



U.S. FOOD AND DRUG ADMINISTRATION MUIRKIRK ROAD CAMPUS MASTER PLAN

Final Environmental Impact Statement
Appendix D – Air Quality Technical Report

April 2023

Prepared by:



In cooperation with:



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Muirkirk Road Campus Master Plan

Air Quality Technical Report

January 1, 2023

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MUIRKIRK ROAD CAMPUS MASTER PLAN

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Introduction

1.0 INTRODUCTION

This air quality report has been prepared by Stantec Consulting Services Inc. (Stantec) for the U.S. General Services Administration (GSA) to assess and report potential impacts that would result from the implementation of the U.S. Food and Drug Administration (FDA) Muirkirk Road Campus (MRC) Master Plan for the continued consolidation of FDA's facilities located in Prince George's County, Maryland in the city of Laurel.

Currently there are approximately 300 employees on the campus. The MRC is approved to house 1,800 employees, but due to telecommuting, the maximum number of employees onsite would be 1,121. This population size was established in the 1966 Site Development plan, approved by Prince George's County and the National Capital Planning Commission (NCPC) in July 1966, and continued in a 1981 development plan for construction of new laboratory space at the site. GSA completed an Environmental Impact Statement (EIS) for the development plan that analyzed the impacts from the construction of new laboratory space at the MRC and the consolidation of four facilities in the Washington, DC, metro area and other sites in St. Louis, MO, and Cincinnati, OH.

A Master Plan is needed to accommodate projected growth and to continue to support FDA's consolidation in order to conduct complex and comprehensive research and reviews. The MRC Master Plan will steer the planning, design, and construction of new buildings; improvements to roadways, utilities, and other infrastructure; and the protection of natural areas. Approximately 438,000 gross square feet (gsf), including 375,000 gsf of additional office space and up to 63,000 gsf of special use/shared space is needed to support FDA's mission at the MRC for Action Alternatives A and C. Alternative B consists of 224,783 gsf of office space, 125,496 gsf of laboratory use, and 33,057 gsf for special use space. An Environmental Impact Statement (EIS) has been prepared to assess the impact of the population increase and additional growth on the MRC. This Air Quality Technical Report is included by reference in the EIS.

In accordance with the guidelines set forth by 23 CFR Part 771, 49 CFR Part 622, the Clean Air Act (CAA U.S.C. Title 42, Chapter 85, 1970, as amended 1990), and the National Environmental Policy Act (NEPA), an air quality analysis is necessary to document the existing air quality conditions in the vicinity of the MRC and to evaluate the potential changes that would occur as a result of the development of the action alternatives. According to the Metropolitan Washington Council of Governments (MWCOC), air quality in the vicinity of the MRC and in the region, which is influenced primarily by transportation-related mobile sources, predominantly motor vehicle traffic on adjacent roadways, has been steadily improving in recent decades (MWCOC, 2020). This air quality technical report assesses and reports the potential air quality impacts resulting from proposed development at the MRC. The EIS considers the No-Action Alternative and three Action Alternatives (Alternatives A, B, and C) to accommodate the additional staff at the MRC under this Master Plan. **Figure 1-1** shows the project location.

This air quality analysis considered the potential effects of the MRC expansion on air-sensitive residential, institutional, and recreational facilities near the MRC. The mobile source air quality analysis considered the effects of air pollutant emissions generated due to added commuter trips on the area roadways and



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the stationary source air quality analysis associated with the three Master Plan Action Alternatives (Alternatives A, B, and C). This report also considers construction, indirect, and cumulative effects.

