would likely represent a minor change in emissions associated with any relative change in distance, speed and grade for diverted trips. The change in emissions associated with the change in roadway grade of the new grade-separated roadways would be negligible.

The Proposed Project would also include improvements in signals, lighting, ticketing, elevators and escalators, parking facilities, and platform deicing systems. While some of these elements would be new and would thus increase electricity use and ensuing emissions, in many cases the replacement of older systems with newer, more efficient systems would reduce electricity consumption and ensuing emissions. Some additional electricity use may be necessary if pumping of stormwater is required for grade-separated crossings.

As described above, electric train trips (revenue service and non-revenue service) would increase as a result of the Proposed Project. This would result in increased emissions from electric power generation. However, those emissions would be offset by the shift of trips from on-road vehicular trips, mostly in single occupancy vehicles, to passenger rail.

Carbon Sequestration

In general, the preservation of trees has a more significant impact on carbon sequestration in large forested areas, where forestation can be ongoing (trees die and new ones grow) and where carbon can be transferred to soils, providing long-term carbon storage and growing capacity.

The removal of trees from the right-of-way would result in some GHG emissions and a reduction of future sequestration capacity. It is estimated that a few hundred trees would be removed from the right-of-way. Trees in the right-of-way are likely to be mostly of smaller size since large trees near the tracks pose a safety risk and are typically removed as a part of normal maintenance of the right-of-way. Therefore, some portion of the trees that would be removed as a consequence of the Proposed Project would otherwise be removed without the Proposed Project due to safety concerns.

Net Emissions

Commensurate with the agency guidance, a net effect of the Proposed Project on GHG emissions was not quantified. However, as part of the larger transit system, improving the overall reliability, attractiveness, and convenience of the LIRR system is an important part of maintaining and increasing transit use into the future and reducing automobile use and concomitant traffic congestion, and thus reducing region-wide GHG emissions. It is important to note in this context that region-wide emissions are not driven solely by the transportation mode choice. Transit use reduces emissions relative to private vehicle use, but also reduces congestion and thus indirectly reduces emissions further. Moreover, the availability of well-connected transit systems also affects land use such that more compact and transit-oriented development occurs, helping to avoid urban sprawl, and resulting in further efficiency in travel, services, utilities, and more. MTA has calculated that, based on all of these factors, while MTA itself (including LIRR, MNR, and NYC Transit) produced 2.1 million metric tons of CO_2 equivalent[17] system-wide in 2010, its transit operations actually reduced the overall emissions of the region by 16.9 million metric tons.

ELEMENTS THAT WOULD REDUCE GHG EMISSIONS

The following sections review and evaluate sustainable design features that might reduce the Proposed Project's GHG emissions within the relevant categories, and identify potential measures for inclusion in the project where practicable.

Clean and Efficient Use of Power

As described above, passenger and freight rail is far more efficient than on-road alternatives. The Proposed Project would further improve efficiency through system improvements and track redundancy, as described above. In addition, most LIRR passenger service within the Project Corridor is electric powered. The use of electric power reduces GHG emissions by including electric power generation from renewable sources in the current mix, and allows for further future reductions as New York State continues to increase that renewable portion.

Additional components of the Proposed Project that could further enhance the use of clean and efficient power:

- *Aluminum Third Rail:* LIRR has been actively testing, modeling and, where appropriate, installing aluminum third rail, which reduces electrical losses to resistance and helps maintain voltage support. Aluminum or aluminum-composite third rail would be used for the Proposed Project.
- *Third Rail Heater Controls:* MTA has completed a successful pilot of remote-controlled third rail heaters, which will allow it to activate essential third rail heaters only when the weather indicates icing conditions are likely. The project will result in savings from both the decrease in electrical energy used to unnecessarily heat exposed third rail and the maintenance costs associated with turning on and off conventional heater switches. Remote-controlled third rail heaters would be considered for the Proposed Project.
- *Lighting and Signals:* Specifying the selection of LED lighting and signals where possible (or other high-efficiency lights where available LED are not appropriate) and automated and motion sensor controlled lighting where appropriate.

[17] CO_2 equivalent is a measure of all GHGs combined weighted by their effectiveness in trapping inbound energy.

- *Other Powered Systems:* Specifying energy efficient pumps or any other necessary powered equipment in bid documents.

Transit-Oriented Development and Sustainable Transportation

As described above, by design, the Proposed Project would support and improve LIRR service, thus helping to maintain and enhance transit-oriented development and efficient land use in the region overall.

