



I-495 & I-270 Managed Lanes Study

FINAL AIR QUALITY TECHNICAL REPORT

June 2022



U.S. Department
of Transportation

**Federal Highway
Administration**

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

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1 INTRODUCTION

1.1 Overview

The Federal Highway Administration (FHWA), as the Lead Federal Agency, and the Maryland Department of Transportation State Highway Administration (MDOT SHA), as the Local Project Sponsor, are preparing a Final Environmental Impact Statement (FEIS) in accordance with the National Environmental Policy Act (NEPA) for the I-495 & I-270 Managed Lanes Study (Study). The I-495 & I-270 Managed Lanes Study (Study) is the first environmental study under the broader I-495 & I-270 Public-Private Partnership (P3) Program.

This Final Air Quality Technical Report has been prepared to support the FEIS and focuses on the analysis of the Preferred Alternative. The Preferred Alternative, also referred to as Alternative 9 – Phase 1 South, includes building a new American Legion Bridge and delivering two high-occupancy toll (HOT) managed lanes in each direction on I-495 from the George Washington Memorial Parkway in Virginia to east of MD 187 on I-495, and on I-270 from I-495 to north of I-370 and on the I-270 eastern spur from east of MD 187 to I-270. Refer to **Figure 1-1**. This Preferred Alternative was identified after extensive coordination with agencies, the public and stakeholders to respond directly to feedback received on the DEIS to avoid displacements and impacts to significant environmental resources, and to align the NEPA approval with the planned project phased delivery and permitting approach.

The purpose of the Final Air Quality Technical Report is to present the existing conditions, an assessment of potential direct impacts of the Preferred Alternative to air quality and final mitigation, if applicable, for unavoidable impacts. This Final Air Quality Technical Report builds upon the analysis in the Draft Air Quality Technical Report, DEIS and Supplemental DEIS (SDEIS), and has been prepared to support and inform the FEIS.

1.2 Study Corridors and the Preferred Alternative

In the SDEIS, published on October 1, 2021, FHWA and MDOT SHA identified the Preferred Alternative: Alternative 9 – Phase 1 South to be consistent with the previously determined phased delivery and permitting approach, which focuses on Phase 1 South. As a result, Alternative 9 – Phase 1 South includes the same improvements proposed as part of Alternative 9 in the DEIS but focuses the build improvements within the Phase 1 South limits only. The limits of Phase 1 South are along I-495 from the George Washington Memorial Parkway to west of MD 187 and along I-270 from I-495 to north of I-370 and on the I-270 east and west spurs as shown in **dark blue** in **Figure 1-1**. The improvements include two new HOT managed lanes in each direction along I-495 and I-270 within the Phase 1 South limits. There is no action, or no improvements included at this time on I-495 east of the I-270 east spur to MD 5 (shown in **light blue** in **Figure 1-1**). While the Preferred Alternative does not include improvements to the remaining parts of I-495 within the Study limits, improvements on the remainder of the interstate system may still be needed in the future. Any such improvements would advance separately and would be subject to additional environmental studies and analysis and collaboration with the public, stakeholders and agencies.

The 48-mile corridor Study limits remain unchanged: I-495 from south of the George Washington Memorial Parkway in Fairfax County, Virginia, to west of MD 5 and along I-270 from I-495 to north of I-

370, including the east and west I-270 spurs in Montgomery and Prince George's Counties, Maryland (shown in both dark and light blue in **Figure 1-1**).

Figure 1-1: I-495 & I-270 Managed Lanes Study Corridors – Preferred Alternative



1.3 Description of the Preferred Alternative

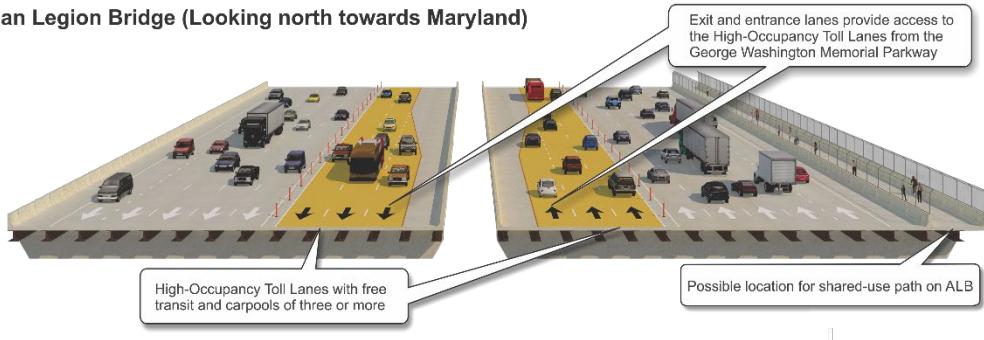
The Preferred Alternative includes a two-lane HOT managed lanes network on I-495 and I-270 within the limits of Phase 1 South only (**Figure 1-2**). On I-495, the Preferred Alternative consists of adding two, new HOT managed lanes in each direction from the George Washington Memorial Parkway to east of MD 187. On I-270, the Preferred Alternative consists of converting the one existing HOV lane in each direction to a HOT managed lane and adding one new HOT managed lane in each direction on I-270 from I-495 to north of I-370 and on the I-270 east and west spurs. There is no action, or no improvements included at this time on I-495 east of the I-270 east spur to MD 5. Along I-270, the existing collector-distributor (C-D) lanes from Montrose Road to I-370 would be removed as part of the proposed improvements. The managed lanes would be separated from the general purpose lanes using pylons placed within a four-foot wide buffer. Transit buses and HOV 3+ vehicles would be permitted to use the managed lanes toll-free.

Figure 1-2: Preferred Alternative Typical Sections (HOT Managed lanes Shown in Yellow)

I-495 from the George Washington Memorial Parkway to east of MD 187



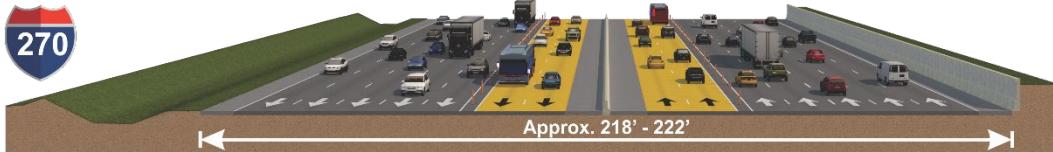
I-495: American Legion Bridge (Looking north towards Maryland)



I-495 east of MD 187 to west of MD 5 - NO ACTION AT THIS TIME



I-270 from I-495 to I-370



2 EXISTING CONDITIONS

2.1 Background

As required by the Clean Air Act and Amendments (CAA), the EPA sets the National Ambient Air Quality Standards (NAAQS) for airborne pollutants that have adverse impacts on human health and the environment, referred to as criteria pollutants. The criteria pollutants are carbon monoxide (CO), sulfur dioxide (SO₂), ozone (O₃), particulate matter (PM_{2.5} and PM₁₀), nitrogen dioxide (NO₂), and lead (Pb). In addition to the criteria pollutants for which there are NAAQS, EPA also regulates Mobile Source Air Toxics (MSATs). The nine priority MSATs are: benzene, 1,3-butadiene, formaldehyde, acrolein, acetaldehyde, diesel particulate matter, ethylbenzene, naphthalene, and polycyclic organic matter. Greenhouse gases (GHGs) are another pollutant monitored by EPA. The primary GHGs in the Earth's atmosphere are Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O), and Fluorinated Gases. The methodologies for assessing the pollutants are summarized in the **DEIS, Chapter 4, Section 4.8** and within the *Air Quality Technical Report (DEIS, Appendix I)*.

2.1.1 Attainment Status

The Study is located in Montgomery County, Maryland and Fairfax County, Virginia. The EPA Green Book¹ lists these counties as attainment for all NAAQS with the exception of the 2015 8-hour ozone standard, for which the counties are nonattainment. Since the area is designated attainment for fine particulate matter (PM_{2.5}), transportation conformity requirements pertaining to PM_{2.5} do not apply for this project² and no further analysis of PM_{2.5} emissions were evaluated per FHWA guidance.³

Since the Study is located in a region where the maintenance period for CO has expired, the CO NAAQS and EPA project-level ("hot-spot") transportation conformity requirements do not apply (**DEIS, Section 4.8.2**). However, CO is highlighted in the FHWA 1987 guidance as a transportation pollutant to be summarized in an EIS. Therefore, the DEIS presented the results of the potential impacts for CO at worst-case intersections throughout the study corridors. The methodologies and assumptions applied for the analysis are consistent with FHWA⁴ and EPA guidance.^{5,6} An updated traffic analysis on the Preferred Alternative was performed to determine the worst-case intersections and interchanges throughout the corridor. A discussion of the results of that analysis is presented in **Section 3.2**.

¹ <https://www.epa.gov/green-book>

² For background, the EPA issued a final rule (81 FR 58010), effective October 24, 2016, on "Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements" that stated, in part: "Additionally, in this document the EPA is revoking the 1997 primary annual standard for areas designated as attainment for that standard because the EPA revised the primary annual standard in 2012." (See: <https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf>). Accordingly, Fairfax County is no longer designated as maintenance for PM_{2.5}, and the associated USEPA regulatory requirements for conformity for PM_{2.5} are eliminated for northern Virginia.

³ Guidance for Preparing and Processing Environmental and Section 4(f) Documents October 30, 1987. <https://www.environment.fhwa.dot.gov/projdev/impTA6640.asp>

⁴ <https://www.environment.fhwa.dot.gov/projdev/impTA6640.asp>

⁵ <https://www3.epa.gov/scram001/guidance/guide/coguide.pdf>

⁶ <https://nepis.epa.gov/Exe/ZyPdF.cgi?Dockey=P100M2FB.pdf>

3 ENVIRONMENTAL CONSEQUENCES

3.1 Regional Conformity

Since the study area is designated as non-attainment for the 2015 ozone standard, there must be a currently conforming transportation plan and program at the time of project approval, and the project must come from a conforming plan and program (or otherwise meet criteria specified in 40 CR 93.109(b)).

The Study is currently included in the NCRTPB Fiscal Year (FY) 2019 – 2024 TIP [TIP ID 6432 and Agency ID AW0731 (planning activities)]⁷ and the NCRTPB Visualize 2045 Long Range Plan (CEID 1182, CEID 3281, and Appendix B page 56)⁸. This Study is included in the Air Quality Conformity Determination⁹ that accompanies the Visualize 2045 Plan. The Visualize 2045 Air Quality Analysis is based upon the latest planning assumptions available for the Washington region. The analysis used MOVES2014a, the latest emission factor model specified by EPA for use in preparation of state implementation plans and conformity assessments at the time of analysis.

As part of the conformity requirements, consultation with affected agencies such as the EPA, FHWA, FTA, and the Metropolitan Washington Air Quality Committee (MWAQC), as well as with the public was completed. 23 CFR 450.324(c) requires that The Metropolitan Planning Organization review and update the transportation plan at least every 4 years in air quality nonattainment and maintenance areas to confirm the transportation plan's validity and consistency with current and forecasted transportation and land use conditions and trends and to extend the forecast period to at least a 20-year planning horizon¹⁰. The National Capital Region Transportation Planning Board (TPB) is currently updating the Visualize 2045 plan, to be completed in 2022. The design concept and scope for the Preferred Alternative, which is not significantly different than that included in the current version of Visualize 2045, will be included in the Air Quality Conformity analysis accompanying the update to Visualize 2045 which will be approved in 2022.

3.2 Carbon Monoxide Analysis

Since the Study is located in a region that is attainment of the NAAQS for CO, only NEPA applies; EPA project level ("hot-spot") transportation conformity requirements do not apply. The Maryland counties were redesignated from a nonattainment area to attainment and entered a 20-year maintenance period for CO in March 1996. The area was considered a maintenance area for the 20 years following until March 2016 when the counties completed the maintenance period. Since the Maryland counties have completed the maintenance period, transportation conformity no longer applies for CO. Similarly, Fairfax County is designated attainment for CO. In addition, as discussed in **Section 2.1.1**, CO is highlighted in the FHWA 1987 guidance as a transportation pollutant to be summarized in an EIS. A CO analysis is not required for conformity since the study area is designated as maintenance for CO, however, since CO is a proxy for transportation emissions, potential impacts for CO were still analyzed for transparency under NEPA for

⁷ ¹⁹ FY 2019 – 2024 Transportation Improvement Program for the National Capital Region. October 17, 2018.

<https://www.mwcog.org/visualize2045/document-library/>

⁸ ²⁰ Visualize 2045: A Long-Range Transportation Plan for the National Capital Region. October 17, 2018.

<https://www.mwcog.org/visualize2045/document-library/>

⁹ ²¹ Air Quality Conformity Analysis of Visualize 2045 and the FY 2019 – 2024 Transportation Improvement Program. October 17, 2018. <https://www.mwcog.org/visualize2045/document-library/>

¹⁰ [https://ecfr.federalregister.gov/current/title-23/chapter-I/subchapter-E/part-450#p-450.324\(c\)](https://ecfr.federalregister.gov/current/title-23/chapter-I/subchapter-E/part-450#p-450.324(c))

affected intersections and interchanges impacted by the Study. See DEIS Air Quality Technical Report **Section 3.2** for methodology.

An updated traffic analysis to determine the worst-case intersections and interchanges (using maximum peak hour volume and maximum peak hour delay) associated with the Preferred Alternative throughout the corridors was performed. The detailed results of that analysis are included in **Appendix A**. The results of the traffic study showed that, although some interchanges and intersections that were identified as being worst case in the updated analysis differed from the analysis included in the DEIS, overall, the maximum peak hour volumes and maximum peak hour delays were less than those for the top three intersections and interchanges used in the DEIS analysis. For this reason, the DEIS analysis can still be assumed to have projected worst-case emissions and that the project would not cause or contribute to a violation of the CO NAAQS.

3.3 MSAT Analysis

Because the Preferred Alternative includes no action for the majority of the study area, the affected network was updated to focus on just those segments near the project area using the FHWA suggested methodology for determining segments with meaningful changes resulting from the proposed improvements. Based on the traffic analysis associated with the Preferred Alternative, fewer links met the affected network criteria compared to the Alternatives analyzed in the DEIS, which reduced the footprint of the affected area. The updated affected network was developed using the updated Regional Travel Demand Forecast Metropolitan Washington Council of Governments (MWCOG) Regional Travel Demand Model for the Preferred Alternative in 2025 and 2045 analysis years. The results of an updated MSAT analysis using traffic data derived from this affected network are presented below.

3.3.1 MSAT Modeling Methodology

The methodology for the updated MSAT analysis is consistent with the MSAT modeling methodology described in the DEIS with the following exceptions:

- The latest version of the EPA MOVES model (MOVES3.0.1) was used which includes updated onroad exhaust emission rates, including HD GHG Phase 2 and Safer Affordable Fuel Efficiency (SAFE) rules, updated onroad activity, vehicle populations and fuels, added gliders and off-network idle, and revised inputs for hotelling and starts.
- Revised Affected Network for the Existing, Interim and Design Year Build and No Build conditions to reflect a smaller project area compared to the previous Affected Network in the DEIS along with a revised Design Year of 2045 (compared to 2040 in the DEIS); and
- Revised MOVES data manager files from MWCOG for the Affected Network.

In accordance with the latest MSAT guidance, the Study is still best characterized as one with “higher potential MSAT effects” since the projected Design Year traffic is still expected to reach the 140,000 to 150,000 AADT criteria.

3.3.2 Affected Network

The MSAT analysis reflects the updated affected network from the DEIS for the Preferred Alternative to focus on just those segments within and near the project area using the traffic for the Preferred Build Alternative and the FHWA suggested methodology for determining segments with meaningful changes.

A. Previously Developed Affected Network

The affected network in the DEIS and Air Quality Technical Report (AQTR) was developed using procedures identified in the FHWA guidance and the Frequently Asked Questions (FAQ) Conducting Quantitative MSAT Analysis for FHWA NEPA Documents¹¹ for identifying segments within the traffic study area where meaningful changes were expected. One of more of the following criterion was used to develop the Affected Network for the FEIS:

- Changes of $\pm 5\%$ or more in AADT on congested highway links of LOS D or worse
- Changes of $\pm 10\%$ or more in AADT on uncongested highway links of LOS C or better
- Changes of $\pm 10\%$ or more in travel time
- Changes of $\pm 10\%$ or more in intersection delay

For background, the criteria listed above were applied to the Metropolitan Washington Council of Governments (MWCOG) regional forecasting model for the 2040 design year, which was the latest model year available at the time the DEIS was initiated. This same model was used as the basis for all traffic forecasting and operational analysis in the DEIS. For the original network, all the criteria were applied, and no modeling artifacts were eliminated from the selected network. The resulting network that was included in the AQTR and the DEIS is shown below in **Figure 3-1**. Additional detail on the MWCOG model is described in the DEIS.

¹¹ Federal Highway Administration. *Frequently Asked Questions Conducting Quantitative MSAT Analysis for FHWA NEPA Documents*. November 7, 2017.