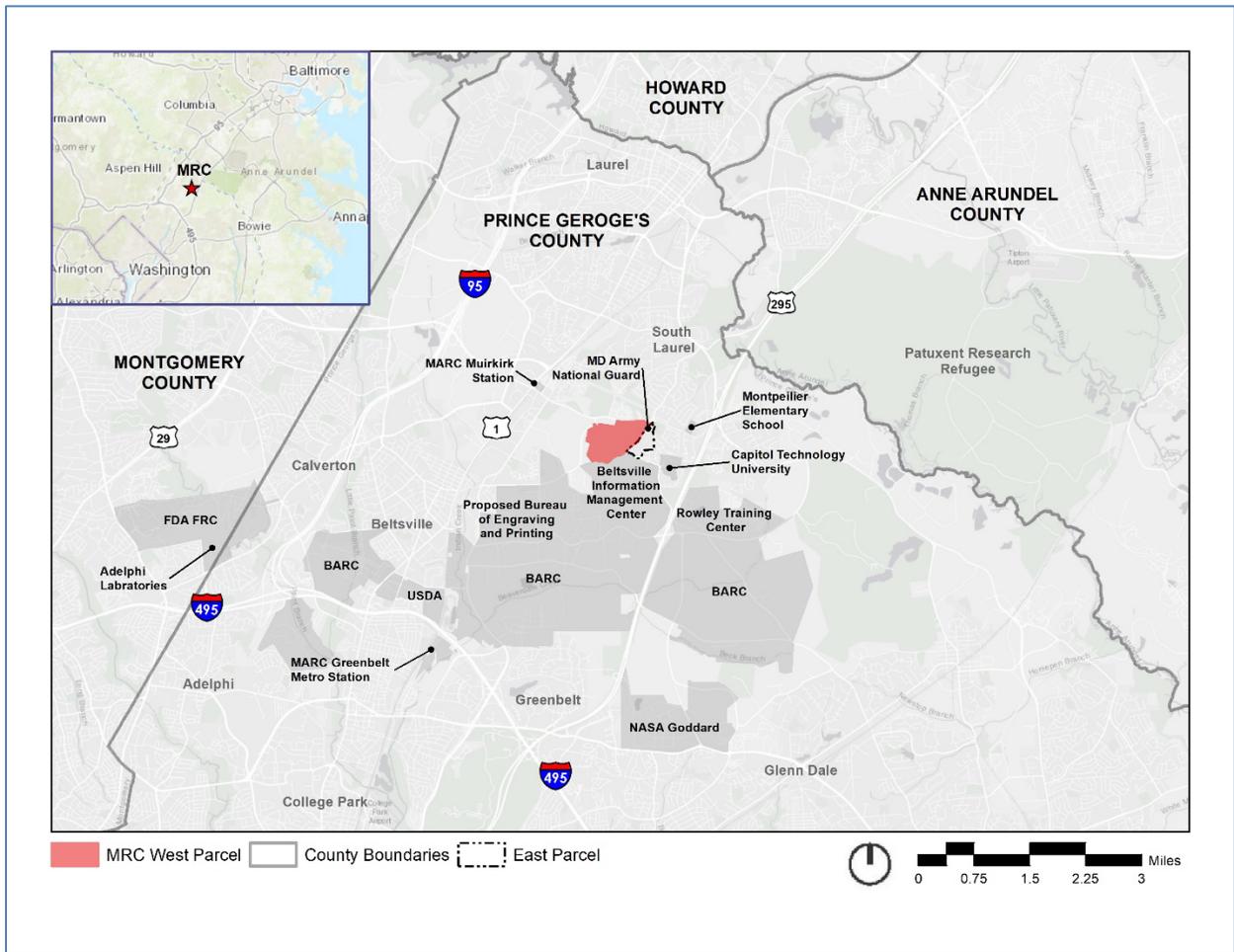


Figure 1-1. Project Location Map



2.0 AFFECTED ENVIRONMENT

The MRC is in the City of Laurel in Prince George’s County, Maryland between Washington, DC and Baltimore, MD (**Figure 2 1**). The main entrance to the MRC is at 8301 Muirkirk Road. The campus lies two miles east of the terminus of Maryland Route 200, 1.5 miles northwest of the Powder Mill Road/Baltimore-Washington Parkway interchange, and 11 driving miles from FDA’s headquarters campus at the Federal Research Center (FRC). FDA owns 249 acres of land at Muirkirk Road, of which 197 acres is the West Parcel and is bounded to the north by Muirkirk Road and residential properties; to the east by Odell Road and the MRC East Parcel; to the south by Odell Road, the Beltsville Information Management Center, and the Special Collection Service; and to the west by Ellington Drive (**Figure 2 2**). The southern portion of the campus is dedicated to animal research and home to the Animal Research Facility operated by the Center for Veterinary Medicine (CVM), which occupies 113 acres. The southern portion also includes four pastures, referred to as Pasture A-D, which taken together cover about 32 acres. The total land area of the southern section (the Pastures and Animal Research Facility) is roughly 145 acres (**Table 2-1**). The existing FDA offices and laboratories are concentrated on the northern portion of the campus, which in total covers approximately 52 acres.

Table 2-1. Existing MRC West Parcel Acreages

| West Parcel | Acres |
|---|------------|
| Existing FDA Office & Laboratories | 52 |
| Pastures (A through D) | 32 |
| Animal Research Facility | 113 |
| Total Acreage of MRC West Parcel | 197 |

The MRC East Parcel has been divided into three smaller parcels. One parcel is occupied by the Maryland Army National Guard and another by the South Laurel Pumping Station. The third parcel is undeveloped forested land. The Maryland Army National Guard occupies approximately 23 acres. About 10 acres of the 23 acres have been built on. The South Laurel Pumping Station occupies approximately 4 acres. The remaining area of approximately 25 acres has not been built. See **Figure 2-2** for the area boundary of the East Parcel.

2.1 NATIONAL AMBIENT AIR QUALITY STANDARDS

The CAA authorizes the U.S. Environmental Protection Agency (USEPA) to develop National Ambient Air Quality Standards (NAAQS) for certain air pollutants (criteria pollutants) deemed harmful to public health and the environment. USEPA has set both primary and secondary standards. The primary standards protect public health including sensitive populations such as asthmatics, children, and the elderly. The secondary standards protect the public welfare, including protection against reduced visibility and damage to crops, animals, vegetation, and buildings. The criteria pollutants include nitrogen dioxide (NO₂), sulfur dioxide (SO₂), carbon monoxide (CO), ozone (O₃), particulate matter (PM_{2.5}/PM₁₀), and lead (Pb). The standards are given as pollutant concentrations such as parts per million (ppm), parts per billion (ppb), and micrograms per cubic meter of air (µg/m³). The concentration standards for each of these criteria pollutants are presented in **Table 2-2**.