Reduce Construction Operation Emissions

Biodiesel: Reducing direct emissions from construction activity could be achieved by requiring the use of biodiesel for construction engines. Biodiesel blends of up to 20 percent (B20) can generally be used as a "drop in" fuel for any diesel engine. EPA defined the minimum GHG reduction of pure biodiesel (B100) as 20 percent for standard biodiesel, and 50 percent for advanced biodiesel. Therefore, using standard or advanced B20 would minimize GHG emissions during construction, when compared to use of regular diesel fuel, by a minimum of 4 or 10 percent, respectively. On previous construction projects, MTA has required use of biodiesel. By including an investigation of the availability and cost of standard or advanced B20 for the Proposed Project construction, and requiring its use if found to be practicable, direct emissions from construction engines could be minimized by at least 4 or 10 percent, respectively.

Use Building Materials with Low Carbon Intensity

Rail Ties

MTA's Railroad Tie Task Force was tasked with developing increasingly sustainable railroad tie solutions.[18] The task force reported that LIRR railroad ties consisted of either creosote-treated wood or concrete. LIRR does not purchase tropical hardwood railroad ties. Since 2002, LIRR has installed composite plastic ties in ballasted track in sections of track with low train volumes. LIRR experienced issues with a large number of these ties, primarily associated with the hardware that fastens the track to the tie. The task force determined that certain issues regarding the physical characteristics of the materials needed to be resolved before composite plastic or recycled plastic could be more widely used. Given the high volume of trains within the Main Line corridor, the Proposed Project would be constructed using concrete ties.

Cement

The Proposed Project would require cement to produce concrete for railroad ties, retaining walls and sound attenuation walls, platforms, parking garages, and other elements such as walkways. Cement replacements such as slag or flyash, known as supplementary cementitious material (SCM), are regularly used in cement due to their low-cost relative to the cement they replace, with the quantities optimized to meet structural requirements. Reducing the amount of cement would reduce the quantity of fuel combusted, electricity used, and CO_2 liberated through pyro-processing of limestone (a chemical process resulting in directly emitting CO_2).

In addition to standard SCMs, the carbon footprint of cement can be further reduced by the introduction of interground raw limestone. Cement used in the U.S. in accordance with ASTM C-150 allows for a maximum of 5 percent interground limestone. The ASTM C1157 standard allows for greater interground limestone content but whether it is selected for use would need to be verified. Cement fitting this standard is commonly used in Canada and Europe and is sometimes referred to as Portland limestone cement (PLC). The applicability and cost of this

[18] MTA. *Sustainable Railroad Tie Task Force Report*. April 2009.

approach could be investigated for the Proposed Project, and implemented if found to be practicable.

Steel

Recycled steel would most likely be used for most rebar and structural steel since the steel available in the region is mostly recycled. Requiring the procurement of recycled steel to the extent practicable would ensure substantially lower GHG emissions for this component.

Recycling

Construction waste can be largely diverted from landfills by separating out materials for reuse and recycling. Setting a target of a minimum of 75 percent is a common approach for ensuring recycling. Materials that may be appropriate for diversion include wooden pallets, scrap steel, and crushed concrete.

GHG EMISSION REDUCTION STRATEGIES FOR THE PROPOSED PROJECT

In order to ensure that the Proposed Project incorporates measures that would reduce GHG emissions where practicable, the following commitments would be undertaken as part of the bidding and contracting process:

1. Contracts would specify that all lighting and signals will be LED or, when LED is not reasonably available or practicable (including lifetime cost considerations) for a particular application, other highly efficient technology will be selected.
2. Contracts would specify that all pumps and other powered equipment will be energy efficient where reasonably available and practicable (including cost-benefit considerations), with preference for Energy Star certified equipment where available.
3. Contractors would be encouraged to explore the use of B20 biodiesel for construction engines.
4. Contractors would be encouraged to explore the use of cement with higher inter-ground limestone content.
5. ^ Design-build contractor will use best efforts to incorporate innovative measures to reduce the project's carbon footprint.
6. To the extent practicable, all rail, rebar, and structural metal products will be from recycled sources. The contractor will provide LIRR with documentation of which materials contained recycled content.

C. RESILIENCE TO CLIMATE CHANGE

This section evaluates the potential for changes in climatic conditions under future projected scenarios to affect the Proposed Project, and discusses how the Proposed Project design would introduce resilience to address these concerns.

