Chapter 13: Greenhouse Gas Emissions and Climate Change

A. INTRODUCTION

This chapter discusses energy use, energy savings, greenhouse gas (GHG) emissions, and GHG emissions reduced as a result of the Proposed Project, and its consistency with established sustainability measures and GHG reduction goals. As discussed in the Council on Environmental Quality's (CEQ) guidance,[1] 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 observed at the local level. The U.S. has established sustainability initiatives and goals for greatly reducing GHG emissions and for adapting to climate change.

While the contribution of any single project to climate change is infinitesimal, the combined GHG emissions from all human activity impact the global climate. The nature of the impact dictates that all sectors identify practicable means to reduce GHG emissions. Following the CEQ guidance and given that the Proposed Project operation would reduce GHG emissions and energy use, this chapter does not specify the incremental contributions of the Proposed Project to climate effects, but rather identifies opportunities to further reduce energy consumption and GHG emissions during operation and construction. GHG emissions and energy are discussed in Section B.

The Proposed Project would constitute a major public investment in infrastructure with a useful life on a timescale at which the effects of climate change may become more noticeable. Effects of climate change that could affect the rail bridge, its approaches, and associated infrastructure include, but are not limited to, more frequent and intense heat waves, severe cold weather, more frequent and intense downpours and flooding, sea-level rise, and more intense or more frequent storms. Therefore, this chapter discusses the need to consider the potential effects of climate change when designing or upgrading the proposed infrastructure. The discussion is consistent with the available National Environmental Policy Act (NEPA) guidance. The Proposed Project's resiliency to future climate conditions is discussed in Section C.

As discussed in Chapter 2, "Project Alternatives," this Environmental Assessment (EA) evaluates two Build Alternatives: Alternative 9A and Alternative 9B. Alternative 9A was selected as the Preferred Alternative.

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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.

B. GREENHOUSE GAS EMISSIONS AND ENERGY USE

POLICY, REGULATIONS, STANDARDS, AND BENCHMARKS

As a result of the growing consensus that human activity resulting in GHG emissions has the potential to profoundly affect 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, in December 2015, the U.S. signed the international Paris agreement[2] 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[3] 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 greenhouse gases under the Clean Air Act (CAA), 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, programs, and partnerships, including collaborations with other federal agencies and international organizations, aimed at reducing GHG emission.[4,5]

Various federal policies are aimed at reducing GHG emissions. For example, Executive Order 13514 of October 5, 2009 establishes the policy of the United States that "*Federal agencies increase energy efficiency; measure, report, and reduce their GHG emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution; leverage agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services; design, construct, maintain, and operate high performance sustainable buildings in sustainable locations; strengthen the vitality and livability of the communities in which Federal facilities are located … agencies shall prioritize actions based on a full accounting of both economic and social benefits and costs ...*" USDOT's implementation and reporting under this order[6] includes a focus on enhancing, expanding, and improving the efficiency of the national freight and passenger rail networks.

There are also regional and state efforts to reduce GHG emissions. Maryland is a participant in the Regional Greenhouse Gas Initiative (RGGI), a cooperative effort by Northeast and Mid-Atlantic states to reduce carbon dioxide emissions from power plants by 10 percent by 2019, through a regional cap-and-trade program. The RGGI program is mandated by State law and is fully implemented and enforceable through regulations (COMAR 26.09) adopted and enforced by Maryland Department of the Environment (MDE).

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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).* March 31, 2015.
[4] http://climate.dot.gov/policies-legislation-programs/federal-org-directory.html
[5] http://climate.dot.gov/policies-legislation-programs/dot-partnerships/international-activities.html
[6] http://www.transportation.gov/mission/sustainability/our-sustainability-efforts-0

In 2009, Maryland Governor O'Malley and the Maryland General Assembly passed the *Greenhouse Gas Emissions Reduction Act of 2009* (GGRA). The law requires the State to develop and implement a plan to reduce GHG emissions 25 percent from a 2006 baseline by 2020; the bill was reauthorized in 2016 with a new target of 40 percent reduction by 2030. The State has also established a goal of doubling transit ridership by 2020 from the 2006 levels. These and other strategies for reducing GHG emissions at the state level are described in *Maryland's Greenhouse Gas Emissions Reduction Act Plan*.[7]

METHODOLOGY

Currently, there are no standards or regulations applicable to GHG emission levels or impacts from actions subject to environmental review. Accordingly, the potential effects of the Proposed Project are evaluated in the context of their consistency with the objectives stated in federal and state policies. Potential GHG emissions and emission savings from the Proposed Project are qualitatively assessed, and the feasibility and practicability of various measures available for reducing GHG emissions are discussed. This level of analysis is commensurate with the level of NEPA analysis per the CEQ guidance.