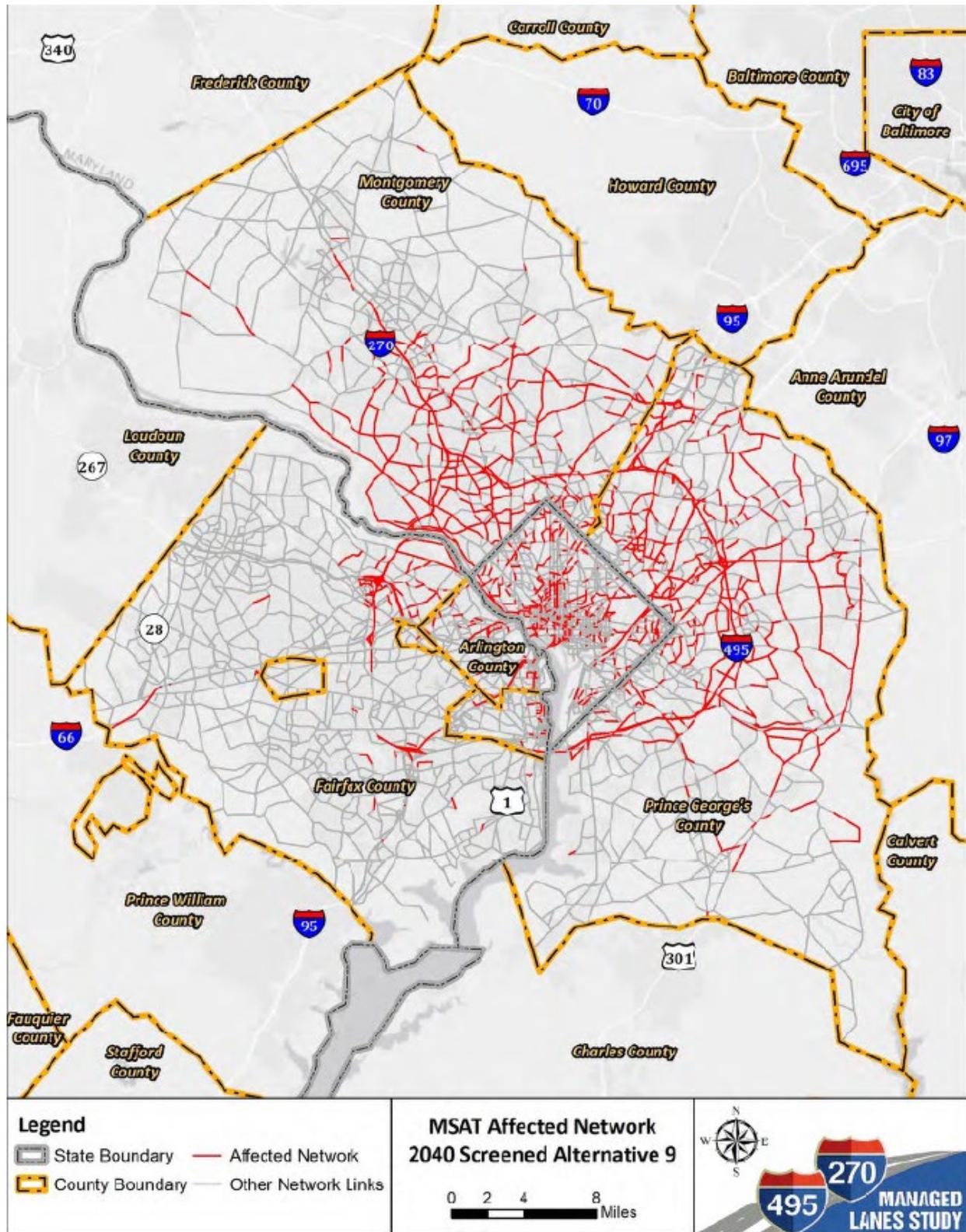


Figure 3-1: MSAT Affected Network Used in DEIS (2040 Design Year)

B. Updated Affected Network

For the FEIS, an updated version of the MWCOG model with projections out an additional five years to the year 2045 was used to develop the affected network. This updated MWCOG model is the basis for all traffic forecasting and operational analysis in the FEIS for the Preferred Alternative. Similar to the DEIS, the MWCOG model initially resulted in a relatively large affected network area. In consultation with FHWA, additional steps were taken to reduce the footprint of the affected network area to make it more consistent with the Preferred Alternative study area. These included eliminating the travel time criterion and removing modeling artifacts.

Eliminate Travel Time Criterion

The project team determined that the application of the travel time criterion was introducing many additional links to the study area that were far removed from the actual geometric changes proposed under the project. Eliminating the travel time criterion from the analysis significantly reduced the footprint of the affected network area.

Remove Artifacts

A final step was taken to refine the revised affected network further by removing modeling artifacts which were defined as non-contiguous flagged links which were not considered meaningful from the Preferred Alternative study area.

Figure 3-2 thru Figure 3-4 show the resultant affected network that was used in the MSAT modeling analysis for the FEIS for the 2016, 2025, and 2045 conditions, respectively. This reflects a more focused corridor-based study area consistent with the NEPA study area (rather than a regional study area) compared to the DEIS. The affected network better represents the actual impacts of the proposed improvements.

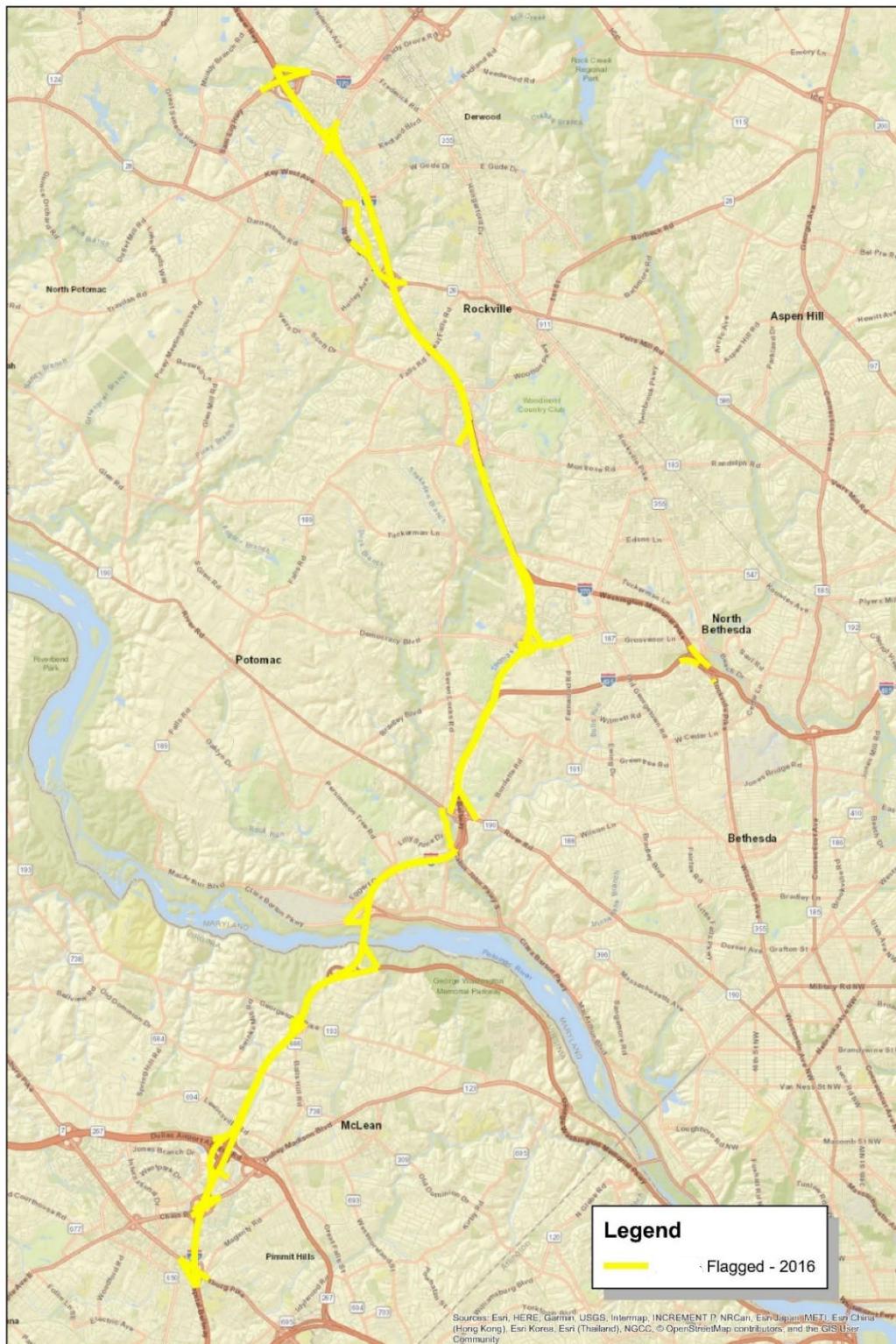


Figure 3-2: FEIS MSAT Affected Network (2016)

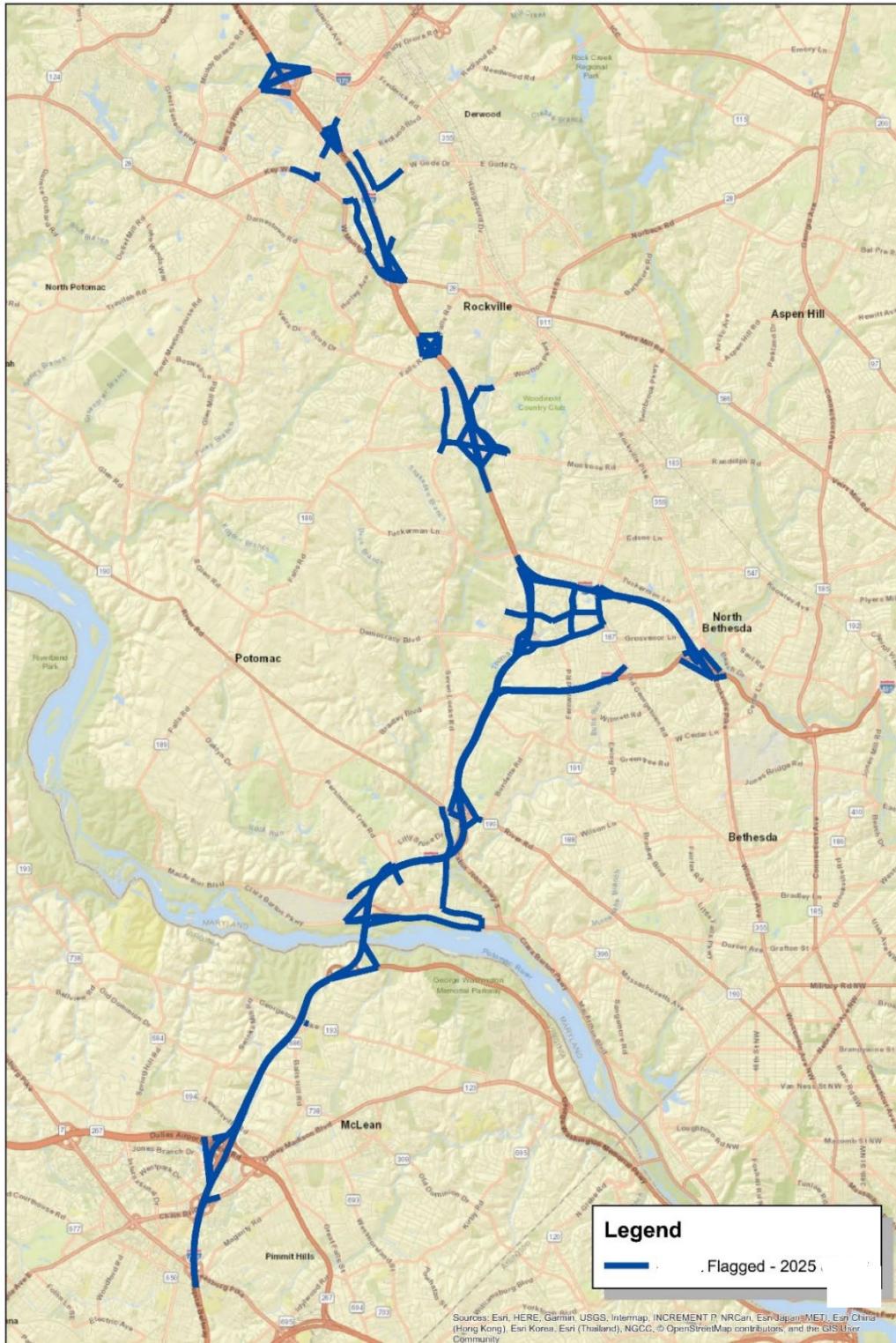


Figure 3-3: FEIS MSAT Affected Network (2025)

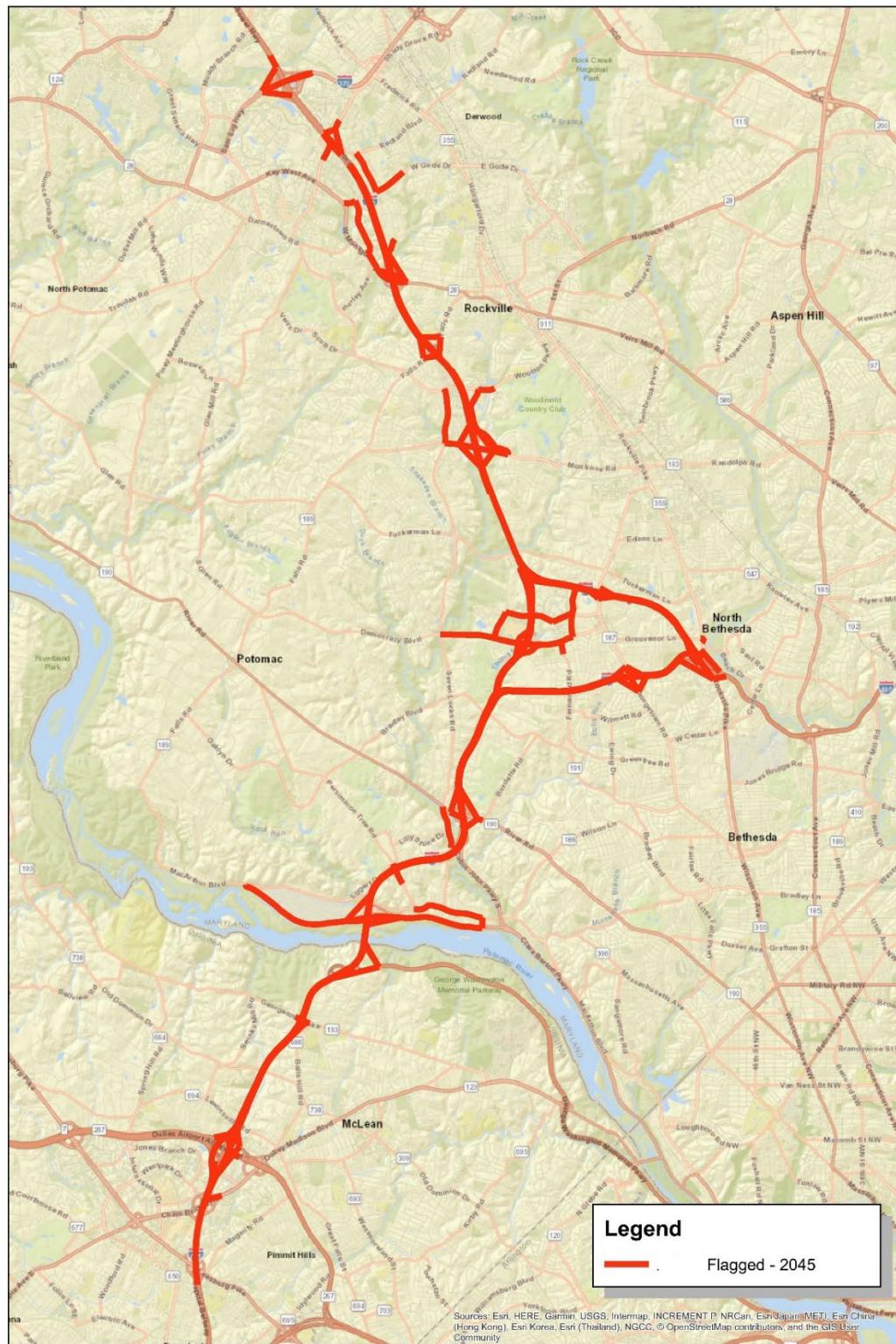


Figure 3-4: FEIS MSAT Affected Network (2045)

The latest version of the EPA MOVES model (MOVES3 Version 3.0.1) was run for each Affected Network using project specific traffic data developed for the Preferred Alternative consistent with the overall project traffic analysis as noted above. MOVES3 is an update to the previous version MOVES2014b which was used in the DEIS and includes many updates to exhaust emission rates to better estimate the real-world emissions of new vehicle technologies. “Compared to the previous MOVES2014 modeling tool, MOVES3 allows users to model the benefits from new regulations promulgated since MOVES2014 was released, incorporates the latest emissions data, and has improved functionality”. Some of the major updates include new regulations such as:

- Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2; and
- Safer Affordable Fuel Efficient (SAFE) Vehicles Rule.

The MOVES RunSpec Inputs and County Data Manager are essentially unchanged from the DEIS, except that the Design Year of 2045 was run and updated MWCOG MOVES files were used for the County Data Manager database along with revised traffic project data for the Preferred Alternative. The MSAT regional emission trends (**DEIS, Appendix I, Section 3.4.2**) and MSAT health impact analysis (**DEIS, Appendix I, Section 3.4.4**) also remain unchanged from the DEIS.

3.3.3 MSAT Results

The results of the quantitative MSAT analysis for the Preferred Alternative Existing, Build and No Build conditions are presented in **Table 3-1**. Projected change in emissions for the Preferred Alternative compared to the 2025 and 2045 No Build conditions are provided in **Table 3-2** and **Table 3-3**, respectively. A graphical representation of the projected annual MSAT emissions for the base year and 2025 and 2045 No Build and Preferred Alternative by pollutant are presented in **Figure 3-5** through **Figure 3-13**. These tables and figures show that in general, all MSAT pollutant emissions are expected to increase slightly for the Preferred Alternative when compared to the No Build condition for 2025 and 2045. All MSAT pollutant emissions are expected to significantly decline in the Opening (average 72.9% decrease) and Design (average 89.29% decrease) years when compared to Existing conditions. These long-term reductions occur despite projected increase in VMT from 2016 to the 2025 and 2045 Build scenarios.