DEVELOPMENT OF POLICY TO IMPROVE CLIMATE CHANGE RESILIENCE

The New York State Sea Level Rise Task Force was created to assess potential impacts of rising seas and increased storm surge on the state's coastline. The Task Force prepared a report of its findings and recommendations including protective and adaptive measures.[19] The recommendations are intended 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

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

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 (SLR).

LIRR continues to participate in the MTA "Climate Adaptation Task Force," formally instituted by Chairman Prendergast in January 2014. The Task Force comprises key personnel throughout the organization and is tasked with developing system-wide climate adaptation policies and standards to be incorporated into all regular MTA operations. In an effort to fortify its assets against future adverse climate events, the Task Force coordinates and organizes initiatives implemented at all MTA operating agencies in preparation for future climate change scenarios. The Task Force meets regularly with relevant local and regional public sector agencies, commercial entities, and academic/research institutions for continuous information exchange and knowledge sharing.

In July 2014, LIRR approved its formal design guideline "to ensure long term protection and resiliency of railroad facilities and/or significant infrastructure assets against future flooding." The design guidelines take into consideration FEMA base flood elevations, US Army Corps of Engineers sea level rise projections, and freeboard recommendation from the NYS Building Code and the American Society of Civil Engineers.

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.[20] New York State's Community Risk and Resiliency Act (CRRA)[21] requires applicants for certain State programs to demonstrate that they have taken into account future physical climate risks from storm surges, SLR, and flooding; CRRA also required the DEC to establish official State SLR projections by January 1, 2016. DEC published a draft on November 2, 2015, proposing to adopt existing projections for use (see discussion of NPCC below). These projections will 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.

The New York City Panel on Climate Change (NPCC) has prepared a set of climate change projections for the New York City region,[22] which was subsequently updated,[23] and has suggested approaches to create an effective adaptation program for critical infrastructure. While the geographic focus of NPCC is New York City, the data and information produced for the Task Force, described below, is relevant for the region, and the sea level rise projections were also proposed, but not officially adopted, by New York State. The NPCC includes leading climatologists, SLR specialists, adaptation experts, and engineers, as well as representatives

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

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

[22] 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.

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

from the insurance and legal sectors. The NPCC summarized a number of baseline and projected climate conditions throughout the 21st century, including heat waves and cold events, intense precipitation and droughts, SLR, and coastal storm levels and frequency. The following summarizes the findings most relevant to the Proposed Project (more detailed ranges and timescales are available):

- *SLR and Storm Surge:* NPCC projects that sea levels are likely to increase by up to 75 inches ("High" scenario) by the end of the century. In general, the occurrence of SLR is characterized as "extremely likely," but there is uncertainty regarding its magnitude and rate. Major hurricanes are characterized as "more likely than not" to increase in intensity and/or frequency, and the likelihood of changes in other large storms (e.g., "Nor'easters") are characterized as unknown. Therefore, the projections for future 1-in-100 coastal storm surge levels for the area include only SLR at this time, and do not account for changes in storm frequency.
- *Temperature:* NPCC projects that annual average temperature is likely to increase by up to 12ºF by the end of the century. In general, the probability of higher temperature is characterized as "extremely likely." Heatwaves (events with a duration of three or more days with maximum temperatures exceeding 90ºF) are "very likely" to increase in frequency, with up to nine events projected in the high estimate by the 2080s in an average year, up from two events per average year in the baseline, and a duration of up to eight days per event, up from four days in the baseline. The number of days per average year with a maximum temperature exceeding 90ºF in that same timeframe could increase from 18 to 87.
- *Precipitation:* NPCC projects that annual average precipitation is likely to increase by up to 25 percent by the end of the century. The number of downpours (intense precipitation events shorter than a day and often shorter than an hour) is "very likely" to increase. By the 2080s, downpours of 1 inch or more could increase from an annual average of 13 events in the baseline to 18 events, and 4 inches or more from an average of 0.3 to 0.7 events.