POTENTIAL IMPACTS OF THE BUILD ALTERNATIVES

The National Railroad Passenger Corporation (Amtrak) and Maryland Area Regional Commuter (MARC) enable travel by a mode that is more energy efficient and emits less GHG per passenger-mile, and usually per net-trip, than travel by car alone. The U.S. Department of Energy (USDOE) has reported that intercity (Amtrak) rail travel (in terms of energy used per passenger-mile) is 33 percent more efficient than travel by car.[8] Amtrak has made efforts to reduce CO_2 emissions from its diesel locomotive fleet and has made additional voluntary commitments and efforts to reduce and report emissions, through the Carbon Disclosure Project (CDP) and The Climate Registry (TCR).[9] Based on Federal Transit Administration (FTA) ridership and energy data,[10] travel via MARC is 9 percent more efficient than by car (in terms of energy used per passenger-mile). MARC is planning for growth in ridership and support of transit oriented development (TOD).[11] There are several factors indicating that this efficiency will increase and associated GHG emission from these passenger rail modes will continue to decrease in the future. Passenger rail projects that may result in increased ridership, such as NEC FUTURE, will result in higher efficiency per passenger mile because they will result in higher ridership per car and/or locomotive. GHG emissions will also decrease in the future as the generation of electric power (used by Amtrak trains) becomes more efficient and increasingly relies on renewable energy.

Rail is also an efficient way to move freight. While there is a large variability in efficiency based on route, equipment, and other characteristics of freight movement via truck and rail, rail is generally much more efficient. For example, a study of a wide variety of competitive freight

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[7] Maryland Department of the Environment. *Maryland's Greenhouse Gas Reduction Act Plan Update*. October, 2015.
[8] Oak Ridge National Laboratory. *Transportation Energy Data Book*. Ed. 34. August 2015.
[9] Amtrak. *How Amtrak Commits to Sustainability*. The Official Blog of Amtrak. January 22, 2014.
[10] FTA. *National Transit Database (NTD) 2014 Data Tables*. Tables 17 and 19. http://www.ntdprogram.gov, accessed 3/10/2016.
[11] MTA Maryland. *MARC Growth and Investment Plan*. September 2007.

routes that analyzed 23 routes found rail to be more fuel efficient in all cases, by a factor ranging from 1.9 to 5.5.[12]

Freight rail operators are also seeking to further improve energy efficiency in their operations. Norfolk Southern (NS) has reported that over five years, from 2010 through 2014, the company reduced its GHG emissions by 8.5 percent per revenue ton-mile of freight; this is the result of several factors, including but not limited to a 2.2 percent increase in locomotive operational efficiency, various idle-emissions reduction measures, and efficiency improvements at facilities.[13] In 2009, NS also introduced a prototype battery-operated switcher locomotive, the NS 999, and has continued to refine it. NS continues to investigate cleaner fuel options and additional energy efficiency measures, with the intent of continuing this trend and setting a new longer-term emission reduction goal. In 2015, NS scored 99 for carbon disclosure in the Climate Disclosure Project's Leadership Index and ranked in the top 10 percent of S&P 500 companies that participated in the voluntary survey.[14]

Therefore, the shift of passengers and freight from on-road modes to rail, enabled by the Proposed Project and components of NEC FUTURE, would result in a net reduction in operational energy use and ensuing GHG emissions.

GHG emissions associated with construction of the Proposed Project would result from direct sources, such as on-road and non-road vehicles, and other engines. GHG emissions would also result from indirect sources, including the energy and emissions associated with producing and transporting materials used in construction, especially energy intensive and carbon intensive materials, such as cement and steel.

ELEMENTS THAT WOULD REDUCE GHG EMISSIONS

As a routine part of designing railway projects, energy efficiency is a primary concern. Track grade and curvature—the main design elements affecting energy consumption[15]—are scrutinized to the extent practicable within the constraints of a rail project (such as land use and acquisition, connection to existing track). This would be the case for the Proposed Project design.