Table 3-1: Projected Annual MSAT Emissions (Tons Per Year) on Affected Network

Projected Annual MSAT Emissions in Tons Per Year (TPY) on Affected Network		Annual Vehicle Miles Traveled (Million AVMT)	Acrolein (TPY)	Benzene (TPY)	1,3 Butadiene (TPY)	Diesel PM (TPY)	Formaldehyde (TPY)	Naphthalene (TPY)	Polycyclic Organic Matter (TPY)	Acetaldehyde (TPY)	Ethylbenzene (TPY)	Total TPY
2016 Base Year	Preferred Alternative	1,359.5	0.42	3.87	0.43	35.9	5.9	0.67	0.31	3.11	2.28	52.89
2025 Opening Year	Preferred Alternative	1,444.4	0.10	1.35	0.08	7.83	1.51	0.15	0.06	0.96	1.01	13.05
	No Build	1,364.6	0.09	1.30	0.08	7.45	1.46	0.14	0.06	0.92	0.98	12.48
2045 Design Year	Preferred Alternative	1,801.5	0.04	0.66	0.05	2.56	0.49	0.03	0.01	0.46	0.68	4.98
	No Build	1,674.4	0.03	0.62	0.05	2.4	0.46	0.03	0.01	0.43	0.64	4.67

Table 3-2: Projected Annual MSAT Change in Emissions on Affected Network

Projected Annual MSAT Change in Emissions on Affected Network		Annual Vehicle Miles Traveled (Million AVMT)	Acrolein (TPY)	Benzene (TPY)	1,3 Butadiene (TPY)	Diesel PM (TPY)	Formaldehyde (TPY)	Naphthalene (TPY)	Polycyclic Organic Matter (TPY)	Acetaldehyde (TPY)	Ethylbenzene (TPY)	Total TPY
2025 Opening Year	Difference (Preferred Alternative - Base)	84.9	-0.32	-2.53	-0.35	-28.1	-4.46	-0.52	-0.24	-2.16	-1.27	-39.95
	Difference (Preferred Alternative - No Build)	79.8	0.003	0.05	0.003	0.38	0.048	0.005	0.002	0.03	0.03	0.551
2045 Design Year	Difference (Preferred Alternative - Base)	442	-0.38	-3.21	-0.43	-33.4	-5.48	-0.64	-0.29	-2.66	-1.61	-48.1
	Difference (Preferred Alternative - No Build)	127.1	0.002	0.038	0.001	0.157	0.03	0.002	0.001	0.02	0.03	0.281

Table 3-3: Projected Annual MSAT Percent Change in Emissions on Affected Network

Projected Annual MSAT Percent Change in Emissions on Affected Network		Annual Vehicle Miles Traveled (Million AVMT)	Acrolein	Benzene	1,3 Butadiene	Diesel PM	Formaldehyde	Naphthalene	Polycyclic Organic Matter	Acetaldehyde	Ethylbenzene
2025 Opening Year	Percent Difference (Preferred Alternative - Base)	6.24%	-75.7%	-65.2%	-80.8%	-78.2%	-74.7%	-77.9%	-78.6%	-69.3%	-55.7%
	Percent Difference (Preferred Alternative - No Build)	5.85%	3.3%	3.77%	3.54%	5.08%	3.29%	3.35%	3.69%	3.46%	3.15%
2045 Design Year	Percent Difference (Preferred Alternative - Base)	32.5%	-91.49%	-82.9%	-98.8%	-92.9%	-91.8%	-94.9%	-95.1%	-85.3%	-70.4%
	Percent Difference (Preferred Alternative - No Build)	7.6%	5.4%	6.0%	4.7%	6.5%	5.7%	6.0%	6.1%	5.4%	5.13%

In general:

- For each MSAT, the long-term trend in emissions is downward. The downward trend in emissions is a result of technological improvements (i.e., more stringent vehicle emission and fuel quality standards coupled with ongoing fleet turnover) and is achieved despite increased VMT in this period.
- For each MSAT, the differences in forecast emissions for Build and No Build are relatively small, especially compared to the long-term downward trend in emissions for each MSAT.
- The Preferred Alternative conditions are expected to result in significant reductions in all MSATs compared to the Base Year in both the Opening and Design years as shown in **Table 3-1** through **Table 3-3**.

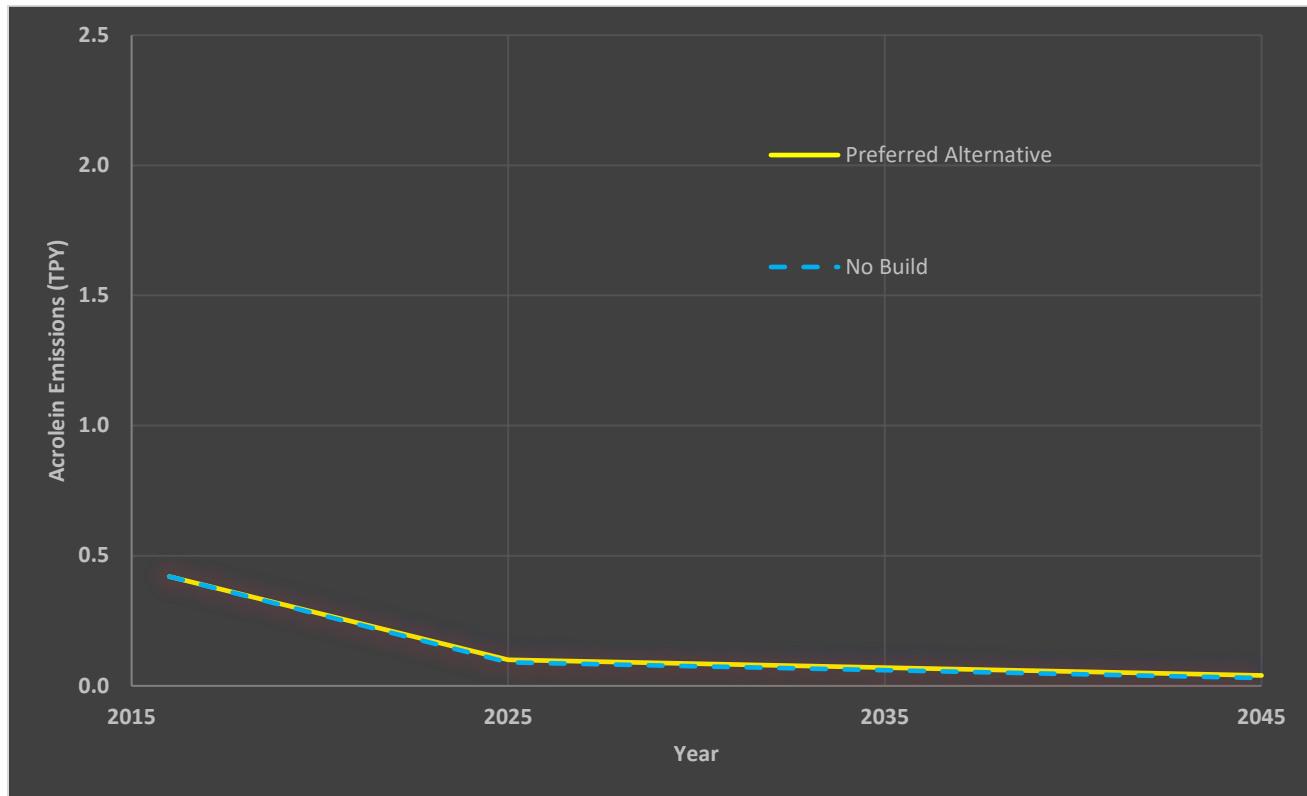


Figure 3-5: Acrolein MSAT Annual Emissions for Base, Opening, and Design Year Conditions

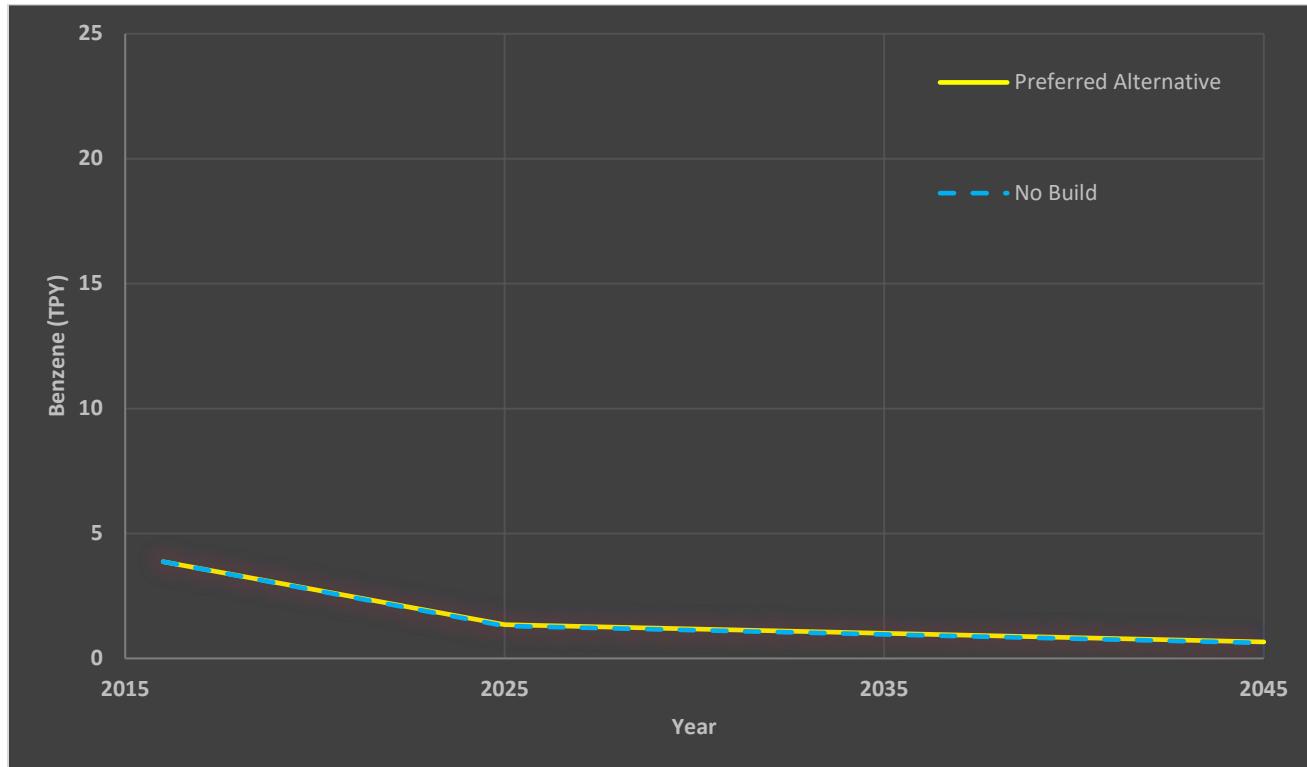


Figure 3-6: Benzene MSAT Annual Emissions for Base, Opening, and Design Year Conditions

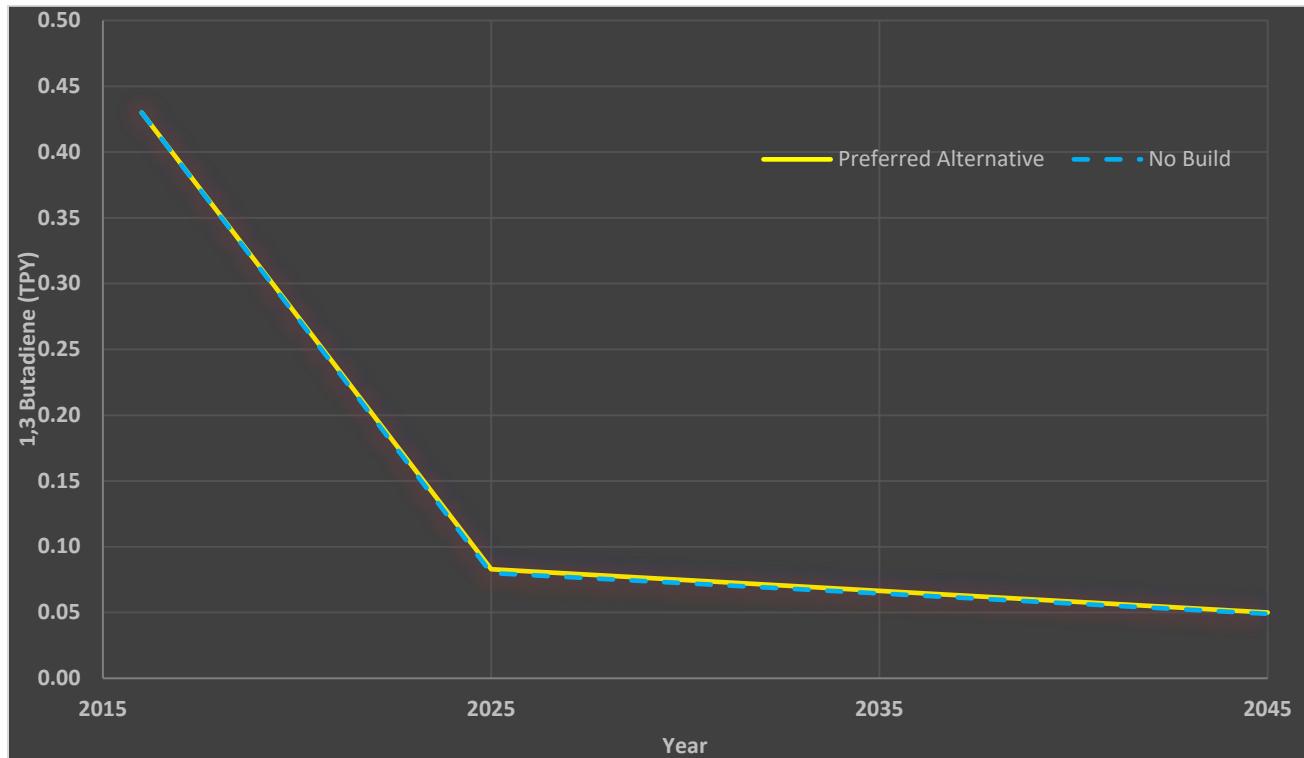


Figure 3-7: 1,3 Butadiene MSAT Annual Emissions for Base, Opening, and Design Year Conditions

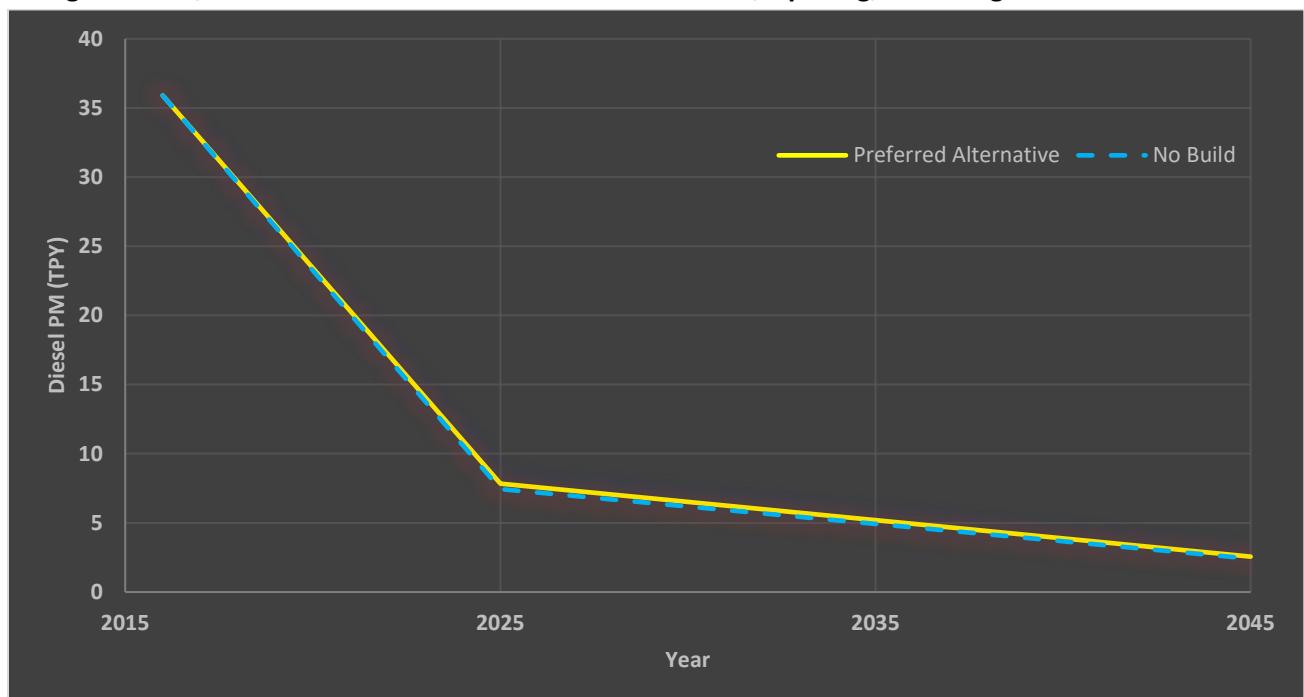


Figure 3-8: Diesel MSAT Annual Emissions for Base, Opening, and Design Year Conditions

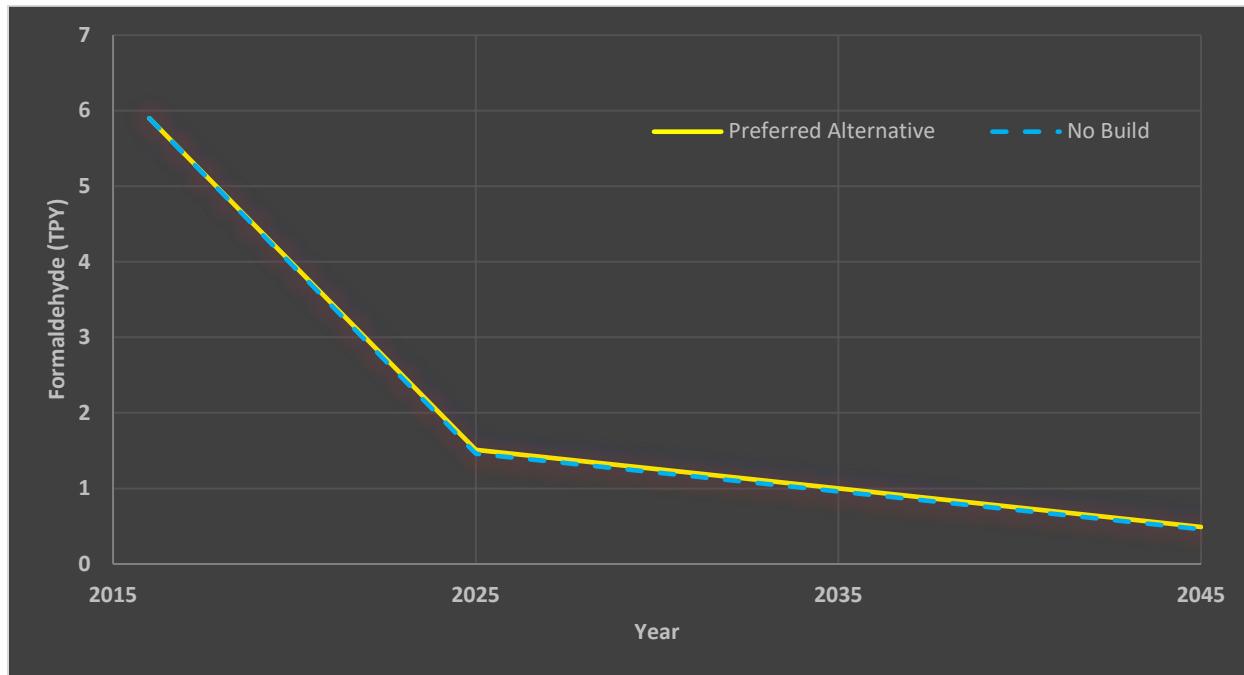


Figure 3-9: Formaldehyde MSAT Annual Emissions for Base, Opening, and Design Year Conditions