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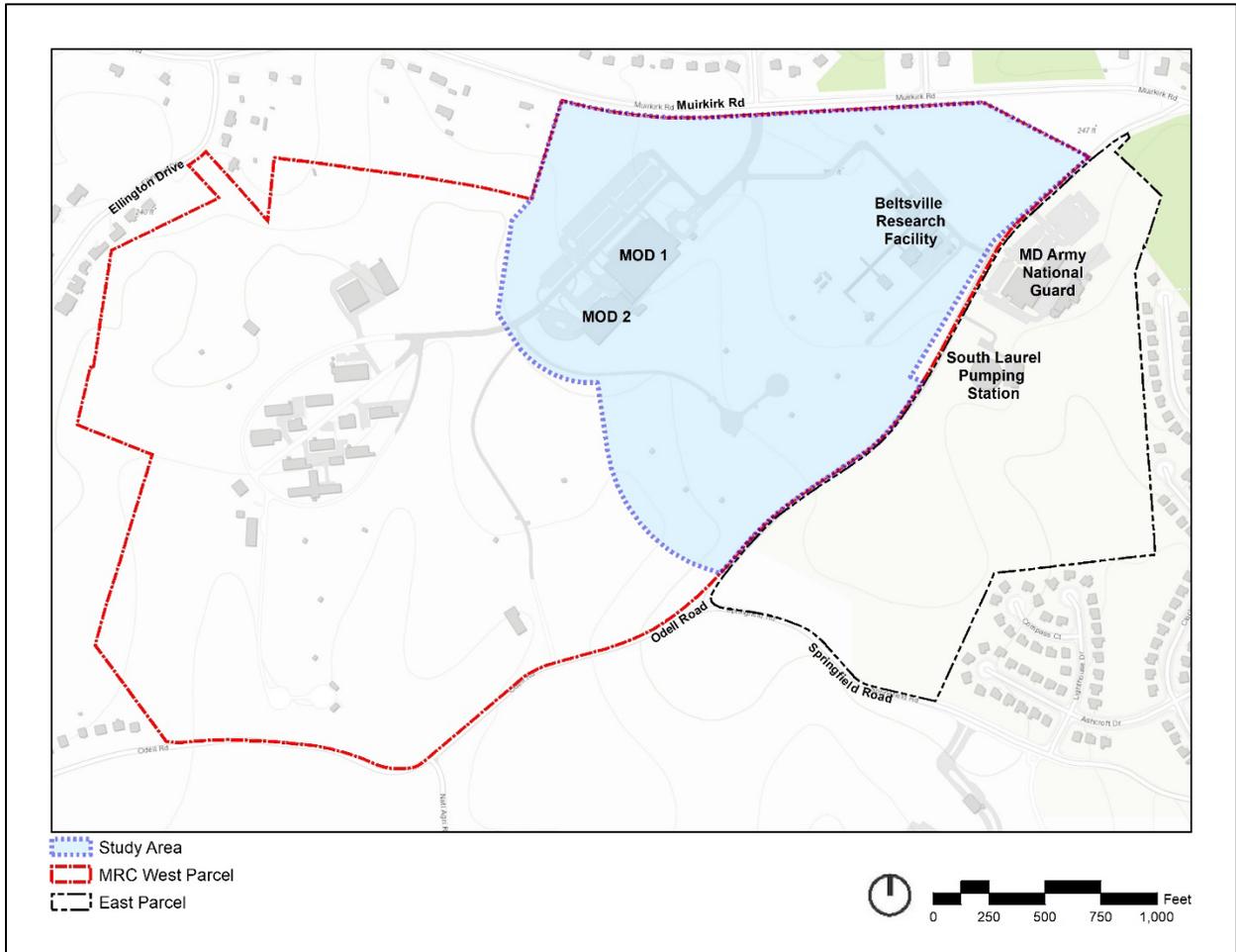


Figure 2-1. MRC Map



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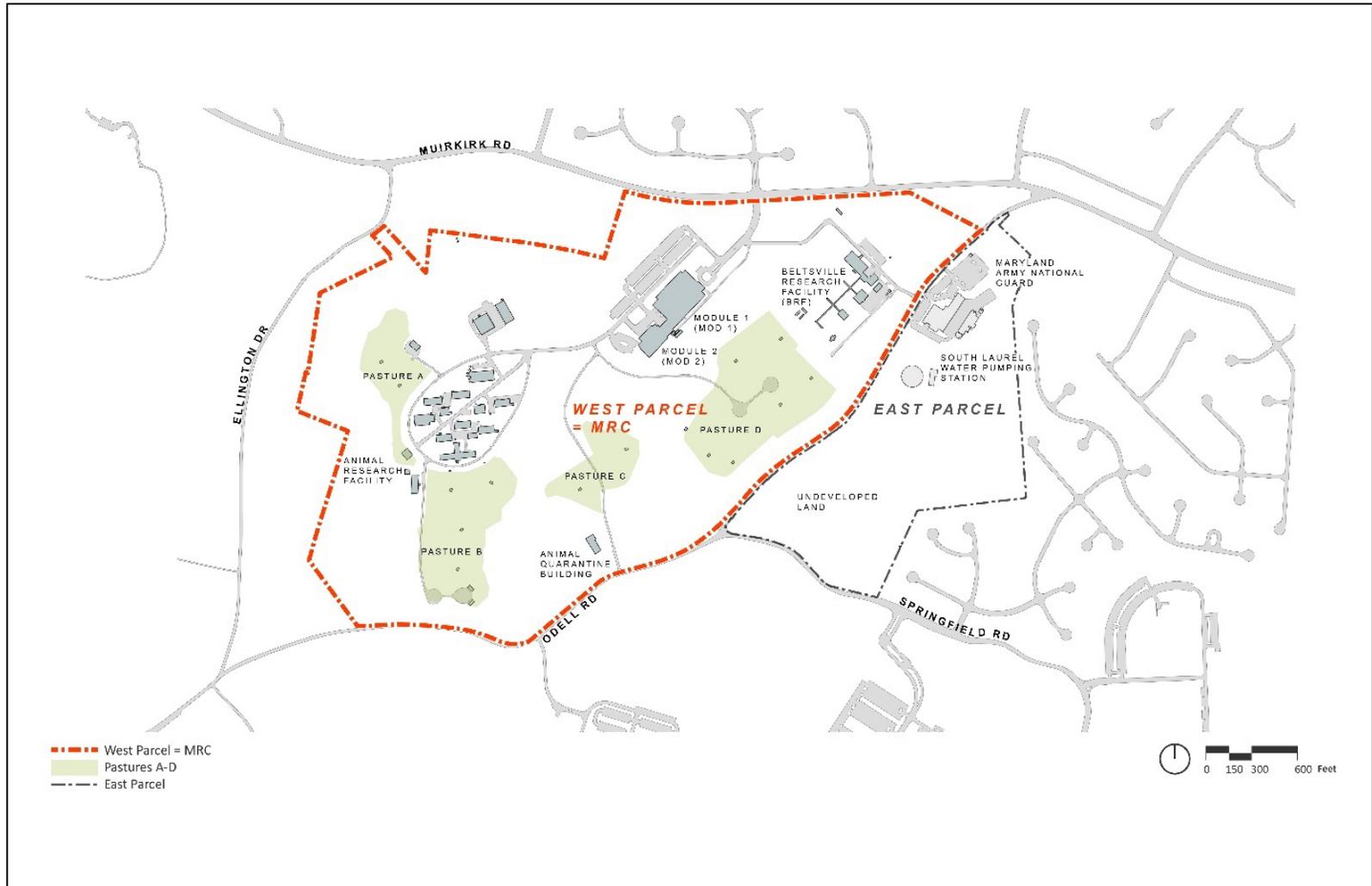