Regarding construction, the Proposed Project would use cement replacements, such as slag, fly-ash, silica fume, and calcined clay to the extent practicable. While the vast majority of structural steel and rebar available are from recycled sources, the Proposed Project would nonetheless set a minimum target of 25 percent of recycled steel to be used and tracked as part of the contract requirements.

Overall, the Proposed Project would result in long-term reductions in GHG emissions from freight transport due to the efficient nature of rail versus on-road modes, as described above. In general, system-wide, including energy and emissions embedded in construction of roadway and railway infrastructure, there is a net energy and GHG benefit of rail systems versus on-road

[12] Federal Railroad Administration. *Comparative Evaluation of Rail and Truck Fuel Efficiency on Competitive Corridors*. November 19, 2009.
[13] Norfolk Southern. *Norfolk Southern 2015 Sustainability Report*. 2015.
[14] CDP. https://www.cdp.net, accessed 3/11/16.
[15] Increased grade requires more power to overcome gravity, and the power conserved in the downhill direction does not fully compensate for the increase in the uphill direction. Added curvature requires more power to overcome friction.

systems.[16,17] The Proposed Project would be consistent with state, regional, and federal policies for GHG emissions reduction.

C. CLIMATE CHANGE RESILIENCE

DEVELOPMENT OF POLICY TO IMPROVE CLIMATE CHANGE RESILIENCE

In recognition of the important role that the federal government has to play to address adaptation to climate change, a federal executive order signed October 5, 2009 charged the Interagency Climate Change Adaptation Task Force, composed of representative from more than 20 federal agencies, with recommending policies and practices that can reinforce a national climate change adaptation strategy. The 2011 progress report by the Task Force included recommendations to build resilience to climate change in communities by integrating adaptation considerations into national programs that affect communities, facilitating the incorporation of climate change risks into insurance mechanisms, and addressing additional cross-cutting issues, such as strengthening resilience of coastal, ocean, and Great Lakes communities.[18] In February 2013, federal agencies released Climate Change Adaptation Plans for the first time. The President's Climate Action Plan[19] outlines a plan for resiliency that includes building stronger and safer infrastructure through agency support in investment, developing standards, and other measures, and was followed by an executive order[20] directing agencies to implement the plan. In January 2015, a Presidential executive order was issued[21] requiring that federal actions use natural systems and approaches where possible when developing adaptation alternatives for consideration. The executive order also redefined the floodplain elevation as either:

- Future projected levels;
- The level that results from adding 2 feet (or 3 feet for critical actions) to the current base flood elevation;
- The "500-year" elevation (elevation of the flood with 0.2 percent probability in any given year); or
- The level obtained via other methods yet to be developed.

USDOT is currently working with State Departments of Transportation (DOTs) and Metropolitan Planning Organizations (MPOs) to develop approaches to conduct climate change vulnerability and risk assessments of transportation infrastructure.

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[16] Nahlik et al. *Journal of Industrial Ecology*. Goods Movement Life Cycle Assessment for Greenhouse Gas Reduction Goals. May 2015.

[17] Horvath, A. *Int J Life Cycle Assessment.* 11: 229. doi:10.1065/lca2006.02.244 February 2006.

[18] The White House Council on Environmental Quality. *Progress Report of the Interagency Climate Change Adaptation Task Force: Federal Actions for a Climate Resilient Nation*. October, 2011.

[19] Executive Office of the President. *The President's Climate Action Plan*. June 2013.

[20] The White House. *Executive Order—Preparing the United States for the Impacts of Climate Change*. November 1, 2013.

[21] The White House. *Executive Order [13690]—Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*. January 30, 2015.

PROJECTED CHANGES IN CLIMATE IN THE STUDY AREA

Due to its low-lying topography and proximity to the mid-Atlantic coast, the State of Maryland is one of the most vulnerable states in the country to sea level rise. Tide gauge measurements show that Maryland has experienced approximately one-foot of sea level rise over the last century and impacts, such as increased coastal flooding, inundation of low-lying lands, more shoreline erosion, and salt-water intrusion, have been detected.[22] The Scientific and Technical Working Group to the Maryland Climate Change Commission[23] recommended that while it may be acceptable to use the "Best" projection of sea-level rise of 3.7 feet (end of century) for planning facilities or public infrastructure that would have a relatively short useful life (not extending beyond this century) or which could tolerate very occasional inundation, the "High" estimate of 5.7 feet may be more appropriate for investment in infrastructure or facilities with longer expected lifetimes or where there is a very low acceptance of any flooding risk. The Working Group also recommended that planners and engineers take into consideration anticipated changes in storm surge heights and tidal flood levels as a result of future sea-level rise.