MTA published its framework for adaptations to climate change in 2008.[24] The framework identified three key trends significantly impacting MTA operations: higher average temperatures, rising sea levels with related coastal surges, and increased storm activity with more severe precipitation events and related flooding. The review of LIRR infrastructure focused on coastal flooding. The general discussion also included concerns with lower priority for MTA regarding energy impacts (rising temperatures will require more energy for cooling), street flooding (increased severe precipitation events and culverts and pumps may not be designed to meet that increase), and other changes (e.g., wind, snow, ice, drought). MTA convened an agency-wide Climate Adaptation Task Force in 2014 tasked with developing system-wide climate-adaptation policies and standards to be incorporated into all regular MTA operations. MTA currently collaborates with the above mentioned ongoing state and city adaptation efforts.

In addition, LIRR's Environmental Management Corporate Policy and Procedure states as a principle that *the Long Island Rail Road and its employees will work proactively to foresee and prevent the occurrence of any environmental issues.*

[24] MTA. *MTA Adaptations to Climate Change – A Categorical Imperative*. October 2008.

Climate change considerations and measures that would be implemented to increase climate resilience are discussed below. In addition, the Proposed Project would be designed according to any applicable federal or state laws so as to meet or exceed the codes in effect at the time.

RESILIENCE OF THE PROPOSED PROJECT TO CLIMATE CHANGE

In the case of the Proposed Project, the LIRR right-of-way, grade crossings, parking garages, and stations are located at a distance ranging from approximately 3.5 to 8 miles from the nearest coast—well away from future projected coastal flooding hazard areas based on the highest SLR projections for the area. The potential "100-year" flood hazard area projected for the year 2100 is presented in **Figure 17-1**. Therefore, coastal flooding is not a concern for the Proposed Project. Note that if flooding occurs in other branches due to an extreme weather event, the Proposed Project could provide additional capacity.

The existing approximately 70- to 90-foot high wooden utility poles within the LIRR ROW would be replaced by new, 85- to 90-foot high steel utility poles along the entire Project Corridor, with the exception of grade crossing locations, where new wooden poles of similar height to existing poles would replace existing poles. The new steel poles would be far more resilient to the effects of extreme weather than the existing poles; this would help to ensure greater resilience of the overall system.

Other future resilience concerns relevant to the Proposed Project are discussed below. Overall, the Proposed Project would be designed to accommodate any reasonably foreseeable potential future changes in climate, and therefore would be consistent with state and federal policies requiring climate change resiliency.

DRAINAGE AND LOCAL FLOODING ASSOCIATED WITH DOWNPOUR EVENTS

With potentially substantial increases in the frequency and scale of downpour events, design of drainage for the main line and for depressed roadway areas of the grade crossings would need to account for potentially larger stormwater capacities in order to avoid local flooding during these events. However, due to space constraints within the right-of-way, stormwater practices can only be designed for the current 100-year storm event.

DESIGN OF TRACK FOR HEATWAVES

Since LIRR traction power is provided via third rail, catenary systems and their potential difficulties in extreme temperatures are not of concern for the Proposed Project.

Track buckling (rail deformation in extreme heatwaves) has been known to be an issue of concern. In general, track buckling occurs predominately on continuously welded track, though it also can occur on older jointed track when the ends of the track become frozen in place.[25] Track buckling is most prevalent on an isolated hot day in the springtime or early summer, rather than mid to late summer when temperatures are more uniformly hot. Buckling also is more likely to occur in alternating sun/shade regions and in curves. Track design generally accounts for track buckling via design criteria—for the main line, design criteria address a range of zero to 120 ºF. This design criteria generally prevents buckling even at rail temperatures of up to 150

[25] European Commission. *Impacts of Climate Change on Transport: A Focus on Road and Rail Transport Infrastructures.* Available: http://ftp.jrc.es/EURdoc/JRC72217.pdf. 2012.