Figure 2-2. FDA Area Boundaries



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Table 2-2. National Ambient Air Quality Standards

| Pollutant | | Primary/Secondary | Averaging Time | Level | Form |
|-------------------------------------|-------------------|-----------------------|-------------------------|-------------------------------------|---|
| Carbon Monoxide (CO) | | primary | 8 hours | 9 ppm (10 mg/m ³) | Not to be exceeded more than once per year |
| | | | 1 hour | 35 ppm (40 mg/m ³) | |
| Lead (Pb) | | primary and secondary | Rolling 3-month average | 0.15 µg/m ³ (1) | Not to be exceeded |
| Nitrogen Dioxide (NO ₂) | | primary | 1 hour | 100 ppb (188 µg/m ³) | 98 th percentile of 1-hour daily maximum concentrations, averaged over 3 years |
| | | primary and secondary | 1 year | 53 ppb (2) (100 µg/m ³) | Annual Mean |
| Ozone (O ₃) | | primary and secondary | 8 hours | 0.070 ppm (3) | Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years |
| Particle Pollution (PM) | PM _{2.5} | primary | 1 year | 12.0 µg/m ³ | Annual Mean, averaged over 3 years |
| | | secondary | 1 year | 15.0 µg/m ³ | Annual Mean, averaged over 3 years |
| | | primary and secondary | 24 hours | 35 µg/m ³ | 98 th percentile, averaged over 3 years |
| | secondary | | | | |
| | PM ₁₀ | primary and secondary | 24 hours | 150 µg/m ³ | Not to be exceeded more than once per year on average over 3 years |
| Sulfur Dioxide (SO ₂) | | primary | 1 hour | 75 ppb (4) (196 µg/m ³) | 99 th percentile of 1-hour daily maximum concentrations, averaged over 3 years |
| | | secondary | 3 hours | 0.5 ppm (1300 µg/m ³) | Not to be exceeded more than once per year |

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m³ as a calendar quarter average) also remain in effect.

(2) The level of the annual NO₂ standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O₃ standards additionally remain in effect in some areas. Revocation of the previous (2008) O₃ standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The previous SO₂ standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2) any area for



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which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO₂ standards or is not meeting the requirements of a SIP call under the previous SO₂ standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Source: [National Ambient Air Quality Standards Table](#)

2.2 NATIONAL AMBIENT AIR QUALITY STANDARD ATTAINMENT STATUS

Areas where concentrations of criteria pollutants are below the NAAQS are designated by USEPA as being in “attainment” and areas where a criteria pollutant level exceeds the NAAQS are designated as being in “nonattainment.” Ozone (O₃) nonattainment areas are categorized based on the severity of nonattainment: marginal, moderate, serious, severe, or extreme. CO and PM₁₀ nonattainment areas are categorized as moderate or serious. The Washington DC-MD-VA Region, which includes the FDA MRC, is designated as a marginal nonattainment area for O₃ under the 2015 8-hour standard (USEPA 2020)¹. The Washington DC-MD-VA region is designated as in attainment or maintenance of the NAAQS for all other criteria pollutants. For further details please refer to Section 2.4.

The Washington DC-MD-VA Region, which includes the FDA MRC, is designated as a marginal nonattainment area for O₃ (area has a design value of 0.071 ppm up to, but not including 0.081 ppm) under the 2015 8-hour standard (MWCOG, 2020). From 2001-2003, the region had an ozone 8-hour design value of 0.099 ppb, which was designated as moderate nonattainment for the now-revoked 1997 NAAQS. The 2008 8-hour ozone (now revoked) was designated as marginal maintenance with a design value of 0.081 ppb from 2008-2010. On August 15, 2019, the region was redesignated by the USEPA regarding the 2008 8-hr ozone standard from marginal nonattainment to attainment maintenance (EPA, 2021). While the area still has ozone issues, precursor emissions such as volatile organic compounds, nitrogen oxides and particulate matter are reducing, therefore ozone concentrations are slowly declining. The District’s Ambient Air Quality Trends Reports illustrates these trends (DOEE, 2020).

Similarly, from 2001-2003, the region had a PM_{2.5} annual design value of 15.8 µg/m³, which exceeded the then standard of 15. However, the region was designated as a maintenance area for the now-revoked 1997 PM_{2.5} NAAQS as outlined in the final rule in the October 6, 2014, Federal Register (79 FR60081). As a result, the first of two 10 year maintenance plans were applied and is active through 2025. The status will be reassessed and likely institute the second 10-year plan. The current 3-year design value for the Maryland portion of the Washington DC-MD-VA region from 2018-2020 is 8.7 µg/m³ (EPA 2021b). The Washington DC-MD-VA region is designated as in attainment of the NAAQS for all other criteria pollutants.

2.3 AIR QUALITY MONITORING DATA

The Maryland Department of the Environment (MDE) operates 25 air quality monitoring sites throughout the state of Maryland. These monitoring sites measure ground-level concentrations of criteria pollutants, and pollutant concentrations from monitoring sites is available from USEPA’s AirData website (USEPA, 2021). The closest air monitoring station to the study area is located 1.2 miles from the FDA Vet Campus in Beltsville, Maryland. Ambient O₃ and CO data recorded from this monitoring station from 2017 to 2019

¹ USEPA Greenbook Designation Area Report 8-hr Ozone (2015) <https://www3.epa.gov/airquality/greenbook/jbca.html>



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are presented in Table 2-2 below. Exceedances of the O₃ 8-hour standard were reported during each year – three times in 2017 and 2018, and four times in 2019. It should be noted that the NAAQS is the 4th high 8-hr averaged over three years. No exceedances of any CO NAAQS were recorded during the same timeframe.