Other changes potentially relevant to the Proposed Project would include temperature, wind, and precipitation. The Working Group found that

- Average temperature is projected to increase by approximately 3 degrees Fahrenheit (°F) by mid-century; the amount of warming later in the century is dependent on the mitigation of GHG emissions, with summer temperatures projected to increase by as much 9°F, and heat waves extending throughout most summers.
- Projections of precipitation are much less certain than those for temperature, but modest increases are more likely in the winter and spring. Because of more intermittent rainfall and increased evaporation with warmer temperatures, droughts lasting several weeks are projected to be more likely during the summer.

The Working Group did not provide specific projections for Maryland regarding wind. However, based on general projections for the region, it is possible that there would be an increase in the frequency and/or severity of severe storms, including high wind gust events.

RESILIENCE OF THE PROPOSED PROJECT TO CLIMATE CHANGE

Given the scope and anticipated 100-year lifespan of the proposed replacement bridges, and based on the above federal guidance, the most appropriate design flood elevation (DFE) for the Proposed Project would be the best available estimates for future end-of-century flood elevations—in the range of 3.7 to 5.7 feet above the current "100-year flood" elevation (the flood elevation with a probability of one percent of occurrence in any given year). Based on the current data from FEMA, the future 100-year flood elevation would range up to 13 feet NAVD88 over water in the center of the bridge, 11 feet NAVD88 on land in Havre de Grace, and 10 feet NAVD88 on land in Perryville.

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[22] State of Maryland, *Climate Change and Coast Smart Construction Infrastructure Siting and Design Guidelines*, January 2014.

[23] Boesch, et al. Updating Maryland's Sea-level Rise Projections. Special Report of the Scientific and Technical Working Group to the Maryland Climate Change Commission. University of Maryland Center for Environmental Science, Cambridge, MD, June 26, 2013.

The bridge itself would be designed to provide a 60-foot vertical clearance above MHW to reasonably meet current and future demand of the navigation traffic, and would, therefore, be well above the future potential flooding levels described above. This clearance would be reduced over time by sea level rise, estimated to be between 3.7 feet and 5.7 feet by the end of the century. The current moveable swing span provides a 52-foot vertical clearance above MHW in the closed position and a 127-foot vertical clearance in the open position, limited by overhead electric transmission lines. Based on a detailed navigation study,[24] the existing navigation channel addresses the needs of most mariners without requiring an opening, with only 3 to 11 openings per year since 2007. The proposed increase in vertical clearance, from 52 feet to 60 feet, may provide additional clearance for some vessels, which may be reduced in the future as the sea level rises. However, these few vessels do currently pass under the existing bridge at low tide, and could continue to do so in the future with the additional 8 feet of elevation. Overall, while there may be a small degradation in the benefit of additional clearance provided by the new bridge, the penalty for additional elevation beyond that considered for the Proposed Project would be substantial energy demand for freight moving across the bridge, and the need for additional property acquisition to design the approaches to a higher bridge.

The bridge approaches, landings, and track elevations modified or constructed by the Proposed Project would all be well above the above-mentioned flood elevations and, therefore, no special design considerations are necessary.

In addition to flooding, railways are potentially vulnerable to high temperatures and wind gusts. The Proposed Project would include auto-tensioned catenary designed to ensure that overhead electrical contact systems do not sag during heatwaves. Track design generally accounts for track buckling via design criteria—for the bridges criteria for structural steel temperature addresses a range of zero to 120°F. This generally prevents buckling even at rail temperatures of up to 150°F.[25] The bridge design will also accommodate changes in length of spans due to thermal movement. 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.[26] 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. 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 be unlikely to necessitate track design changes.[25]

Since there is currently no reliable indication that wind climate will substantially change, the bridge and catenary will be designed to resist wind based on the latest wind load design criteria.

Overall, 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. ✷

[24] HNTB for Amtrak. *Susquehanna River Bridge Project Navigation Study*. January 2014.

[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.

[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.