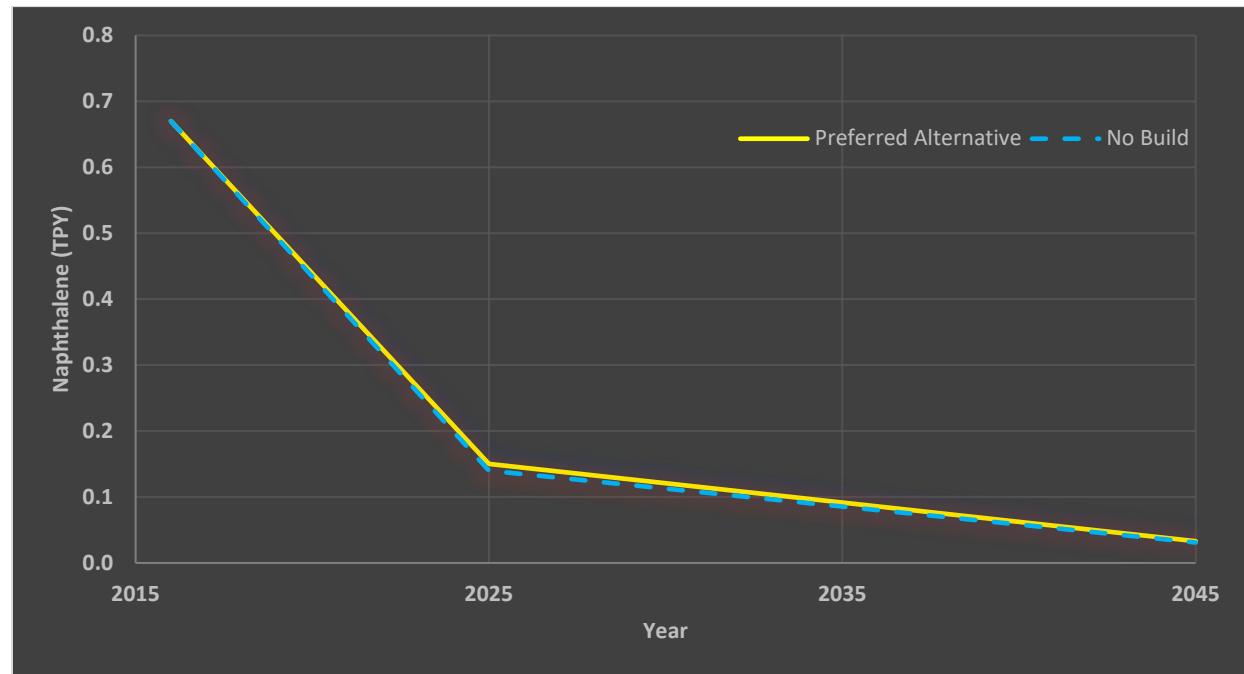


Figure 3-10: Naphthalene MSAT Annual Emissions for Base, Opening, and Design Year Conditions

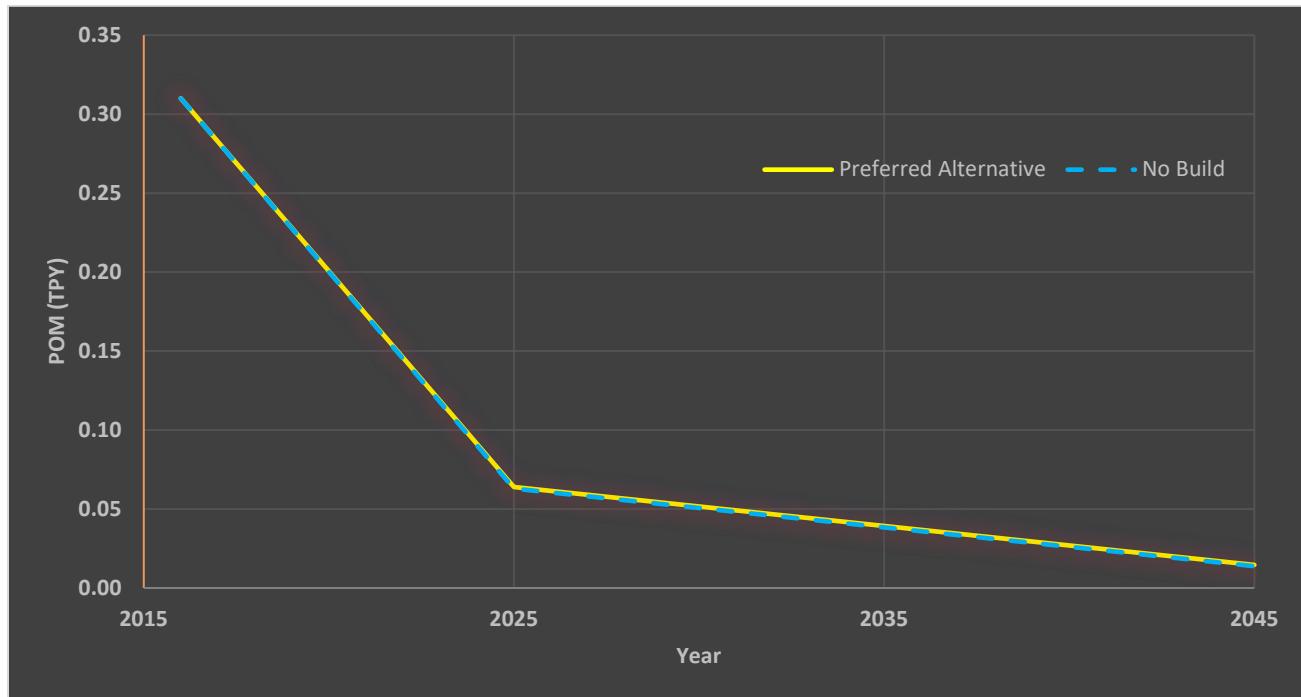


Figure 3-11: Polycyclic Organic Matter MSAT Annual Emissions for Base, Opening, and Design Year Conditions

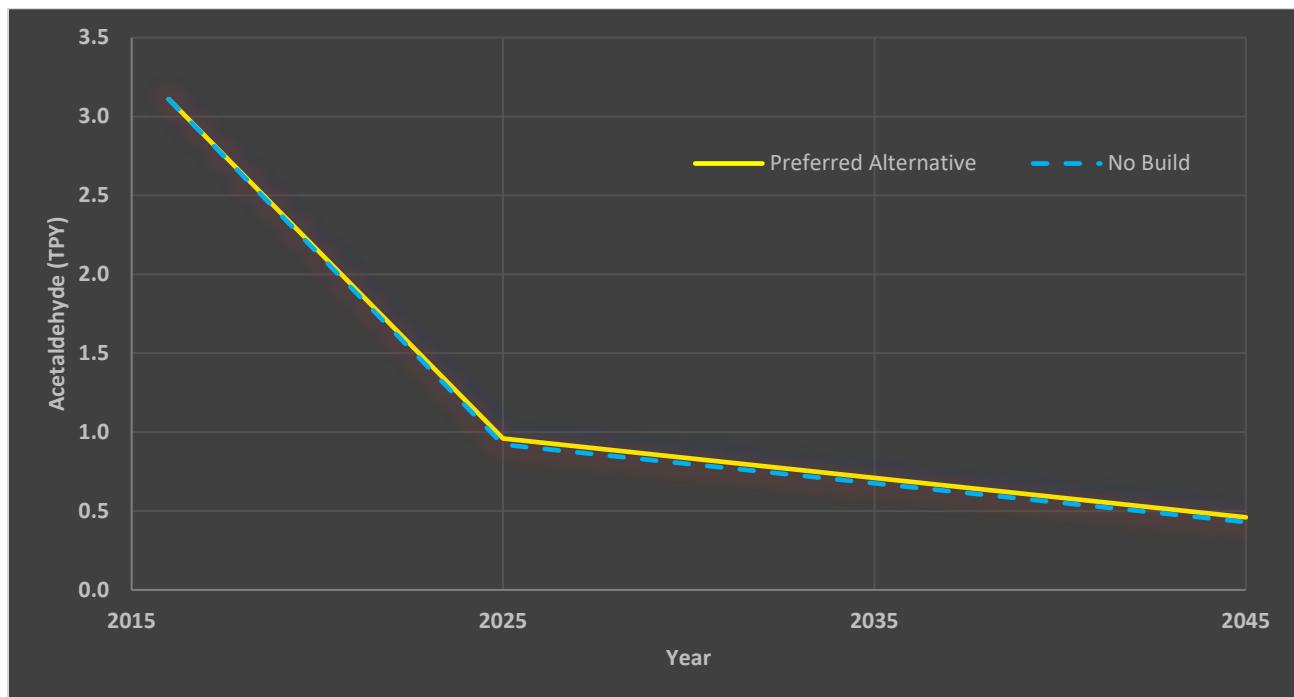


Figure 3-12: Acetaldehyde MSAT Annual Emissions for Base, Opening, and Design Year Conditions

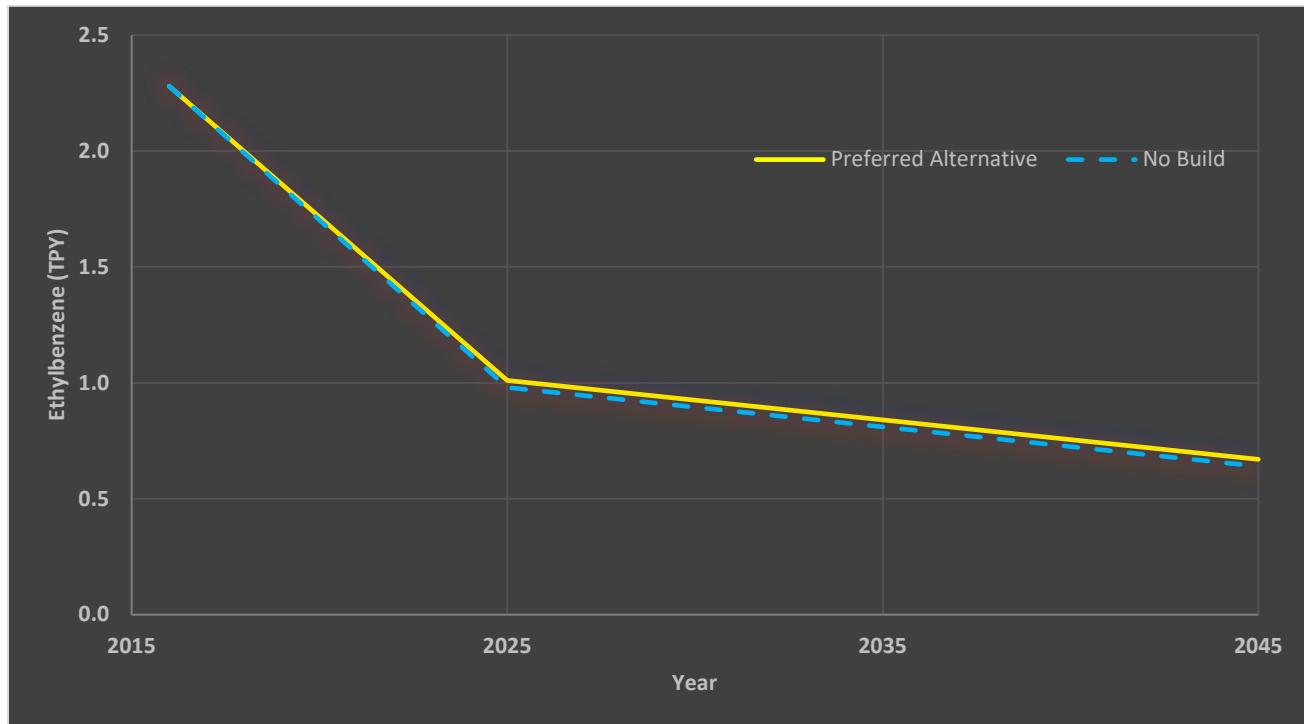


Figure 3-13: Ethylbenzene MSAT Annual Emissions for Base, Opening, and Design Year Conditions

3.3.4 Incomplete or Unavailable Information for Project Specific MSAT Health Impacts Analysis

Information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in MSAT emissions associated with a proposed set of highway alternatives.¹² The outcome of such an assessment, adverse or not, would be influenced more by the uncertainty introduced into the process through assumption and speculation rather than any genuine insight into the actual health impacts directly attributable to MSAT exposure associated with a proposed action.

The EPA is responsible for protecting the public health and welfare from any known or anticipated effect of an air pollutant. They are the lead authority for administering the CAA and its amendments and have specific statutory obligations with respect to hazardous air pollutants and MSAT. The EPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. They maintain the IRIS, which is “a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects” (EPA, <https://www.epa.gov/iris/>). Each report contains assessments of non-cancerous and cancerous effects for individual compounds and quantitative estimates of risk levels from lifetime oral and inhalation exposures with uncertainty spanning perhaps an order of magnitude.

¹² Appendix C, Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents. October 18, 2016. https://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat/page03.cfm

Other organizations are also active in the research and analyses of the human health effects of MSAT, including the Health Effects Institute (HEI). A number of HEI studies are summarized in Appendix D of FHWA's Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents. Among the adverse health effects linked to MSAT compounds at high exposures are: cancer in humans in occupational settings; cancer in animals; and irritation to the respiratory tract, including the exacerbation of asthma. Less obvious is the adverse human health effects of MSAT compounds at current environmental concentrations (HEI Special Report 16, <https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects>) or in the future as vehicle emissions substantially decrease.

The methodologies for forecasting health impacts include emissions modeling; dispersion modeling; exposure modeling; and then final determination of health impacts – each step in the process building on the model predictions obtained in the previous step. All are encumbered by technical shortcomings or uncertain science that prevents a more complete differentiation of the MSAT health impacts among a set of project alternatives. These difficulties are magnified for lifetime (i.e., 70 year) assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over that time frame, since such information is unavailable.

It is particularly difficult to reliably forecast 70-year lifetime MSAT concentrations and exposure near roadways; to determine the portion of time that people are actually exposed at a specific location; and to establish the extent attributable to a proposed action, especially given that some of the information needed is unavailable.

There are considerable uncertainties associated with the existing estimates of toxicity of the various MSAT, because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by HEI (Special Report 16, <https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects>). As a result, there is no national consensus on air dose-response values assumed to protect the public health and welfare for MSAT compounds, and in particular for diesel PM. The EPA states that with respect to diesel engine exhaust, “[t]he absence of adequate data to develop a sufficiently confident dose-response relationship from the epidemiologic studies has prevented the estimation of inhalation carcinogenic risk (<https://www.epa.gov/iris>).”

There is also the lack of a national consensus on an acceptable level of risk. The current context is the process used by the EPA as provided by the CAA to determine whether more stringent controls are required in order to provide an ample margin of safety to protect public health or to prevent an adverse environmental effect for industrial sources subject to the maximum achievable control technology standards, such as benzene emissions from refineries. The decision framework is a two-step process. The first step requires EPA to determine an “acceptable” level of risk due to emissions from a source, which is generally no greater than approximately 100 in a million. Additional factors are considered in the second step, the goal of which is to maximize the number of people with risks less than 1 in a million due to emissions from a source. The results of this statutory two-step process do not guarantee that cancer risks from exposure to air toxics are less than 1 in a million; in some cases, the residual risk determination could result in maximum individual cancer risks that are as high as approximately 100 in a million. In a June 2008

decision, the US Court of Appeals for the District of Columbia Circuit upheld EPA's approach to addressing risk in its two-step decision framework. Information is incomplete or unavailable to establish that even the largest of highway projects would result in levels of risk greater than deemed acceptable.¹³

Because of the limitations in the methodologies for forecasting health impacts described, any predicted difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with predicting the impacts. Consequently, the results of such assessments would not be useful to decision makers, who would need to weigh this information against project benefits, such as reducing traffic congestion, accident rates, and fatalities plus improved access for emergency response, that are better suited for quantitative analysis.

3.3.5 MSAT Conclusions

What is known about mobile source air toxics is still evolving. Information is currently incomplete or unavailable to credibly predict the study-specific health impacts due to changes in MSAT emissions associated with each of the study Alternatives. Under the Preferred Alternative, there may be slightly higher MSAT emissions in the design year relative to the No Build Alternative due to increased VMT. However, lower MSAT levels are expected in the future compared to existing conditions due to cleaner engine standards coupled with fleet turnover. The magnitude of the EPA-projected reductions is so great that, even after accounting for VMT growth, MSAT emissions in the study area would be significantly lower in the future than they are today.

3.4 Greenhouse Gas Analysis

GHG emissions are different from criteria air pollutants since their effects are in the global atmosphere rather than localized. Greenhouse gas emissions from vehicles using roadways are a function of distance traveled (expressed as vehicle miles traveled (VMT)), vehicle speed, and road grade.