Table 2-3. Ambient Air Quality Data for O₃ and CO, 2017-2019, AQS Site 24-033-0030, HU-Beltsville, 12003 Old Baltimore Pike, Beltsville, MD

| Pollutant | Averaging Time | Form | 2017 | 2018 | 2019 |
|-------------------------------|----------------|---------------------|-------|-------|-------|
| Ozone (O ₃) [ppm] | 8-hour | First Highest | 0.073 | 0.092 | 0.077 |
| | | Second Highest | 0.072 | 0.073 | 0.074 |
| | | Third Highest | 0.071 | 0.071 | 0.071 |
| | | Fourth Highest | 0.069 | 0.07 | 0.071 |
| | | # of Exceedances | 3 | 3 | 4 |
| | | Average Fourth High | 0.070 | | |
| Carbon Monoxide (CO) [ppm] | 1-Hour | First Highest | 1.036 | 1.238 | 1.355 |
| | | Second Highest | 0.902 | 0.869 | 1.124 |
| | | Third Highest | 0.854 | 0.859 | 1.077 |
| | | Fourth Highest | 0.845 | 0.843 | 1.076 |
| | | # of Exceedances | 0 | 0 | 0 |
| | | Average Fourth High | 0.921 | | |
| Carbon Monoxide (CO) [ppm] | 8-Hour | First Highest | 0.700 | 0.800 | 1.000 |
| | | Second Highest | 0.700 | 0.800 | 1.000 |
| | | Third Highest | 0.700 | 0.800 | 1.000 |
| | | Fourth Highest | 0.700 | 0.800 | 0.900 |
| | | # of Exceedances | 0 | 0 | 0 |
| | | Average Fourth High | 0.800 | | |

Source: USEPA AirData, AQS Site ID 24-033-0030, [Interactive Map of Air Quality Monitors](#)

2.4 GENERAL CONFORMITY

Section 176(c) of the CAA prohibits Federal entities from taking actions in non-attainment or maintenance areas which do not conform to the State Implementation Plan (SIP) for the attainment and maintenance of the NAAQS. In November 1993, the USEPA promulgated the General Conformity Regulations (58 FR 63214) to ensure that Federal actions do not cause or contribute to new violations of the NAAQS, do not worsen existing violations of the NAAQS, and do not delay attainment of the NAAQS. The General Conformity regulations laid out in 40 CFR Part 93.153(b) ensure that all Federal actions not covered by the Clean Air Act's Transportation Conformity regulations conform to the State Implementation Plan (SIP) for achieving the NAAQS.

As mentioned in Section 2.2, the MRC is located in the Washington, D.C. area which is designated as Marginal Nonattainment for the 2015 8-Hour Ozone NAAQS. Previously, the area was designated as a Maintenance Area under the 1971 CO NAAQS, the now-revoked 1997 fine particulate (PM_{2.5}) NAAQS, and the 2008 Ozone NAAQS. Lastly, the area was classified as moderate nonattainment under the now-



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revoked 1997 Ozone NAAQS. Table 2-3 includes a summary of current and past Nonattainment and Maintenance designations.

Table 2-4 Summary of Nonattainment and Maintenance designations for the project area.

| National Ambient Air Quality Standard (NAAQS) – District of Columbia | Status Description for Project Area ¹ |
|--|--|
| 1971 Carbon Monoxide | Redesignated to “in Maintenance” in 1996. |
| 1997 PM _{2.5} (Now-revoked) | Redesignated to “in Maintenance” in 2014. |
| 1979 1-Hour Ozone (Now-revoked) | Designated as “Severe Nonattainment” in 1992; Standard revoked on June 15, 2005. |
| 1997 8-Hour Ozone (Now-revoked) | Designated as “Moderate Nonattainment” in 2004; Standard revoked on April 6, 2015. |
| 2008 8-Hour Ozone | Redesignated as “in Maintenance” on August 15, 2019. |
| 2015 8-Hour Ozone | Designated as “Marginal Nonattainment” in 2018. |

¹ EPA Greenbook – District of Columbia, retrieved in October 2021 from online portal: https://www3.epa.gov/airquality/greenbook/anayo_dc.html.

To demonstrate General Conformity with all relevant NAAQS, direct and indirect emissions were estimated for CO, PM_{2.5/10}, NO_x and VOC using EPA’s MOVES3.0.4 emissions model and compared to published allowable emission rates defined in 40 CFR 93.153(b)(1) and 93.153(b)(2). During construction and pre-construction, direct emissions include:

- Construction equipment tailpipe emissions for each alternative examined, and
- Fugitive particulate emissions from earth-moving activities.

Once construction is completed and regular operations at the site commence, direct emissions will be sourced from:

- Emergency generator(s); and
- Natural gas-fired space heaters.

Indirect emissions for each alternative include onroad emissions of PM_{2.5/10}, CO, NO_x, and VOC sourced from:

- Onroad commuter tailpipe emissions sourced from construction workers traveling to and from the site each workday during construction; and
- Onroad commuter tailpipe emissions sourced from facility staff once the facility is being used for regular operations.

Table 2-4 includes pre-project direct and indirect emissions from construction activities and emissions, both direct and indirect, resulting from the completed project during 2021, 2030 and 2040.



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Table 2-5. Demonstration of General Conformity during the Construction Phase

| Pollutant of Interest | PM _{2.5/10} | VOC | NOx | CO |
|--|----------------------|-------|-------|-------|
| Emission Limit for General Conformity in Other Ozone NAAs inside Ozone Transport Region ¹ (tpy) | 100 | 50 | 100 | 100 |
| Construction and Worker Emissions, All Phases for Alternative with Maximum Emissions ² | 14.85 | 12.49 | 54.41 | 17.40 |
| Post- Construction Project Emissions for Action Alternative A-C in 2030 (tpy) | 3.25 | 5.20 | 33.84 | 8.03 |
| Post- Construction Project Emissions for Action Alternative B3 in 2030 (tpy) | 3.19 | 5.09 | 33.42 | 8.03 |
| Post- Construction Project Emissions for Selected Alternative in 2040 (tpy) | 1.85 | 1.71 | 15.39 | 8.01 |

¹The project area is currently located in an area designated as Marginal Nonattainment, therefore general conformity was demonstrated via comparison to the limits in 40 CFR 93.153(b)(1) and (2).

²Alternative A included the highest projected emissions of all construction alternatives examined.

2.5 GREENHOUSE GAS REPORTING

The White House Council on Environmental Quality (CEQ) provides guidance for federal agencies on consideration of greenhouse gas (GHG) emissions in NEPA reviews. CEQ provides a reference point of 25,000 metric tons of CO₂-equivalent (MTCO_{2e}) emissions on an annual basis (CEQ 2014). Below this number, GHG emissions quantitative analysis is generally not warranted unless quantification below that reference point is easily accomplished.