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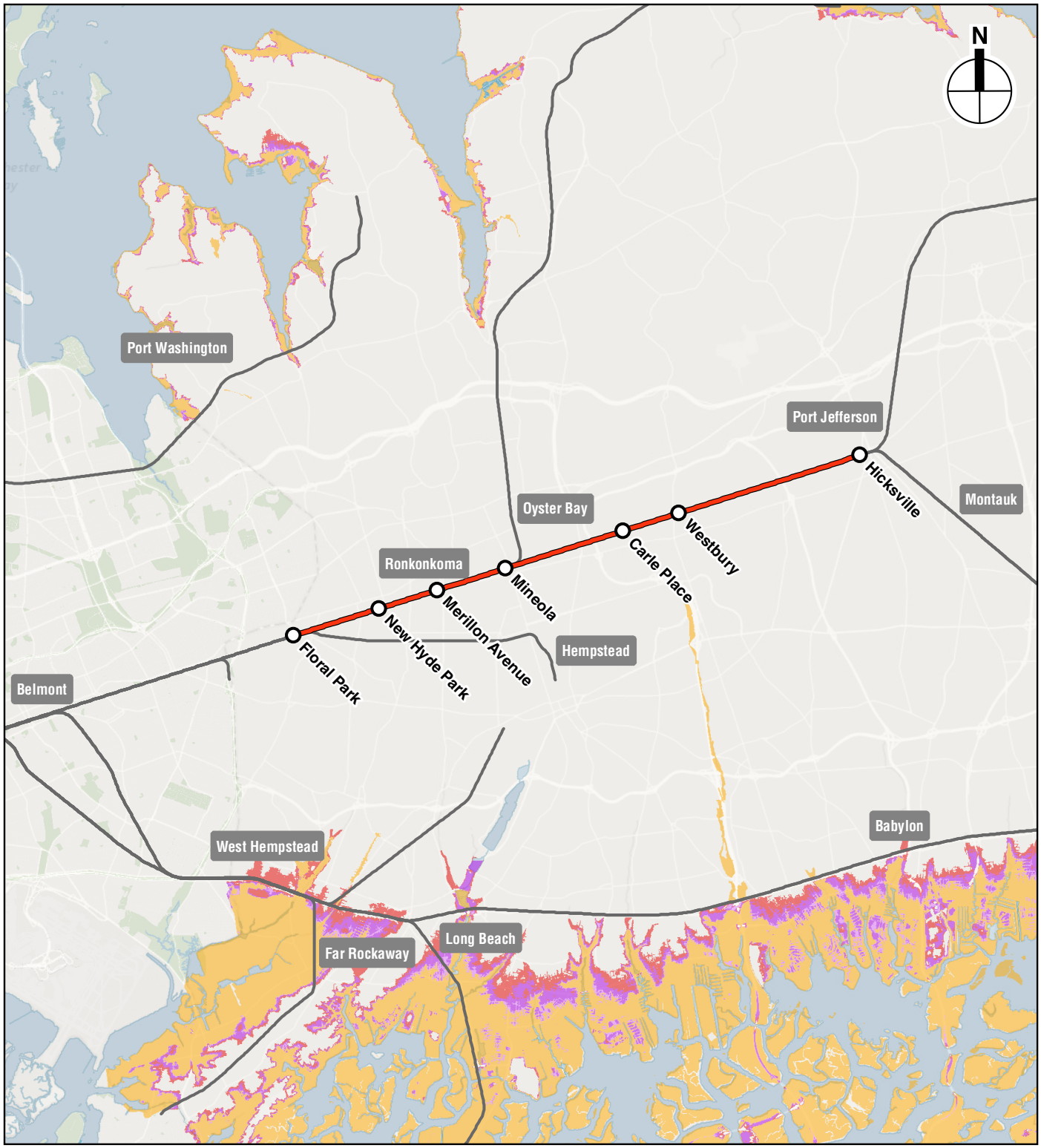

0 5 MILES

ProjectSite
LIRR Station
LIRR Branch

Lowest (Most Recent SFHA + 0.7 ft)
Intermediate-Low (Most Recent SFHA + 1.6 ft)
Intermediate-High (Most Recent SFHA + 3.9 ft)
Highest (Most Recent SFHA + 6.6 ft)

LIRR Expansion Project
Floral Park to Hicksville

Projected Flood Zones--2100
Figure 17-1

ºF. [26] The design also would accommodate changes in length of segments due to thermal movement, such as would occur during a heatwave. Since the track is more stable when the rail is in tension at temperatures below the neutral temperature, the target neutral temperature is generally 75 percent of the expected maximum temperature of the region. An increase in temperature may slightly raise the neutral temperature used for installation but is unlikely to necessitate track design changes.[25]

Preventive measures to reduce rail buckling derailment risk include:

- Improving weather forecast and predictive capacity for rail track temperature;
- Utilizing track materials that can withstand projected temperatures (such as concrete ties, continuous welded rail, and rail fasteners); and
- Applying speed limits during high temperature spells.

Overall, appropriate design, maintenance, and operational procedures for track buckling in the current condition would also address the future condition when heatwaves may be more frequent or intense. ✷

[26] FHWA. *U.S. Climate Change Science Program Synthesis and Assessment Product 4.7: Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I.* March 2008.