To date, no GHG emissions NAAQS have been established by the EPA and there is no approved regulatory requirement that has been established to analyze these emissions at a project level for transportation projects. However, based on the President's recent Executive Order¹⁴, the project's impacts on greenhouse gas (GHG) emissions and climate change should be documented in the Environmental Assessment (EA) consistent with the 2016 Council of Environmental Quality (CEQ) Final GHG NEPA guidance¹⁵. In order to meet the 2016 CEQ guidance, a quantitative GHG assessment was conducted consistent with the 2016 final CEQ guidance¹⁶ and covers GHG emissions.

3.4.1 Updated Affected Network for Greenhouse Gas Analysis

¹³ [https://www.cadc.uscourts.gov/internet/opinions.nsf/284E23FFE079CD59852578000050C9DA/\\$file/07-1053-1120274.pdf](https://www.cadc.uscourts.gov/internet/opinions.nsf/284E23FFE079CD59852578000050C9DA/$file/07-1053-1120274.pdf)

¹⁴ Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis". January 20, 2021.

¹⁵ Memorandum for Heads of Federal Departments and Agencies from Christina Goldfuss, Council on Environmental Quality. "Final guidance for Federal Departments and Agencies on Greenhouse Gas Emissions and the Effect of Climate Change in the National Environmental and Policy Act Reviews". August 1, 2016

¹⁶ <https://www.federalregister.gov/documents/2016/08/05/2016-18620/final-guidance-for-federal-departments-and-agencies-on-consideration-of-greenhouse-gas-emissions-and>

For the FEIS, an updated version of the MWCOG model with projections out an additional five years to the year 2045 was used to develop the affected network for the MSAT analysis. This updated MWCOG model is the basis for all traffic forecasting and operational analysis in the FEIS for the Preferred Alternative. The affected network for purposes of the MSAT review was constrained to only the interstate system and immediate roadway links related to the reduced limits of the build improvements under the Preferred Alternative. The reduced affected network for the MSAT analysis was developed in consultation with FHWA to make it more consistent with the Preferred Alternative study area and in recognition that for the purpose of an MSAT analysis, those pollutants are measured at a project level.

Due to the global atmospheric impacts of GHG and the lack of an approved method for evaluating GHG at the project level, the Project has analyzed GHG within MSAT affected network as well as a broader more appropriate level for GHG. The traffic analysis finalized for the Preferred Alternative shows a less than 1% increase in VMT for the project overall. The affected network for purposes of analyzing MSATs for the Preferred Alternative is only a subset of the larger regional transportation network. Specifically, this analysis focused on the areas likely to experience meaningful changes in traffic as a result of the proposed improvements. The reduced affected network assumed for the MSAT review shows an increase in VMT as traffic is pulled from the local roadway network onto the interstate system due to the additional capacity. It does not account for the reduction in VMT from that local roadway network. Refer to **Section 3.3.2** for the details on development of the reduced affected network.

Figure 3-2 thru **Figure 3-4** show the resultant affected network that was used in the MSAT modeling analysis for the FEIS for the 2016, 2025, and 2045 conditions, respectively. This reflects a more focused corridor-based study area consistent with the NEPA study area (rather than a regional study area) compared to the DEIS. Since there is no approved methodology for conducting a project-level quantitative Greenhouse Gas emissions analysis, there are numerous parameters that could be applied to conduct this review. Consistent with guidance on developing an affected network to analyze project-related pollutants, such as MSATs, MDOT SHA analyzed GHG emissions using the same affected network as the MSAT analysis. This definition of the affected network, however, is likely extremely conservative, as GHG emissions are most commonly considered on a regional or even broader level.

GHG emissions for the Existing, Opening and Design year Preferred Build and No Build Alternative were estimated consistent with the MSAT methodology discussed in Section 3.3.1, and include carbon dioxide equivalent (CO₂e) and its constituent pollutants as included in the latest MOVES version 3.0.1. As discussed above, the latest version of MOVES specific to GHG includes regulatory updates:

- Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2; and
- Safer Affordable Fuel Efficient (SAFE) Vehicles Rule

To evaluate VMT for the Preferred Alternative, the VMT derived from the MSAT Affected Network for (refer to **Section 3.3.2**) was used to characterize the VMT changes for the GHG discussion. As noted above, this MSAT methodology is a very conservative approach for estimating GHG emissions given that they are considered a regional, even global pollutant. MSATs are considered more localized pollutants and the guidance for developing the affected network is specific to MSATs. The links identified in the Affected Network in **Section 3.3.2** include only roadway links that could significantly impact the study area. The

results of the quantitative GHG analysis are presented in **Table 3-4** while the change in emissions in tons per year (TPY) are presented in **Table 3-5** for the 2025 and 2045 Preferred Alternative and No Build conditions. A graphical representation of the projected annual GHG related emissions for the Base year, 2025 and 2045 No Build and Preferred Alternative by pollutant are presented in **Figure 3-14** through **Figure 3-19**. The analysis shows GHG emissions are expected to decline in the Opening and Design years for all GHG pollutants when compared to existing conditions. Specifically, for CO₂e, there is projected to be a 94,664 TPY decrease (13% reduction) in the Opening year and a 67,272 TPY decrease (9% reduction) in the Design year. These reductions occur despite projected increase in VMT on the affected network between the 2016 and 2025 and 2045 Build scenarios.

Under the No Build condition, VMT on the affected network would gradually increase for the years between 2016 and 2045 as employment and population in the area increases. Under the Preferred Alternative, VMT would experience an increase due to the factors affecting the No Build condition but would also increase because the additional capacity on I-495 and I-270 from the Preferred Alternative would pull traffic off of local roadways and onto the interstates. Since the affected network is comprised primarily of the interstates and small sections of adjoining roadways, the VMT under the Preferred Alternative experiences a larger increase on the affected network than on the regional model used for the overall project because while the increase in VMT on the interstates is accounted for, the model does not account for the decrease in VMT on local roadways (**Table 3-4**). Therefore, the approach to analyze GHG emissions applying the substantially more narrow affected network used for the MSAT analysis may not accurately reflect regional GHG emissions resulting from the Preferred Alternative.

Table 3-4: Projected Annual CO₂ Equivalent Emissions in Tons Per Year (TPY) on Affected Network

Projected Annual GHG Emissions in Tons Per Year (TPY) on Affected Network		Annual Vehicle Miles Traveled (Million AVMT)	Total Energy Consumption (MMBtu)	Total Gaseous Hydrocarbons (TPY)	Methane (TPY)	Nitrous Oxide (TPY)	Atmospheric CO ₂ (TPY)	CO ₂ Equivalent (TPY)
2016 Base Year	Existing	1,359.5	8,650,256	195	32.2	4.25	782,250	730,307
2025 Opening Year	Preferred Alternative	1,444.4	7,530,968	86	20.8	2.76	634,308	635,643
	No Build	1,364.6	7,231,029	84	20.2	2.71	609,004	610,308
2045 Design Year	Preferred Alternative	1,801.5	7,853,325	60	17.9	3.1	661,662	663,035
	No Build	1,674.4	7,381,940	57	16.9	2.9	621,933	623,243

Table 3-5: Projected Annual CO₂ Equivalent Emissions (Tons Per Year) on Affected Network

Projected Annual GHG Change in Emissions on Affected Network		Annual Vehicle Miles Traveled (Million AVMT)	Total Energy Consumption (MMBtu)	Total Gaseous Hydrocarbons (TPY)	Methane (TPY)	Nitrous Oxide (TPY)	Atmospheric CO ₂ (TPY)	CO ₂ Equivalent (TPY)
2025 Opening Year	Difference (Preferred Alternative - Base)	84.9	-1,119,288	-108.3	-11.4	-1.5	-93,943	-94,664
	Difference (Preferred Alternative - No Build)	79.8	299,939	2.7	0.65	0.05	25,304	25,336
2045 Design Year	Difference (Preferred Alternative - Base)	442	-796,930	-135.0	-14.3	-1.12	-66,589	-67,272
	Difference (Preferred Alternative - No Build)	127.1	471,385	3.0	0.97	0.13	39,728	39,792

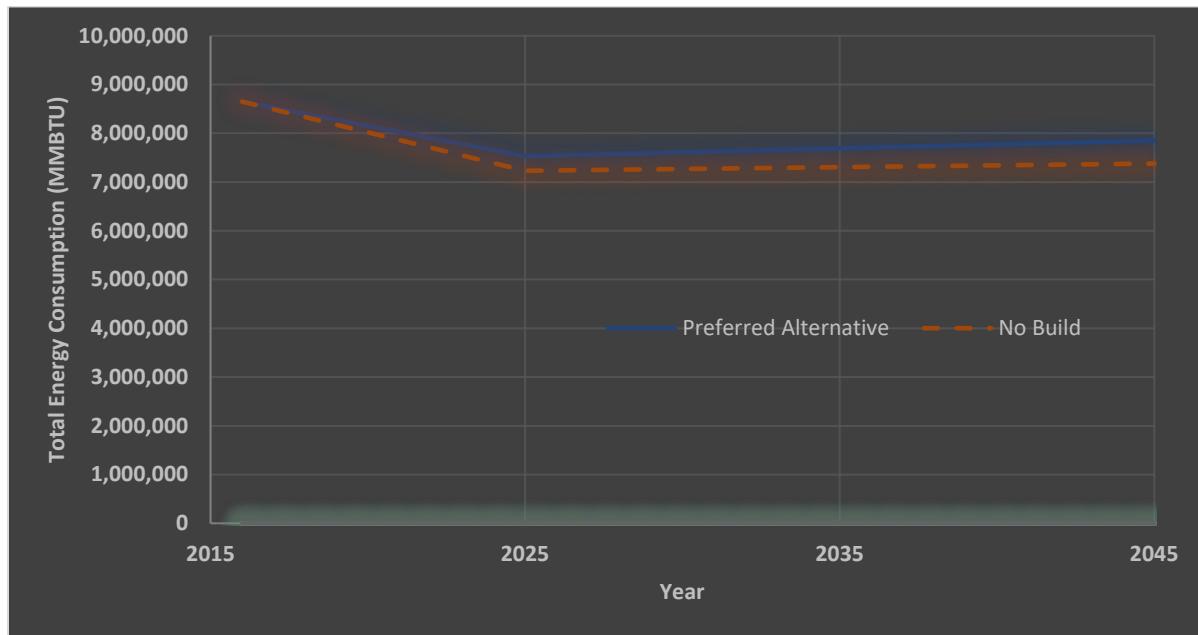


Figure 3-14: Total Energy Consumption for Base, Opening, and Design Year Conditions

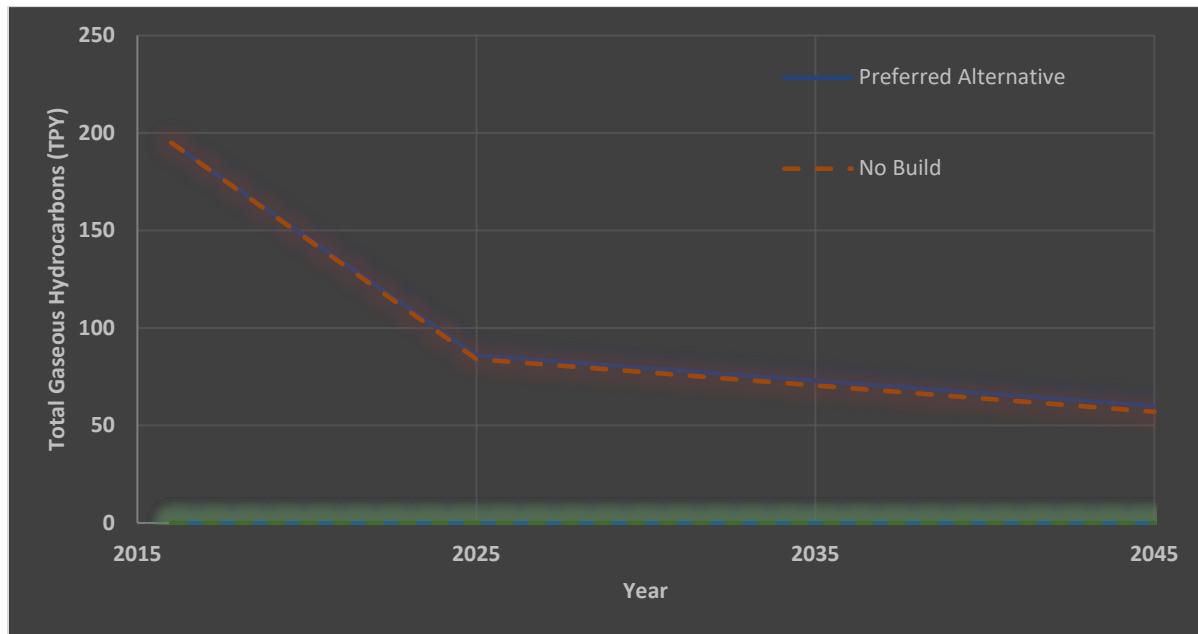


Figure 3-15: Total Gaseous Hydrocarbon GHG Annual Emissions for Base, Opening, and Design Year Conditions

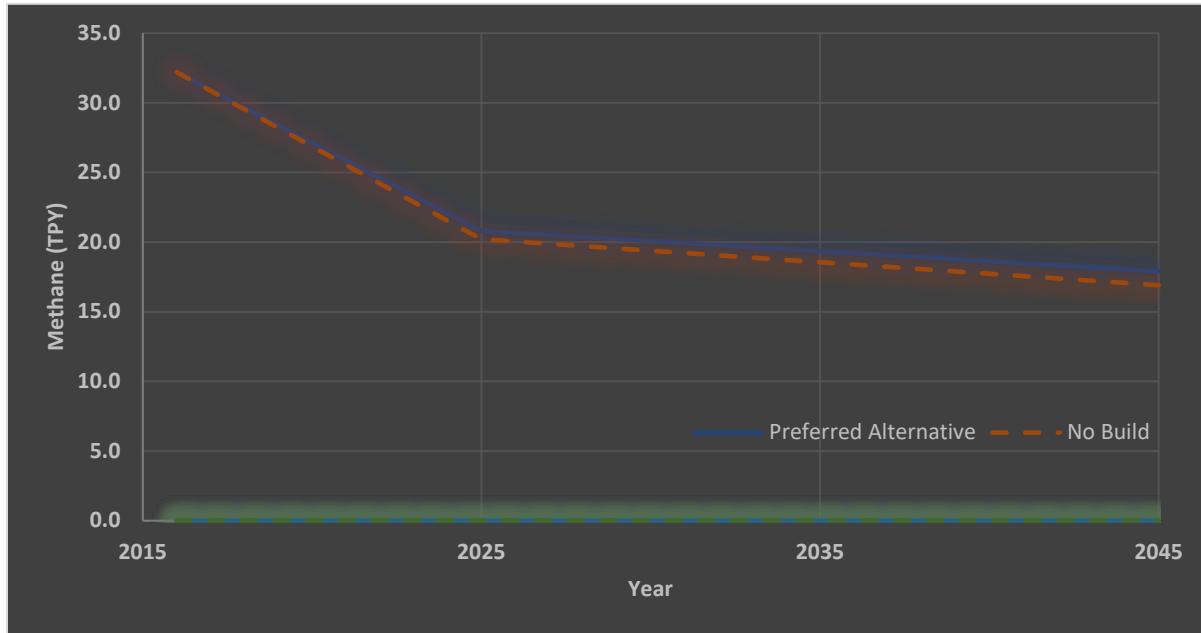


Figure 3-16: Total Methane GHG Annual Emissions for Base, Opening, and Design Year Conditions

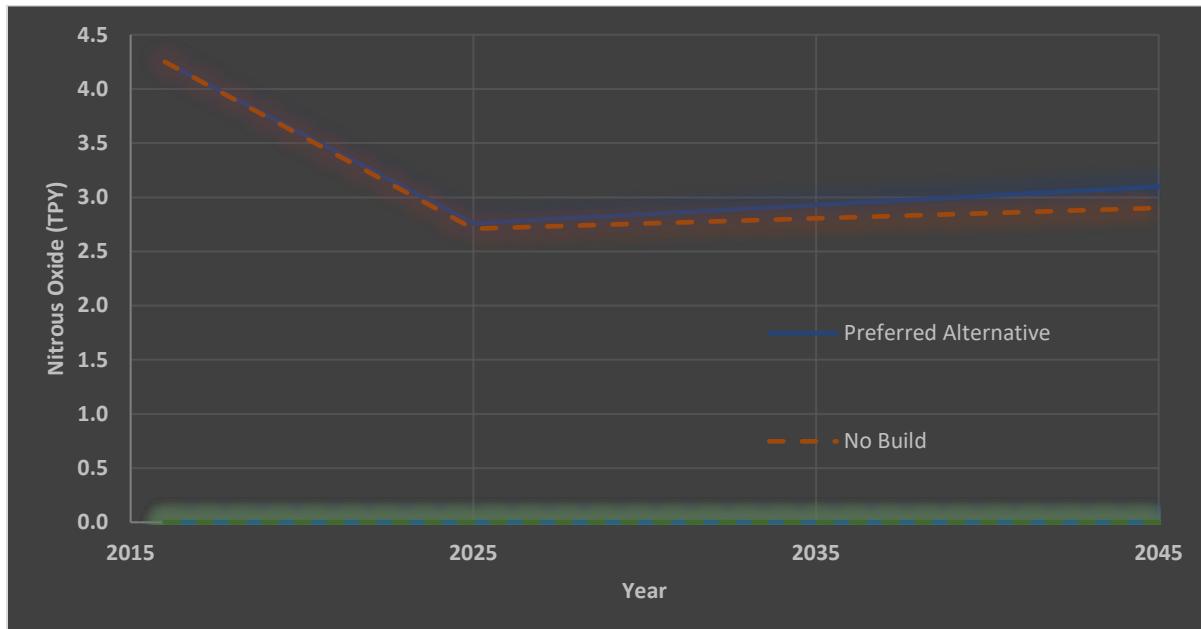


Figure 3-17: Total Nitrous Oxide GHG Annual Emissions for Base, Opening, and Design Year Conditions