On June 26, 2019, CEQ published *Draft National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions in the Federal Register* (84 FR 30097), and the public comment period ended on August 26, 2019. The draft guidance discusses how NEPA analysis and documentation should address GHG emissions. If finalized, the guidance would replace the final guidance CEQ issued on August 1, 2016, entitled *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews*, which was withdrawn on April 5, 2017, for further consideration pursuant to EO 13783, *Promoting Energy Independence and Economic Growth*.

However, prior to CEQ promulgating the new regulations to guide the consideration of GHG emissions in NEPA reviews, that too was rescinded by Executive Order 13990, "Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis" on January 20, 2021. The rescission reverts back to the 2016 final guidance. It also states that the guidance will be reviewed for potential revision and updates. Lastly, the total amount of GHG emissions are expected to be less than 25,000 MTCO_{2e}.



2.7 GREENHOUSE GAS EMISSION REDUCTION ACT

The state of Maryland passed the Greenhouse Gas Emission Reduction Act in 2009. The regulation, administered by MDE, requires the state to develop and implement a plan to reduce GHG emissions by 2020 to a point that is 25% below 2006 emissions. The plan, released in 2012 and updated in 2015, encourages reductions in GHG emissions through a variety of incentive programs targeting the public and private sector. These programs focus on increasing energy efficiency using existing technologies, identifying ways to transition to new energy sources, and stimulating further technological development to reduce GHG emissions.



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3.0 ENVIRONMENTAL CONSEQUENCES

New development associated with the expansion of the MRC has the potential to affect air quality in four ways:

- Increased emissions from current stationary sources of pollutants such as generators and boilers throughout the campus;
- Minimal emission estimates for building natural gas heating units.
- Increased vehicular traffic to the site, which raises vehicle emission levels near the site, and possibly in the region; and
- Generation of airborne dust during construction.

The purpose of this evaluation is to identify and quantify the potential direct, indirect, and cumulative air quality impacts related to the proposed development and operation of the MRC as proposed in the 2023 Master Plan. For this analysis, the emission inventories of mobile and stationary sources for each alternative were evaluated for conformity with the Washington Metropolitan Region SIP.

The MRC currently contains 480,000 gsf of existing building space and accommodates 300 employees.

3.1 NO-ACTION ALTERNATIVE & PROPOSED ACTION ALTERNATIVES

3.1.1 No-Action Alternative

Under the No-Action Alternative, a new MRC Master Plan would not be adopted, and FDA would continue its current operations at the MRC. The site would continue to be occupied by CVM and CFSAN employees and support staff. No new office, laboratory, or special use facilities would be constructed, and the number of employees and support staff would remain at 300 (Error! Reference source not found.). At present, the MRC is home to:

- 480,000 gsf office and laboratory space
- 300 assigned personnel to the MRC (specifically employees and support staff for CVM and CFSAN)
- Approximately 40 visitors per day
- 32 acres of pastures
- 320 parking spaces for employees, support staff, and visitors (all surface parking)



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3.1.2 Action Alternatives

The Master Plan includes three Action Alternatives. Each of the MRC Master Plan Action Alternatives would provide a total of up to approximately 918,000 gsf of building space (Error! Reference source not found.). T The existing MOD 1 and MOD 2 buildings totaling 480,000 gsf would be retained, and up to 438,000 gsf of new office/laboratory buildings, and special use space would be constructed. Special use space under all of the alternatives would include a truck screening facility, visitor/amenity center, maintenance and storage area, conference center, cafeteria, and fitness center. Each of the Master Plan Action Alternatives would add 1,500 new employees and support staff and approximately 207 visitors per day are anticipated. The Master Plan includes 900 parking spaces for employees and support staff (one parking space for every two employees and support staff), and 80 parking spaces for visitors, for a total of 980 parking spaces. The Action Alternatives would add a new entry gate at Odell Road and assumes the back road entrance for emergency and special access would remain.

Each Action Alternative emphasizes connectivity and walkability and envisions underground service corridors and skybridges between existing and new buildings. Each of the Action Alternatives would maintain tree cover and minimize environmental disturbances to include a 100-foot vegetation buffer along the perimeter and a 300-foot buffer along the western perimeter. Bioswales, green roofs, and green façades adjacent to parking garages would be provided.

Table 3-1. Summary of MRC Master Plan Components

| | No-Action Alternative | Action Alternative A | Action Alternative B | Action Alternative C |
|---|-----------------------|----------------------|----------------------|----------------------|
| Office/Laboratory Space – existing to be retained (gsf) | 480,000 | 480,000 | 480,000 | 480,000 |
| Proposed Office Space (gsf) | | 375,000 | 184,500 | 375,000 |
| Proposed Laboratory Space (gsf) | | 0 | 168,000 | 0 |
| Shared/Special Use Space (gsf) | | 63,000 | 40,800 | 63,000 |
| Employees | 300 | 1,500 | 1,500 | 1,500 |
| Total Employee Parking* | 320** | 900 | 900 | 900 |
| Total Visitor Parking* | | 80 | 80 | 80 |

*New parking includes replacement of existing parking displaced by new buildings.

** Includes both employee and visitor parking



3.1.2.1 Alternative A – Compact Campus

Development would be concentrated to the north and west of the MOD 1 and MOD 2 buildings under Alternative A (Figure 3-1). A strategically positioned atrium would allow for a view from the main entry, through the new building, into the forested stream valley at the center of the campus.

Alternative A would include two new office buildings up to five to six stories tall adjacent to the existing MOD 1 and MOD 2 buildings. The existing surface parking lot west of MOD 1 would be replaced with a new building. The new building north of MOD 1 would be visible from the main entrance at Muirkirk Road. However, most of the building volume would be screened by forested areas that form the perimeter landscape buffer. Two new parking garages would be located at the BRF site that would contain 900 parking spaces, and 80 surface parking spaces would be provided for visitors. Facilities at the existing BRF site would be demolished to accommodate the new parking structures. An elevated boardwalk would be constructed within the natural landscape amenity space east of the MOD 1 and MOD 2 buildings. Two pedestrian skybridges would connect MOD 1 to the new buildings to the north and west. Alternative A would also include special use space for shared amenities including a conference center, cafeteria, and fitness center.

ALTERNATIVE A SUMMARY

375,000 gsf of office space in two new buildings

Office buildings up to 5- to 6-stories tall

63,000 gsf of new special use spaces

Two new parking garages with 900 spaces

80 surface parking spaces for visitors

Elevated boardwalk & skybridges



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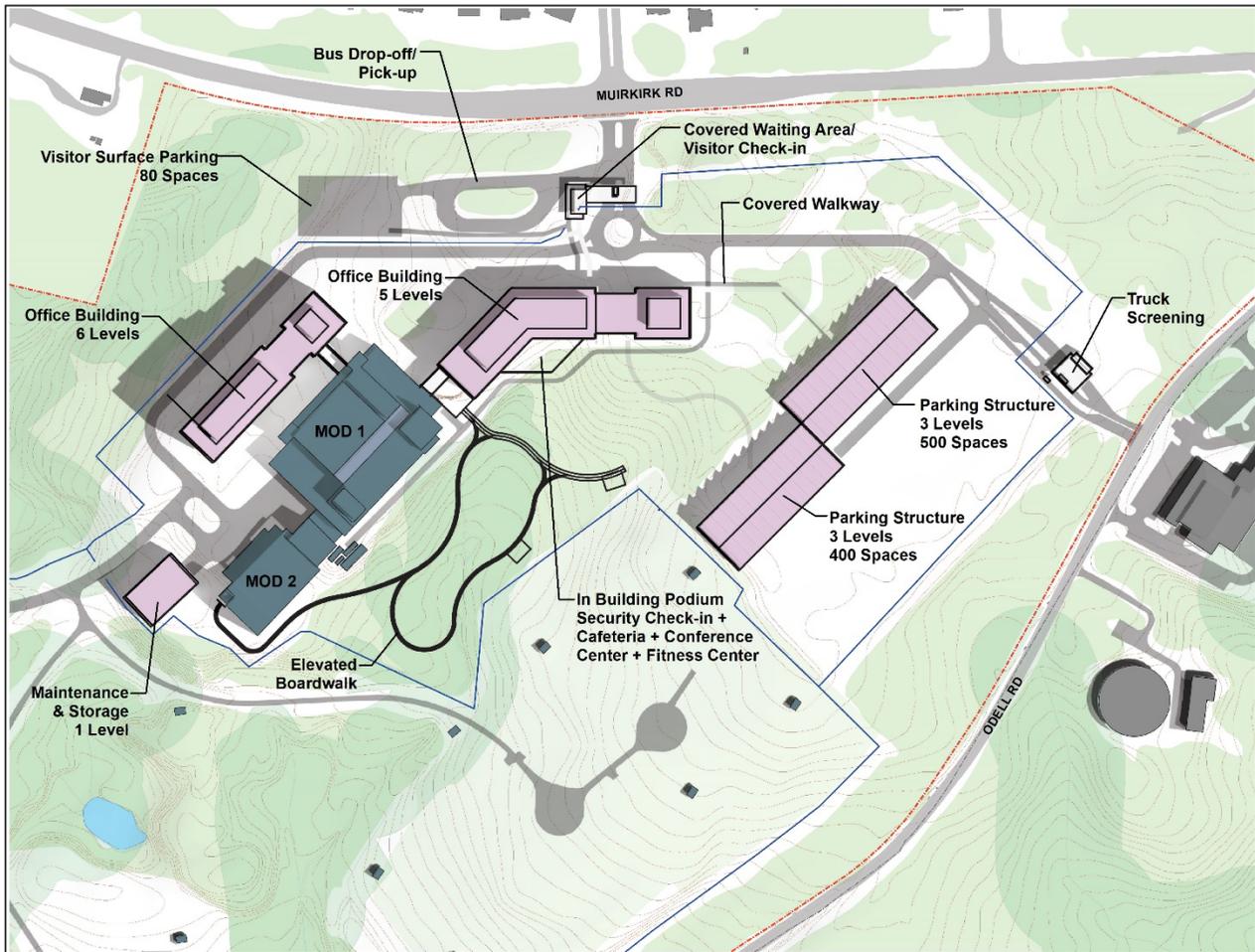


Figure 3-1. Alternative A



3.1.2.2 Alternative B – Dual Campus (Preferred Alternative)

Due to HHS's new workplace strategy, as outlined in Section 2.6, and the additional need for laboratory space, the Design Team refined Alternative B which considered siting, massing, and conceptual design of the new buildings. While the program is different than in the Draft Master Plan and EIS, the development under this Alternative is relatively the same as analyzed in the Draft EIS (Figure 3-2). Development within Alternative B would continue to be distributed between the MOD 1 and MOD 2 buildings and the BRF site. A four-story laboratory building within Alternative B includes a view corridor into the woodlands as you enter the site off Muirkirk Road. In addition, Alternative B has been broken out into three phases as opposed to two that are proposed in Alternatives A and C. These phases include:

- Phase 1 involves construction of an approximate 18,000-square-foot annex to the MOD 2 building. Under this phase the population at the MRC West Parcel would remain at 300. The annex building would be used to accommodate both staff from the BRF and the renovation occurring within MOD 2.
- Phase 2 involves the construction of two laboratory buildings that would accommodate 168 scientists and support staff. The gross area would be approximately 168,000 gsf of office/lab space and 6,300 gsf of special use space. Phase 2 includes the removal of the surface parking lot adjacent to MOD 1 and the construction of a parking garage for 235 spaces. An approximate 10,000 gsf maintenance/storage building adjacent to the new parking garage would also be constructed. Phase 2 would also include maintaining the metal warehouse building and fitness center at the BRF; and creating a temporary surface lot on the BRF site, and new entrance to Odell Road for truck screening. The visitor parking lot would be constructed and the Muirkirk Road entrance would be rebuilt with shared drop-off.
- Phase 3 involves two office buildings that would accommodate a population of 1,332 and shared use space to support the campus. The two new office buildings would be constructed on the site of the BRF. The total gross area is approximately 166,500 gsf of office space and 24,5000 gsf of special use space. This phase would also include a four-level parking garage for 665 spaces. Additionally, Phase 3 activities involves the removal of temporary parking and all remaining existing buildings at the BRF site would be removed.