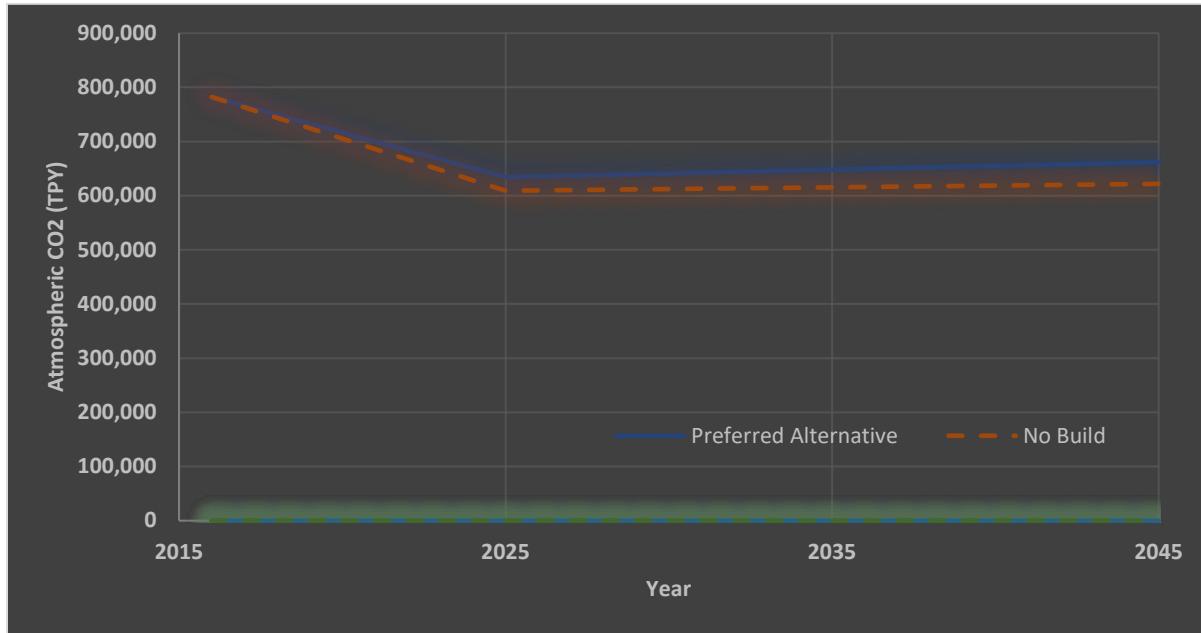


Figure 3-18: Total Atmospheric CO₂ GHG Annual Emissions for Base, Opening, and Design Year Conditions

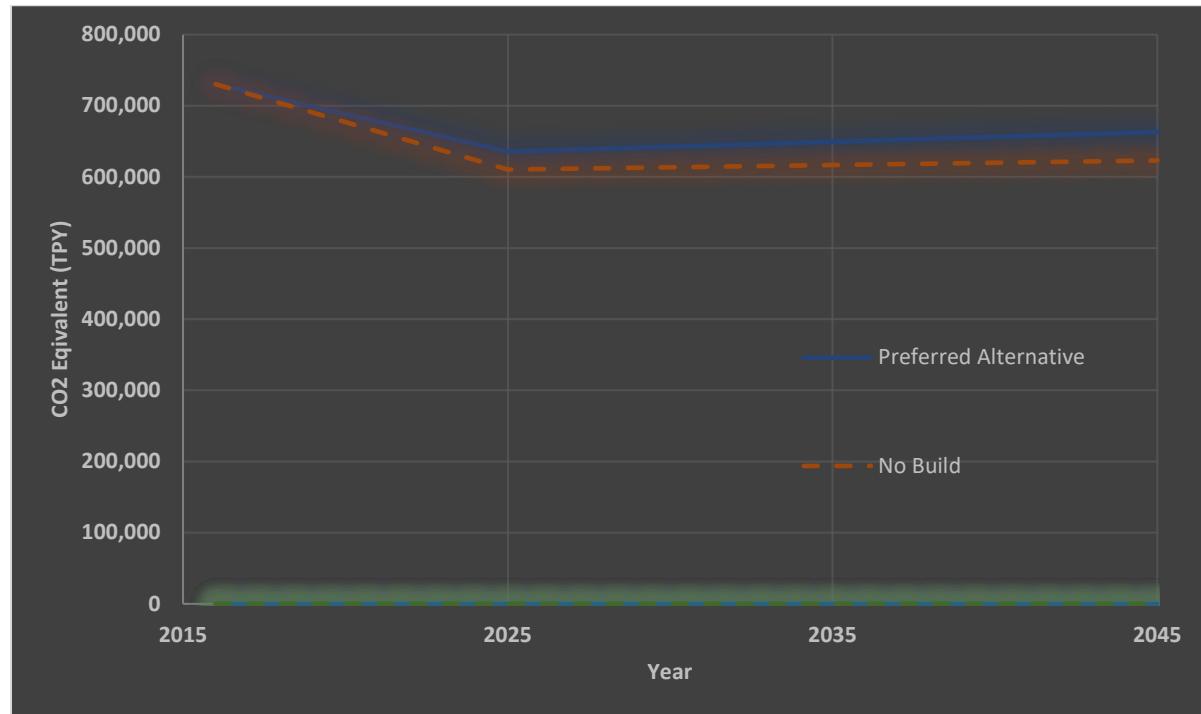


Figure 3-19: Total CO₂ Equivalent GHG Annual Emissions for Base, Opening, and Design Year Conditions

3.4.2 GHG Construction Emissions

GHG emissions from the study will be generated from construction, from vehicles using roadways, and during operations and maintenance activities of the roadways. Construction emissions were discussed in **Section 3.6** of the DEIS and have been updated in the FEIS to include a quantitative analysis of the construction related GHG emissions of the Preferred Alternative using the FHWA's Infrastructure Carbon Estimator Tool (ICE) (Version 2.1.3)¹⁷.

Per the ICE v2.1 User Guide, ICE is designed for a pre-engineering analysis of the energy and GHG emissions impacts of constructing and maintaining transportation infrastructure. A planning-level analysis is appropriate to produce “ballpark” estimates of the construction and maintenance impacts of long-range transportation decisions. It should be thought of as a sketch-planning analysis, rather than a detailed analysis of infrastructure design and construction parameters. A planning level analysis uses high-level estimates of construction activity in terms of lane miles or track miles before refined estimates are available. It is appropriate to analyze decisions that are made in the long-range planning or project development processes, before details about specific facility dimensions, materials, and construction practices are known. ICE does not analyze any tradeoffs between pavement types (e.g., asphalt vs. concrete), roadway designs (e.g., specific alignments and associated grading or structural differences), or bridge designs (e.g., steel vs. concrete structure). Rather it supports broad decision-making, such as the decision to build or not build a certain type of infrastructure, such as a freeway, bike path, or subway station, and alternatives analysis.¹⁸

ICE was run to calculate greenhouse gas (GHG) emissions from construction and maintenance activities over the lifecycle of the Preferred Build Alternative. Activities covered by the tool are broken into the following categories:

1. Materials – This category includes upstream energy and emissions associated with project materials, particularly from four categories:
 - a. Energy and fuel used in raw material extraction
 - b. Energy and fuel used in material production
 - c. Chemical reactions in material production, such as CO₂ emitted from calcination of limestone.
 - d. Energy and fuel used in raw material transportation
2. Transportation – This category includes upstream energy and emissions associated with fuel used to transport materials to site.
3. Construction – Energy and fuel used in construction equipment
4. Operations and Maintenance (O&M) – This category includes routine maintenance of infrastructure features, including:
 - a. Fuel used in snow removal equipment
 - b. Fuel used in vegetation management equipment

¹⁷ https://www.fhwa.dot.gov/environment/sustainability/energy/tools/carbon_estimator/index.cfm

¹⁸ <http://www.dot.state.mn.us/sustainability/ghg-analysis.html>

- c. Fuel used in other routine maintenance, such as sweeping, stripping, bridge deck repair, litter pickup, and maintenance of appurtenances activities
 - d. Energy and emissions from roadway repair and rehabilitation
 - e. Net energy and emissions from pavement preservation activities (optional)
5. Usage – This category is for energy and emissions associated with vehicle operations on roadways. It includes both vehicle use on the infrastructure and additional emissions due to traffic delay from construction.

Default settings in ICE were used for materials, construction equipment and fuel. Maintenance schedules would vary somewhat, and specifics are unknown at this time, therefore default values were used where specific values were not known.

A. ICE Inputs

The Project's design engineers provided various inputs required to run ICE for the Preferred Alternative. A default lifecycle analysis of 30 years was chosen. Data requirements for running ICE included:

- Bridges and Overpasses
- Culverts
- Bike and Pedestrian Activities
- Roadway System and Roadway Projects
- Crossroads Existing and Proposed
- Lighting and Signage
- Vehicle Operation

Site specific values were input as provided, where site specific factors were not known default values were assumed. Specific input and assumptions used for the ICE model are included in **Appendix B**.

B. ICE Results

The summary of the annualized ICE results from the model output for each activity in metric tons per CO₂ equivalent (MTCO₂e) and tons CO₂e (TCO₂e) are shown in **Table 3-6**. The results include GHG emissions related to materials, transportation, construction, operations and maintenance, and vehicle operations. The table includes annualized emissions and total emissions over the 30-year lifespan for MTCO₂e and TCO₂e. The results show that a majority of the ICE GHG emissions are expected to be associated with vehicle operations which include vehicles using the roadways including delay due to construction, followed by materials, O&M, construction and transportation.

Table 3-6: Annualized and Total ICE Greenhouse Gas Emissions (Metric Tons Carbon Dioxide Equivalents [MT CO₂e] and Tons CO₂e)

Activity	Annualized Greenhouse Gas Emissions (MTCO ₂ e)	Annualized Greenhouse Gas Emissions (TCO ₂ e)	Total Greenhouse Gas Emissions (MTCO ₂ e)	Total Greenhouse Gas Emissions (TCO ₂ e)
Materials	5,581	6,151	167,440	184,571
Transportation	318	350	9,546	10,523
Construction	2,312	2,548	69,371	76,468
Operations and Maintenance	4,195	4,624	133,264	146,898
Usage (Vehicle Operations)*	1,191,563	1,313,473	35,746,884	39,404,194
Total	1,203,969	1,327,146	36,126,505	41,026,623

Source: FHWA ICE model Output

* Usage emissions are based on national defaults and are of total usage/vehicle operation emissions rather than as compared to the no-build alternative.

3.4.3 GHG Summary

Maryland is committed to reducing GHG and to preparing our State for the impacts of climate change. The Maryland Commission on Climate Change (MCCC) and its Mitigation Working Group (MWG) have demonstrated that commitment by working collaboratively with experts and stakeholders across State and local agencies, environmental, non-profit and academic institutions. The resulting body of work quantifies baseline GHG emissions by sector to understand the impacts that specific plans, policies, and programs will have on future emissions economy-wide. Statewide analyses do not indicate that the HOT lanes will impede Maryland's ability to meet our GHG emission reduction goals. In fact, the Greenhouse Gas Reduction Act (GGRA) Plan documents Maryland's existing and future emissions reductions under several scenarios, all of which include this project. The document illustrates that Maryland will not only meet the 40% by 2030 goal, but that we are dedicated to working together to exceed that goal and to strive for a 50% reduction by 2030.

MDOT continues to be an active partner in the MCCC and Maryland's GHG reduction efforts. We are leading the way on transportation sector scenario and emissions analyses. We have worked with stakeholders, communities, and our partners on the MWG to better understand the impacts of the changes within the transportation sector, ranging from technology improvements, such as the deployment of automated, connected, and electric vehicles to the importance of improving mobility and expanding telework

The proposed action is relatively minor in scope compared to the larger set of highway VMT and onroad mobile source GHG emissions that were assessed in a 2020 statewide (GHG) analysis¹⁹. Highway capacity expansion projects can reduce emissions by reducing congestion but may also lead to increased VMT

¹⁹ https://mdot.maryland.gov/OPCP/2020-MCCC_Act_MDOT_Report_12-30-2020.pdf

which can increase emissions and can also create additional emissions related to construction and maintenance. However, the emissions for this individual project would be expected to be much less than the collective total of all planned statewide projects and existing on road GHG emissions.

4 MITIGATION

While no mitigation measures are required since the Preferred Alternative does not cause or contribute to a violation of the NAAQS, additional measures have been considered and committed to by MDOT SHA to further reduce impacts to air quality. Measures that will be implemented during construction to help minimize emissions include the following:

- Implementing a ***Diesel Emissions Reduction Program*** that exceeds pertinent Federal and state regulations to minimize air pollution including MSAT emissions during construction consisting of initiatives such as:
 - Ensuring diesel powered construction equipment to meet minimum emissions reduction requirements by engine manufacturer, or by being properly retrofitted with emissions control devices, or that clean fuels be used if necessary to meet the emissions reduction requirements.
 - Retrofitting equipment that is used to be on the EPA Verified Retrofit Technology List.
 - Requiring the use of ultra-low sulfur diesel fuel in construction equipment.
 - Implementing a ***Driver Training program*** to provide incremental savings by more efficiently operating mobile and stationary machinery;
 - Implementing a Truck Staging Area Plan for all construction vehicles waiting to load or unload material where emissions will have the least impact on sensitive areas and the public. These include but not limited to hospitals, schools, residences, motels, hotels, daycare facilities, elderly housing and convalescent facilities. All sources of emissions shall be located as far away as possible from fresh air intakes, air conditioners and windows.
- Implementing a ***Greenhouse Gas Reduction Program*** to reduce emissions during construction including initiatives such as:
 - Use of alternative fuels and vehicle hybridization of construction vehicles, to the maximum extent practicable
 - Maintaining existing vegetation, where possible
 - Use of recycled and reclaimed materials, including use of recycled asphalt, use of industrial byproducts as cement substitutes, and recycled concrete, to the maximum extent practicable.
- Implementing an ***Anti-Idling Policy*** to avoid unnecessary idling of construction equipment in order to reduce engine emissions and to provide air quality benefits to those who live and work in or adjacent to the construction sites. The plan may include, but is not limited to:
 - Idling of all mobile construction equipment, including delivery trucks, shall be limited to three minutes, except under certain conditions.

Long Term operations strategies that will be implemented as part of the MLS and can have an emissions benefit include:

- Incentivizing non-SOV travel options through new, extended or upgraded bicycle and pedestrian improvements, toll-free travel for High Occupancy Vehicles with three or more users (HOV 3+), carpool/vanpool and bus transit.
- Adding new direct access from the managed lanes to transit centers, enhancing multimodal mobility and connectivity.
- Expanding Park and Ride capacity at the Westfield Montgomery Mall Metro Station.
- Adding new bus bays at the Shady Grove Metro Station.
- Implementing a robust public relations campaign to promote HOV travel pre and post construction.

Appendix A

2045 Intersection/Interchange Rankings

Table 1: Design Year (2045) Alternative 9 Phase 1 Intersection Volume Ranking

Volume Rank	Modification Notes	ID	Mainline	Cross Street	Peak AM Hour Volume	Peak PM Hour Volume	Max Peak Hour Volume	Daily Volume	Peak AM Hour LOS	Peak AM Hour Delay (s)	Peak PM Hour LOS (s)	Peak PM Hour Delay	Within ALT 9 Phase 1 South Limits
1		7.IS	MD 5	Auth Road	5960	6445	6445	85300	A	4	A	2	No
2		26.IS	MD 650	Outer Loop Ramp	5260	5620	5620	63330	C	20	B	18	No
3		29.IS	MD 97	Outer Loop Ramp	5320	5535	5535	67720	A	0	A	0	No
4		18.IS	MD 450	Outer Loop Ramp	4140	5510	5510	72145	A	9	B	12	No
5		37.IS	MD 187	Outer Loop Ramp	4525	5365	5365	50050	No Data	No Data	No Data	No Data	Yes
6		11.IS	MD 214	Inner Loop Ramp	4605	5185	5185	73150	C	30	B	19	No
7		17.IS	MD 450	Inner Loop Ramp	3600	5170	5170	65275	B	16	C	22	No
8		46.IS	MD 187	I-270 SB Ramp	3500	5080	5080	61070	B	16	E	67	Yes
9		45.IS	MD 187	I-270 NB Ramp	3495	5075	5075	61215	C	21	B	14	Yes
10		36.IS	MD 187	Inner Loop Ramp	3805	5060	5060	53505	A	0	A	0	Yes
11		12.IS	MD 214	Outer Loop Ramp	4605	4880	4880	63020	B	13	B	12	No
12		28.IS	MD 97	Inner Loop Ramp	4855	4305	4855	64500	A	0	A	0	No
13		16.IS	MD 202	Outer Loop Ramp	3570	4540	4540	87600	C	29	B	18	No
14		1.IS	MD 210	Inner Loop Ramp	4490	3700	4490	64790	B	11	B	13	No
15		5.IS	MD 414	Outer Loop Ramp (2)	4025	4485	4485	60520	C	20	C	29	No
16		15.IS	MD 202	Inner Loop Ramp	3565	4370	4370	61855	A	5	A	6	No
17		24.IS	US 1	Inner Loop Ramp	4145	4210	4210	58140	B	13	C	21	No
18		62.IS	Gude Drive	Direct Access Ramp-I-270	3555	4185	4185	49375	A	0	A	0	Yes
19		23.IS	MD 201	Outer Loop Ramp	4095	3820	4095	52165	C	22	B	12	No
20		51.IS	MD 28	I-270 SB Ramp	2055	3990	3990	64655	A	7	B	11	Yes

Table 2: Design Year (2045) Alternative 9 Phase 1 Intersection Level-of-Service Ranking

LOS Rank	Modification Notes	ID	Mainline	Cross Street	Peak AM Hour Volume	Peak PM Hour Volume	Max Peak Hour Volume	Daily Volume	Peak AM Hour LOS	Peak AM Hour Delay (s)	Peak PM Hour LOS	Peak PM Hour Delay (s)	Max Peak Hour Delay	Within ALT 9 Phase 1 South Limits
1		3.IS	MD 414	Outer Loop Ramp (1)	2290	2765	2765	40600	B	18	F	86	86	No
2		46.IS	MD 187	I-270 SB Ramp	3500	5080	5080	61070	B	16	E	67	67	Yes
3		4.IS	MD 414 EB	Bald Eagle Road	1640	1370	1640	29025	C	22	E	55	55	No
4		11.IS	MD 214	Inner Loop Ramp	4605	5185	5185	73150	C	30	B	19	30	No
5		5.IS	MD 414	Outer Loop Ramp (2)	4025	4485	4485	60520	C	20	C	29	29	No
6		16.IS	MD 202	Outer Loop Ramp	3570	4540	4540	87600	C	29	B	18	29	No
7		25.IS	US 1	Outer Loop Ramp	3730	3735	3735	67105	C	28	C	21	28	No
8		13.IS	Arena Drive	Inner Loop Ramp	1575	2145	2145	29825	C	22	C	27	27	No
9		38.IS	MD 190	Inner Loop Ramp	1570	2920	2920	33820	A	8	C	26	26	Yes
10		55.IS	MD 117	I-270 NB Off Ramp	2325	3750	3750	46915	B	13	C	25	25	No
11		8.IS	Auth Road	Inner Loop Ramp	2580	1890	2580	26275	C	24	B	11	24	No
12		23.IS	MD 201	Outer Loop Ramp	4095	3820	4095	52165	C	22	B	12	22	No
13		32.IS	MD 185	Outer Loop Ramp	3360	3405	3405	46130	C	22	B	15	22	No
14		17.IS	MD 450	Inner Loop Ramp	3600	5170	5170	65275	B	16	C	22	22	No
15		45.IS	MD 187	I-270 NB Ramp	3495	5075	5075	61215	C	21	B	14	21	Yes
16		24.IS	US 1	Inner Loop Ramp	4145	4210	4210	58140	B	13	C	21	21	No
17		41.IS	Georgetown Pike	Outer Loop Ramp	2200	1855	2200	22905	A	9	C	20	20	Yes
18		26.IS	MD 650	Outer Loop Ramp	5260	5620	5620	63330	C	20	B	18	20	No
19		6.IS	MD 414	Inner Loop Ramp	3555	3660	3660	52075	B	12	C	20	20	No
20		52.IS	MD 28	I-270 NB Ramp / Nelson Street	1140	2830	2830	38225	B	14	B	20	20	Yes

Table 3: Design Year (2045) No Build Intersection Volume Ranking

Volume Rank	Modification Notes	ID	Mainline	Cross Street	Peak AM Hour Volume	Peak PM Hour Volume	Max Peak Hour Volume	Daily Volume	Peak AM Hour LOS	Peak AM Hour Delay (s)	Peak PM Hour LOS	Peak PM Hour Delay (s)	Within ALT 9 Phase 1 South Limits
1		7.IS	MD 5	Auth Road	6960	6320	6960	85300	B	19	A	2	No
2		17.IS	MD 450	Inner Loop Ramp	3890	5655	5655	65275	B	17	C	22	No
3		29.IS	MD 97	Outer Loop Ramp	5260	5575	5575	67720	D	39	A	5	No
4		11.IS	MD 214	Inner Loop Ramp	4835	5525	5525	73150	C	27	B	20	No
5		18.IS	MD 450	Outer Loop Ramp	4040	5470	5470	71620	A	10	B	13	No
6		45.IS	MD 187	I-270 NB Ramp	3180	5170	5170	62445	C	20	B	12	Yes
7		46.IS	MD 187	I-270 SB Ramp	3180	5170	5170	62240	B	13	F	85	Yes
8		37.IS	MD 187	Outer Loop Ramp	4850	4995	4995	46600	E	57	A	10	Yes
9		28.IS	MD 97	Inner Loop Ramp	4955	4370	4955	64500	A	6	C	24	No
10		25.IS	US 1	Outer Loop Ramp	4535	4810	4810	67105	C	28	C	20	No
11		5.IS	MD 414	Outer Loop Ramp (2)	4055	4685	4685	60520	B	20	C	27	No
12		1.IS	MD 210	Inner Loop Ramp	4520	4305	4520	64790	B	14	B	13	No
13		36.IS	MD 187	Inner Loop Ramp	3985	4510	4510	47690	C	32	B	12	Yes
14		12.IS	MD 214	Outer Loop Ramp	3540	4505	4505	58175	B	14	B	13	No
15		24.IS	US 1	Inner Loop Ramp	4145	4200	4200	58000	B	12	C	21	No
16		22.IS	MD 201	Inner Loop Ramp	4185	4025	4185	43765	B	10	B	11	No
17		32.IS	MD 185	Outer Loop Ramp	4045	4145	4145	46130	C	24	B	13	Yes
18		23.IS	MD 201	Outer Loop Ramp	4130	3835	4130	52165	B	19	B	11	No
19		6.IS	MD 414	Inner Loop Ramp	3820	3905	3905	52075	B	12	B	19	No
20		27.IS	MD 193	Outer Loop Exit 29	3655	3860	3860	49055	A	5	B	13	No

Table 4: Design Year (2045) No Build Intersection Level-of-Service Ranking

LOS Rank	Modification Notes	ID	Mainline	Cross Street	Peak AM Hour Volume	Peak PM Hour Volume	Max Peak Hour Volume	Daily Volume	Peak AM Hour LOS	Peak AM Hour Delay (s)	Peak PM Hour LOS	Peak PM Hour Delay (s)	Max Peak Hour Delay	Within ALT 9 Phase 1 South Limits
1		46.IS	MD 187	I-270 SB Ramp	3180	5170	5170	62240	B	13	F	85	85	Yes
2		3.IS	MD 414	Outer Loop Ramp (1)	2315	2760	2760	40525	E	64	E	75	75	No
3		40.IS	Georgetown Pike	Inner Loop Ramp	2540	2580	2580	19025	C	23	E	62	62	Yes
4		37.IS	MD 187	Outer Loop Ramp	4850	4995	4995	46600	E	57	A	10	57	Yes
5		4.IS	MD 414 EB	Bald Eagle Road	1630	1720	1720	29025	C	24	D	54	54	No
6		35.IS	Rockville Pike	Pooks Hill Road	No Data	No Data	0	No Data	A	0	D	52	52	No
7		52.IS	MD 28	I-270 NB Ramp / Nelson Street	2200	3285	3285	45600	B	14	D	48	48	Yes
8		38.IS	MD 190	Inner Loop Ramp	1745	2645	2645	36425	A	1	D	42	42	Yes
9		29.IS	MD 97	Outer Loop Ramp	5260	5575	5575	67720	D	39	A	5	39	No
10		2.IS	MD 210	MD 414	2375	1945	2375	30350	C	33	B	11	33	No
11		36.IS	MD 187	Inner Loop Ramp	3985	4510	4510	47690	C	32	B	12	32	Yes
12		25.IS	US 1	Outer Loop Ramp	4535	4810	4810	67105	C	28	C	20	28	No
13		5.IS	MD 414	Outer Loop Ramp (2)	4055	4685	4685	60520	B	20	C	27	27	No
14		11.IS	MD 214	Inner Loop Ramp	4835	5525	5525	73150	C	27	B	20	27	No
15		41.IS	Georgetown Pike	Outer Loop Ramp	2205	1815	2205	40330	C	27	B	19	27	Yes
16		55.IS	MD 117	I-270 NB Off Ramp	2300	3710	3710	46620	B	14	D	26	26	No
17		53.IS	Shady Grove Road	I-270 NB Ramp	2600	2255	2600	35000	B	13	C	26	26	Yes
18		32.IS	MD 185	Outer Loop Ramp	4045	4145	4145	46130	C	24	B	13	24	No
19		13.IS	Arena Drive	Inner Loop Ramp	1580	2420	2420	29825	C	22	C	24	24	No
20		49.IS	Montrose Road	Tower Oaks Boulevard	No Data	No Data	0	No Data	B	17	C	24	24	Yes

Table 5: Design Year (2045) Alternative 9 Phase 1 Interchange Volume Ranking

Volume Rank	ID	Mainline	Cross Road	Peak AM Hour Volume	Peak PM Hour Volume	Max Peak Hour Volume	Peak AM Hour Delay (s)	Peak PM Hour Delay (s)	Within ALT 9 Phase 1 South Limits
1	27.IC	Capital Beltway	George Washington Memorial Parkway	38692	28991	38692	2	2	Yes
2	25.IC	Capital Beltway	MD 190	28637	24087	28637	3	43	Yes
3	34.IC	I-270	MD 28	22117	26955	26955	2	14	Yes
4	33.IC	I-270	MD 189	22539	26707	26707	1	2	Yes
5	11.IC	Capital Beltway	US 50	24422	26222	26222	9	3	No
6	36.IC	I-270	I-370	21196	25345	25345	4	68	Yes
7	3.IC	Capital Beltway	MD 5	13363	25170	25170	223	2	No
8	26.IC	Capital Beltway	Clara Barton Parkway	24068	22157	24068	1	2	Yes
9	20.IC	Capital Beltway	MD 97	22721	23755	23755	19	22	No
10	16.IC	Capital Beltway	I-95	19939	23698	23698	213	67	No
11	35.IC	I-270	Shady Grove Road	20401	23309	23309	2	59	Yes
12	24.IC	Capital Beltway	I-270 Spur	22997	18745	22997	1	55	Yes
13	17.IC	Capital Beltway	MD 650	20857	22799	22799	92	15	No
14	14.IC	Capital Beltway	MD 201	21084	22789	22789	19	68	No
15	8.IC	Capital Beltway	MD 214	20392	22703	22703	61	48	No
16	21.IC	Capital Beltway	MD 185	22561	22405	22561	3	59	No
17	10.IC	Capital Beltway	MD 202	19329	22384	22384	64	38	No
18	12.IC	Capital Beltway	MD 450	20223	22206	22206	4	12	No
19	31.IC	I-270	I-270 Spur	19726	22190	22190	2	1	Yes
20	13.IC	Capital Beltway	Baltimore Washington Parkway	22119	21747	22119	5	70	No

Table 6: Design Year (2045) Alternative 9 Phase 1 Interchange Delay Ranking

Delay Rank	ID	Mainline	Cross Road	Peak AM Hour Volume	Peak PM Hour Volume	Max Peak Hour Volume	Peak AM Hour Delay (s)	Peak PM Hour Delay (s)	Max Peak Hour Delay	Within ALT 9 Phase 1 South Limits
1	3.IC	Capital Beltway	MD 5	13363	25170	25170	223	2	223	No
2	16.IC	Capital Beltway	I-95	19939	23698	23698	213	67	213	No
3	2.IC	Capital Beltway	MD 414	13603	19516	19516	146	2	146	No
4	7.IC	Capital Beltway	Ritchie Marlboro Road	16050	20252	20252	94	13	94	No
5	17.IC	Capital Beltway	MD 650	20857	22799	22799	92	15	92	No
6	1.IC	Capital Beltway	MD 210 & MD 414	15180	19207	19207	81	1	81	No
7	6.IC	Capital Beltway	MD 4	15518	19950	19950	77	2	77	No
8	23.IC	Capital Beltway	MD 187	No Data	No Data	No Data	10	77	77	Yes
9	13.IC	Capital Beltway	Baltimore Washington Parkway	22119	21747	22119	5	70	70	No
10	14.IC	Capital Beltway	MD 201	21084	22789	22789	19	68	68	No
11	36.IC	I-270	I-370	21196	25345	25345	4	68	68	Yes
12	10.IC	Capital Beltway	MD 202	19329	22384	22384	64	38	64	No
13	9.IC	Capital Beltway	Arena Drive	15568	18194	18194	62	61	62	No
14	8.IC	Capital Beltway	MD 214	20392	22703	22703	61	48	61	No
15	35.IC	I-270	Shady Grove Road	20401	23309	23309	2	59	59	Yes
16	21.IC	Capital Beltway	MD 185	22561	22405	22561	3	59	59	No
17	24.IC	Capital Beltway	I-270 Spur	22997	18745	22997	1	55	55	Yes
18	4.IC	Capital Beltway	Suitland Road	9604	14280	14280	53	29	53	No
19	18.IC	Capital Beltway	MD 193	17786	20149	20149	52	30	52	No
20	22.IC	Capital Beltway	I-270 and MD 355	21159	20822	21159	15	51	51	No

Table 7: Design Year (2045) No Build Interchange Volume Ranking

Volume Rank	ID	Mainline	Cross Road	Peak AM Hour Volume	Peak PM Hour Volume	Max Peak Hour Volume	Peak AM Hour Delay (s)	Peak PM Hour Delay (s)	Within ALT 9 Phase 1 South Limits
1	33.IC	I-270	MD 189	36307	40047	40047	1	2	Yes
2	11.IC	Capital Beltway	US 50	24919	25638	25638	3	9	No
3	3.IC	Capital Beltway	MD 5	13231	24302	24302	304	2	No
4	25.IC	Capital Beltway	MD 190	23836	21209	23836	14	59	Yes
5	34.IC	I-270	MD 28	20041	23254	23254	2	14	No
6	20.IC	Capital Beltway	MD 97	22749	20775	22749	29	66	No
7	16.IC	Capital Beltway	I-95	19783	22706	22706	195	98	No
8	21.IC	Capital Beltway	MD 185	22616	19803	22616	3	135	No
9	13.IC	Capital Beltway	Baltimore Washington Parkway	22151	21102	22151	5	74	No
10	14.IC	Capital Beltway	MD 201	21170	22111	22111	21	59	No
11	8.IC	Capital Beltway	MD 214	21307	22016	22016	53	56	No
12	32.IC	I-270	Montrose Road	20567	21791	21791	3	5	Yes
13	10.IC	Capital Beltway	MD 202	19897	21742	21742	43	34	No
14	12.IC	Capital Beltway	MD 450	20203	21486	21486	4	32	No
15	15.IC	Capital Beltway	US 1	19846	21250	21250	6	60	No
16	17.IC	Capital Beltway	MD 650	20589	20969	20969	90	33	No
17	22.IC	Capital Beltway	I-270 and MD 355	20689	17710	20689	6	131	No
18	27.IC	Capital Beltway	George Washington Parkway	19947	18968	19947	51	86	Yes
19	36.IC	I-270	I-370	19595	19054	19595	14	176	Yes
20	26.IC	Capital Beltway	Clara Barton Parkway	19550	17949	19550	4	52	Yes

Table 8: Design Year (2045) No Build Interchange Delay Ranking

Delay Rank	ID	Mainline	Cross Road	Peak AM Hour Volume	Peak PM Hour Volume	Max Peak Hour Volume	Peak AM Hour Delay (s)	Peak PM Hour Delay (s)	Max Peak Hour Delay	Within ALT 9 Phase 1 South Limits
1	3.IC	Capital Beltway	MD 5	13231	24302	24302	304	2	304	No
2	16.IC	Capital Beltway	I-95	19783	22706	22706	195	98	195	No
3	36.IC	I-270	I-370	19595	19054	19595	14	176	176	Yes
4	21.IC	Capital Beltway	MD 185	22616	19803	22616	3	135	135	No
5	2.IC	Capital Beltway	MD 414	14195	19060	19060	132	2	132	No
6	22.IC	Capital Beltway	I-270 and MD 355	20689	17710	20689	6	131	131	No
7	1.IC	Capital Beltway	MD 210 & MD 414	15547	18638	18638	94	1	94	No
8	23.IC	Capital Beltway	MD 187	12476	11150	12476	44	94	94	Yes
9	17.IC	Capital Beltway	MD 650	20589	20969	20969	90	33	90	No
10	7.IC	Capital Beltway	Ritchie Marlboro Road	16533	18996	18996	88	46	88	No
11	4.IC	Capital Beltway	Suitland Road	9121	13884	13884	87	31	87	No
12	27.IC	Capital Beltway	George Washington Memorial Parkway	19947	18968	19947	51	86	86	Yes
13	19.IC	Capital Beltway	US 29	17273	17994	17994	76	64	76	No
14	13.IC	Capital Beltway	Baltimore Washington Parkway	22151	21102	22151	5	74	74	No
15	6.IC	Capital Beltway	MD 4	15312	18762	18762	74	23	74	No
16	18.IC	Capital Beltway	MD 193	17647	17875	17875	53	74	74	No
17	20.IC	Capital Beltway	MD 97	22749	20775	22749	29	66	66	No
18	35.IC	I-270	Shady Grove Road	19275	19189	19275	2	64	64	Yes
19	15.IC	Capital Beltway	US 1	19846	21250	21250	6	60	60	No
20	25.IC	Capital Beltway	MD 190	23836	21209	23836	14	59	59	Yes

Appendix B

ICE Inputs

MEMORANDUM – FHWA ICE Methodology

FHWA's Infrastructure Carbon Estimator Tool (ICE; FHWA n.d.) was used to calculate estimated Project related GHG emissions from construction and maintenance over the lifecycle of the Project Build Alternatives. Estimates include emissions from materials (production, transportation, chemical reactions), construction equipment and fuel, and routine maintenance of the Project. Default settings in ICE were used for materials as well as construction equipment and fuel. While maintenance schedules would vary somewhat depending on the Alternative selected, that variability is too speculative to know at this point in Project engineering to include in ICE. For this reason, default values were used.

ICE Inputs

The Project's design engineers provided various inputs required to run ICE. Details of construction materials would be developed in a later phase of the Project. Inputs to ICE were obtained from the Project's design engineers. The following inputs were provide by the Project design engineers:

- Lifetime of the Project: ICE defaults to 30 years and this is fore the lifecycle analysis.
- Bridges and Overpasses
 - Number of new single-span bridges & overpasses: 3
 - Number of new two-span bridges & overpasses: 5
 - Number of new multi-span bridges over land: 15
 - Number of new multi-span bridges over water: 2
 - Number of reconstructed single-span bridges & overpasses: 3
 - Number of reconstructed two-span bridges & overpasses: 25
 - Number of reconstructed multi-span bridges over land: 12
 - Number of reconstructed multi-span bridges over water: 2
 - Number of single-span bridges & overpasses where the project is only adding a lane (i.e., not reconstructing): 0
 - Number of two-span bridges & overpasses where the project is only adding a lane (i.e., not reconstructing): 0
 - Number of multi-span bridges over land where the project is only adding a lane (i.e., not reconstructing): 0
 - Number of multi-span bridges over water
 - For any of the multi-span bridges we need to know the number of spans
 - New
 - 150957001 – 9
 - 150971001 – 5
 - Reconstructed
 - 150100001 – 7
 - 150108001 – 3
 - For the new and reconstructed bridges, we need to know the total number of lanes
 - New
 - 150957001 – 1
 - 150971001 – 1
 - Reconstructed
 - 150100001 – 14
 - 150108001 – 15
 - For the bridges where the project is merely adding lanes and not reconstructing, we need to know the number of lanes added: 0 (see O&M note above)
 - Culverts
 - Small

No of single box culverts	2
No of double box culverts	0
Number of Pipe Culverts	1
Average length (ft)	272

Medium

No of single box culverts	1
No of double box culverts	3
Number of Pipe Culverts	3
Average length (ft)	326

Large

No of single box culverts	0
No of double box culverts	0
Number of Pipe Culverts	37
Average length (ft)	389

- Bike/Pedestrian Facilities
 - Total miles of off-street bicycle or pedestrian paths
 - Ex: 0.06 miles, Proposed: 1.31 miles
 - Total miles of on-street bike lanes (if any)
 - Ex: 0.19 miles, Proposed: 1.18 miles
 - Total-miles of on-street sidewalks (if any)
 - Ex: 2.84 miles, Proposed: 3.58 miles
- Roadway System
 - Total existing centerline miles
 - Ex: 22.43 miles
 - Total newly constructed centerline miles: 0 miles
- Roadway Project
 - Existing lane miles broken down by urban or rural interstates, principal arterials, minor arterials, and collectors.

	Phase 1 South
Freeway	189.19
Major Highway	14.99
Arterial	3.75
Major Collectors	0
Collector	0
Residential Primary	0.49

- Roadway construction lane miles broken down by the road type for the following construction types:
 - New roadway: 0
 - Construct additional lane(s)

	Phase 1
Freeway	210.02

Major Highway	13.68
Arterial	0
Collector	0

- Realignment: 0 on Arterials and Collectors
- Lane widening

- These are crossroads that have proposed lanes wider than existing.

	Phase 1
Major Highway	4.81
Arterial	2.33
Collector	0

- Shoulder improvement (if not conducted as part of other lane widening/realignment/etc. efforts)

- These are crossroads with existing and proposed lane configuration and width matching. Anything beyond the edge of road is proposed to be improved.

	Phase 1
Freeway	4.50
Major Highway	0
Arterial	1.42
Major Collectors	0
Collector	0
Residential Primary	0.49

- % of roadway on rocky and/or mountainous terrain (if any): 0
- Lighting
 - Number of roadway miles 18
 - Support structure type (i.e., vertical, vertical and vertical with 8' arm, high mast) 40' light pole with 10' bracket arm
 - Lumen or lumen range
 - 4000-5000
 - 7000-8800
 - 8500-11500
 - 21000-28000
 - 46500-52800
 - 52500-58300
 - Average number of HPS lights per roadway mile
 - Average number of LED lights per roadway mile 38 per mile
- Signage
 - Number of roadway miles 18 miles
 - Average number of small (3'x3') signs per mile 20
 - Average number of medium (6'x6') signs per mile 18
 - Average number of medium (10'x14') signs per mile 16
- Vehicle Operations

		Length (miles)	2018 (Baseline)	2023 (Construction Start)	2027 (Opening Year)		2045 (Design Year)	
			Existing	No Build	No Build	Build ¹	No Build	Build
Daily VMT (Miles)	I-270 (West to South) (Clockwise)	I-370 to MD 28	3	678,000	705,000	726,000	N/A	822,000
		MD 28 to I-270 Spur	5.5	1,424,500	1,474,000	1,514,000	N/A	1,694,000
		GWMP to MD 190	2.5	607,500	627,000	643,000	N/A	712,500
		MD 190 to I-270 Spur	2	506,000	519,000	530,000	N/A	578,000
		I-270 Spur to MD 187	1.5	178,500	181,000	184,000	N/A	193,500
	I-95 (Clockwise)	MD 187 to MD 355	1.5	178,500	181,000	184,000	N/A	193,500
		MD 355 to I-95	8.5	1,997,500	2,031,000	2,057,000	N/A	2,176,000
		I-95 to US 50	8	1,840,000	1,867,000	1,888,000	N/A	1,984,000
		US 50 to MD 214	4	940,000	956,000	968,000	N/A	1,024,000
		MD 214 to MD 4	4	884,000	905,000	921,000	N/A	996,000
	Total VMT - Build Phase 1 South Area	15	3,394,500	3,506,000	3,597,000	N/A	4,000,000	4,150,500
Total VMT - Full Study Area		45	10,026,500	10,257,000	10,440,000	N/A	11,265,500	11,554,500
Average Daily Congested Speed (mph) ²			33	31	30	N/A	24	29

Notes:
 1) Data is not available as of June 2021 because volume development and modeling for Build opening year conditions is a work in progress.
 2) Average speeds during construction would be assumed to be the same as No Build because the contractor will be required to maintain all lanes during the peak periods.

- Please confirm the following are not part of the project

- Parking facilities No
- BRT No
- Light-rail No
- Heavy-rail No
- Custom Pavement No

ICE Results

The following tables summarize the ICE results for the Project.

Annualized Greenhouse Gas Emissions (Metric Tons Carbon Dioxide Equivalents [MT CO2e])

The summary of the annualized ICE results from the model output for each activity in metric tons per CO2 equivalent (MTCO2e) are shown in the table below. The results include GHG emissions related to materials, transportation, construction, operations and maintenance, and vehicle operations. The table include annualized emissions and total emissions over the 30 year lifespan for MTCO2e. The results show that a majority of the ICE GHG emissions are expected to be associated with vehicle operations which includes vehicles on roadways including delay due to construction, followed by materials, O&M, construction and transportation.

Annualized and Total ICE Greenhouse Gas Emissions (Metric Tons Carbon Dioxide Equivalents [MT CO2e])

Activity	Annualized Greenhouse Gas Emissions (MTCO2e)	Total Greenhouse Gas Emissions (MTCO2e)
Materials	5,581	167,440
Transportation	318	9,546
Construction	2,312	69,371
Operations and Maintenance	4,195	133,264
Usage (Vehicle Operations)	1,136,608	34,098,236
Total	1,149, 262	34,477,856

Source: FHWA ICE model Output

Total Greenhouse Gas Emissions (MT CO2e)

Project Inputs

Display result in 508 compliant format:

No

Hide Instructions

No

INSTRUCTIONS

1. Populate location (state) and lifetime (years) for your analysis.
2. Select operating mode (*Project* or *Planning*) for your analysis. (The tool can analyze different individual projects (*Project* mode) or a suite of projects in a comprehensive plan (*Planning* mode)).
3. Select the infrastructure type(s) to analyze. Input all requested data using information from the project or plan you want to analyze. Then navigate to the relevant *analysis page(s)* for your project or the individual project(s) in your plan and complete the analysis for each infrastructure type by entering information in all cells that are shaded yellow. Blue and gray cells display fixed values and results; do not change the information in these cells.
4. Apply any selected mitigation measures on the *Mitigation Strategies* tab.
5. Review outputs on the *Summary Results* tab.
6. For further instructions, refer to the accompanying User Guide for detailed descriptions of factors and assumptions used in this tool.

Clear All User Data

Tool Use Planning

Infrastructure location (state)
MO
The lifetime of your plan or project (years)
30
Use custom electric emission profile (RPS)?
No



Title: Enter comments and comment titles. These will be displayed on the Summary Results worksheet.	I-495/I-270 Managed Lanes Alternative 9, Phase I South Data provided 6/14/2021	Title: Title: Title:
---	---	----------------------------

Planning Summary of Inputs - See Individual Tabs for Details

Bridges & Overpasses

Bridge/Overpass Structure	Construct New Bridge/Overpass				Reconstruct Bridge/Overpass				Add Lane to Bridge/Overpass			
	Number of bridges & overpasses	Average number of spans per structure	Average number of lanes per structure	Total number of lane-spans	Number of bridges & overpasses	Average number of spans per structure	Average number of lanes reconstructed per structure	Total number of lane-spans	Number of bridges & overpasses	Average number of spans per structure	Average number of lanes per structure added	Total number of lane-spans
Single-Span	3	1	1	3	3	1	14.5	43.5		1		0
Two-Span	5	2	1	10	25	2	14.5	725		2		0
Multi-Span (over land)	15	7	1	105	12	5	14.5	870				0
Multi-Span (over water)	2	7	1	14	2	5	14.5	145				0

[Specification](#)

[Baseline Energy Use and GHG Emissions](#)

[Mitigated Results](#)

[Results - Charts](#)

Culverts

	Number of culverts	Average culvert length (ft)
Default Culvert	47	372

[Specification](#)

[Baseline Energy Use and GHG Emissions](#)

[Mitigated Results](#)

[Results - Charts](#)

[Lighting](#)

Number of roadway miles	18
-------------------------	----

Lighting Structures		Lumen Range	Ave. number of HPS lights per roadway mile	Ave. number of LED lights per roadway mile
Support Structure Type				
Vertical		4000-5000		
Vertical		7000-8800		
Vertical		8500-11500		
Vertical		11500-14000		
Vertical		21000-28000		
Vertical and Vertical with 8' Arm		4000-5000		
Vertical and Vertical with 8' Arm		7000-8800		
Vertical and Vertical with 8' Arm		8500-11500		
Vertical and Vertical with 8' Arm		11500-14000		
Vertical and Vertical with 8' Arm		21000-28000		
High Mast		28800 - 42000		38
High Mast		46500-52800		
High Mast		52500-58300		

[Specification](#)[Baseline Energy Use and GHG Emissions](#)[Mitigated Results](#)[Results - Charts](#)

[Pathways](#)

Bicycle and Pedestrian Facilities		
Project Type	New Construction	Resurfacing
Off-Street Bicycle or Pedestrian Path - miles	1.31	
On-Street Bicycle Lane - lane miles	1.18	0.19
On-Street Sidewalk - miles	3.58	N/A

[Specification](#)[Baseline Energy Use and GHG Emissions](#)[Mitigated Results](#)[Results - Charts](#)

Roadways

Roadway System	
Total existing centerline miles	22.43
Total newly constructed centerline miles	

Facility type	Roadway System	Roadway Construction				
		Existing Roadway (lane miles)	New Roadway (lane miles)	Construct Additional Lane (lane miles)	Realignment (lane miles)	Shoulder improvement (centerline miles)
Rural Interstates						
Rural Principal Arterials						
Rural Minor Arterials						
Rural Collectors						
Urban Interstates / Expressways	189.19		210.02			4.5
Urban Principal Arterials	14.99		13.68			4.81
Urban Minor Arterials / Collectors	3.75			2.33		1.91

Include roadway rehabilitation activities (reconstruct and resurface)	Yes
---	-----

% roadway construction on rocky / mountainous terrain	0%
---	----

[Specification](#)

[Baseline Energy Use and GHG Emissions](#)

[Mitigated Results](#)

[Results - Charts](#)

Signage

Number of roadway miles	18
-------------------------	----

Signage Structures	Avg. number of signs per roadway mile
Small (3'x3') - 14 Gauge Steel Post (MDOT SIGN-150-D)	20
Medium (6'x6') - 14 Gauge Steel Posts (MDOT SIGN-150-D)	18
Large (10'x14') - 8 Gauge Cantilever Arm (MDOT SIGN-300-A)	16

[Specification](#)

[Baseline Energy Use and GHG Emissions](#)

[Mitigated Results](#)

[Results - Charts](#)[Vehicle Ops](#)

Vehicle Operating Emissions				
	Year		Avg Daily VMT on project	Average Daily (Congested) Speed (mph) (or NA)
	Default	Custom		
Project Opening Year	2022	2027	10440000	30
Project Interim Year	2027	2032	10997000	29
Project Design/Horizon Year	2057	2045	11554000	29

Construction Delay, Additional Emissions				
	Year		Avg Daily VMT impacted by project	Average Daily (Congested) Speed (mph) (or NA)
	Default	Custom		
Construction start year	2022	2023	10192000	NA
Pre-construction (baseline) year	2021	2016	9759000	55
Project Opening Year	2027	2027		

[Specification](#)[Baseline Energy Use and GHG Emissions](#)[Mitigated Results](#)[Results - Charts](#)

Appendix C

MOVES RunSpecs MSATs

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Preferred Alternative :

Year: 2016

County: Montgomery

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REV OCT 21]]></description>
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uantSigma

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Preferred Alternative :

Year: 2025

County: Montgomery

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REV October 21]]></description>
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processname="Crankcase Running Exhaust"/>
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processname="Running Exhaust"/>
        <pollutantprocessassociation pollutantkey="72" pollutantname="Anthracene particle" processkey="15"
processname="Crankcase Running Exhaust"/>
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processname="Running Exhaust"/>
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processname="Evap Fuel Leaks"/>
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processkey="15" processname="Crankcase Running Exhaust"/>
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processname="Crankcase Running Exhaust"/>
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processname="Evap Fuel Leaks"/>
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processkey="15" processname="Crankcase Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total"
processkey="1" processname="Running Exhaust"/>
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processkey="15" processname="Crankcase Running Exhaust"/>
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processname="Crankcase Running Exhaust"/>
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processname="Running Exhaust"/>
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processname="Crankcase Running Exhaust"/>
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processkey="15" processname="Crankcase Running Exhaust"/>
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processkey="11" processname="Evap Permeation"/>
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processkey="11" processname="Evap Permeation"/>
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processkey="13" processname="Evap Fuel Leaks"/>
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    </databaseselections>
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useParameters      No

]]></internalcontrolstrategy>
    </internalcontrolstrategies>
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numberofsimulations="0"/>
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        <fueltype selected="true"/>
        <fuelsubtype selected="false"/>
        <emissionprocess selected="false"/>
        <onroadoffroad selected="true"/>
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        <sourceusetype selected="false"/>
        <movesvehicletype selected="false"/>
        <onroadscc selected="false"/>
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        <sector selected="false"/>
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        <hpclass selected="false"/>
        <regclassid selected="false"/>
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    <outputvmtdata value="true"/>
    <outputsho value="false"/>
    <outputsh value="false"/>
    <outputshp value="false"/>
    <outputshidling value="false"/>
    <outputstarts value="false"/>
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    </outputfactors>
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    </runspec>

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    <description><![CDATA[I-495 & I-270 MLS: 2106 2025 No Build MSAT Analysis
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Preferred Alternative :

Year: 2025

County: Montgomery

```
REV OCTOBER 21]]></description>
<models>
    <model value="ONROAD"/>
</models>
<modelscale value="Inv"/>
<modeldomain value="SINGLE"/>
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    <geographicselection type="COUNTY" key="24031" description="MARYLAND - Montgomery County"/>
</graphicselections>
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    <month id="1"/>
    <month id="4"/>
    <month id="7"/>
    <month id="10"/>
    <day id="5"/>
    <beginhour id="1"/>
    <endhour id="24"/>
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</timespan>
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        <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="43"
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processname="Running Exhaust"/>
        <pollutantprocessassociation pollutantkey="72" pollutantname="Anthracene particle" processkey="15"
processname="Crankcase Running Exhaust"/>
        <pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="1"
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processname="Running Exhaust"/>
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uantSigma

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Preferred Alternative :

Year: 2045

County: Montgomery

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REV OCTOBER 26]]></description>
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Preferred Alternative :

Year: 2045

County: Montgomery

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REV OCTOBER 26]]></description>
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processkey="1" processname="Running Exhaust"/>
        <pollutantprocessassociation pollutantkey="182" pollutantname="Indeno(1,2,3,c,d)pyrene gas"
processkey="15" processname="Crankcase Running Exhaust"/>
        <pollutantprocessassociation pollutantkey="82" pollutantname="Indeno(1,2,3,c,d)pyrene particle"
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processname="Crankcase Running Exhaust"/>
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processname="Running Exhaust"/>
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        <pollutantprocessassociation pollutantkey="185" pollutantname="Naphthalene gas" processkey="1"
processname="Running Exhaust"/>
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processname="Crankcase Running Exhaust"/>
        <pollutantprocessassociation pollutantkey="185" pollutantname="Naphthalene gas" processkey="11"
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processname="Crankcase Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="15"
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    <pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="1"
processname="Running Exhaust"/>
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    <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons"
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    <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons"
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processkey="13" processname="Evap Fuel Leaks"/>
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processkey="15" processname="Crankcase Running Exhaust"/>
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    <pollutantprocessassociation pollutantkey="83" pollutantname="Phenanthrene particle" processkey="1"
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    <pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="15"
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    <pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total"
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    <pollutantprocessassociation pollutantkey="184" pollutantname="Pyrene gas" processkey="1"
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    <pollutantprocessassociation pollutantkey="84" pollutantname="Pyrene particle" processkey="15"
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    <pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="15"
processname="Crankcase Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="15"
processname="Crankcase Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="1"
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processname="Crankcase Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="15"
processname="Crankcase Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption"
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processkey="15" processname="Crankcase Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons"
processkey="11" processname="Evap Permeation"/>
    <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons"
processkey="13" processname="Evap Fuel Leaks"/>
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processkey="1" processname="Running Exhaust"/>

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        <pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds"
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        <pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds"
processkey="11" processname="Evap Permeation"/>
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processkey="13" processname="Evap Fuel Leaks"/>
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]]></internalcontrolstrategy>
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            <emissionprocess selected="false"/>
            <onroadoffroad selected="true"/>
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            <sourceusetype selected="false"/>
            <movesvehicletype selected="false"/>
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        <outputsho value="false"/>
        <outputsh value="false"/>
        <outputshp value="false"/>
        <outputshidling value="false"/>
        <outputstarts value="false"/>
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            <massfactors selected="true" units="Grams" energyunits="Joules"/>
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        </runspec>

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