An elevated boardwalk would be constructed within the natural landscape that would connect the laboratory buildings with the office buildings. A skybridge between the laboratory and office buildings would encourage collaboration. Alternative B would also include space for shared amenities including a conference center, cafeteria, and fitness center.

ALTERNATIVE B SUMMARY

184,500 square feet of office space to 5-stories tall

168,000 square feet of laboratory space up to 4-stories tall

30,800 sf of new special use spaces

10,000 sf of maintenance/storage space (shared space)

Two new parking garages with 900 spaces

80 surface parking spaces for visitors

Elevated boardwalk



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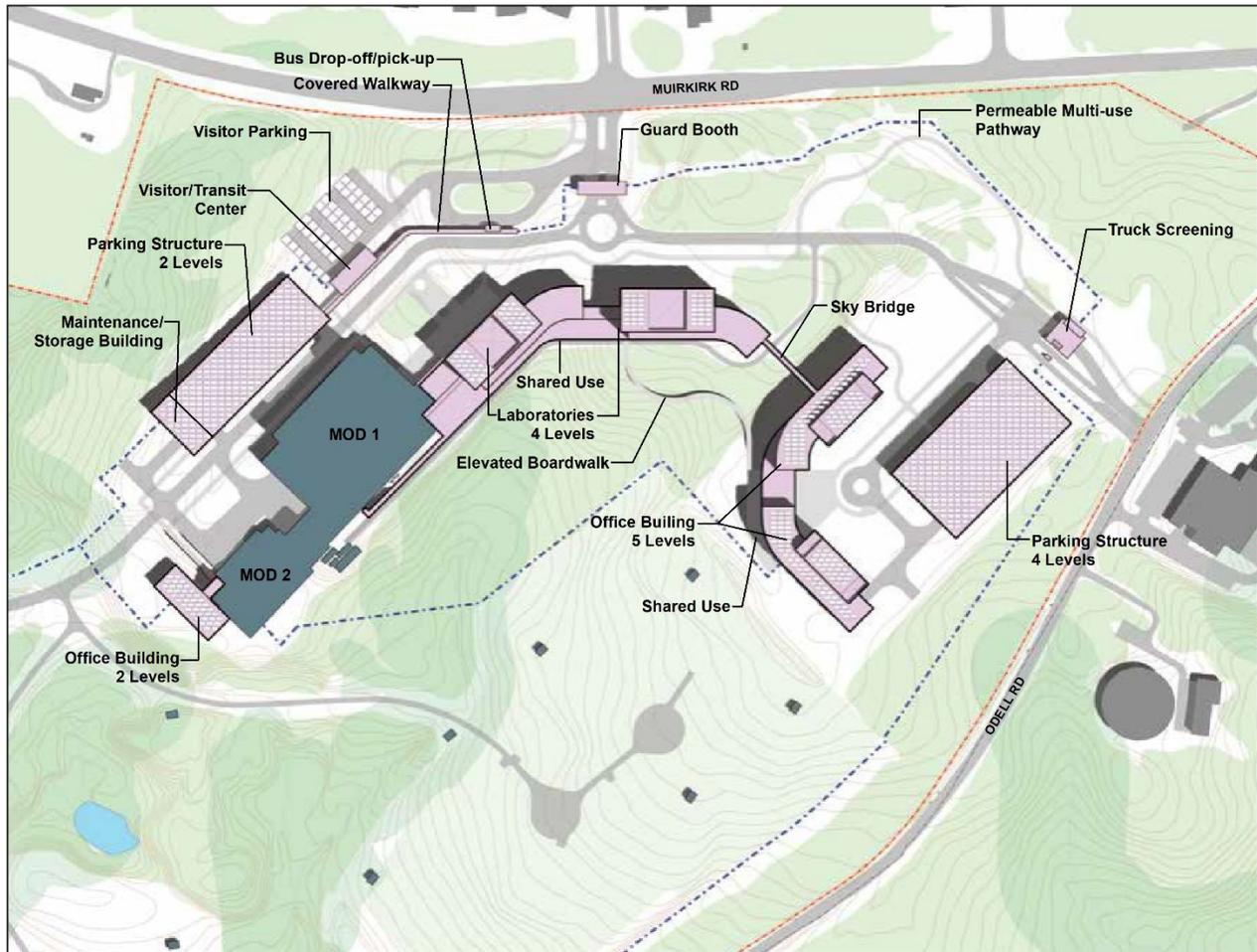


Figure 3-2. Alternative B (Preferred Alternative)



3.1.2.3 Alternative C – Northeast Campus

Development would primarily occur at the BRF except for a maintenance/storage building south of MOD 2 (Figure 3-3). The new buildings would barely be visible from the main entrance at Muirkirk Road as most of the building volume would be screened by forested areas that form the perimeter landscape buffer. The forested stream valley at the center of the campus would be visible from both buildings.

With Alternative C, the MOD 1 and MOD 2 buildings would remain. Alternative C includes two new office buildings that would be up to five stories tall at the BRF connected by a covered walkway (Error! Reference source not found.). Two new parking garages up to three stories tall would be constructed to the east of the new buildings at the BRF. The parking garages would contain a total of 750 parking spaces and 230 surface parking spaces would also be provided. A portion of the existing surface parking lot adjacent to the MOD 1 and MOD 2 buildings would be returned to natural landscape. Of the 283 surface parking spaces currently located there, only 150 would remain. Eighty surface parking spaces would be provided adjacent to the repurposed BRF building. An elevated boardwalk would be constructed within the natural landscape amenity space west of the MOD 1 and MOD 2 buildings. Alternative C would repurpose the existing BRF building for a visitor center/security screening area. Alternative C would also include space for shared amenities including a conference center, cafeteria, and fitness center.

ALTERNATIVE C SUMMARY

375,000 square feet of office space at two new connected buildings

Office buildings up to 5-stories tall

63,000 sf of new special use spaces

Two new parking garages with 750 spaces

230 surface parking spaces for employees and visitors

Elevated boardwalk



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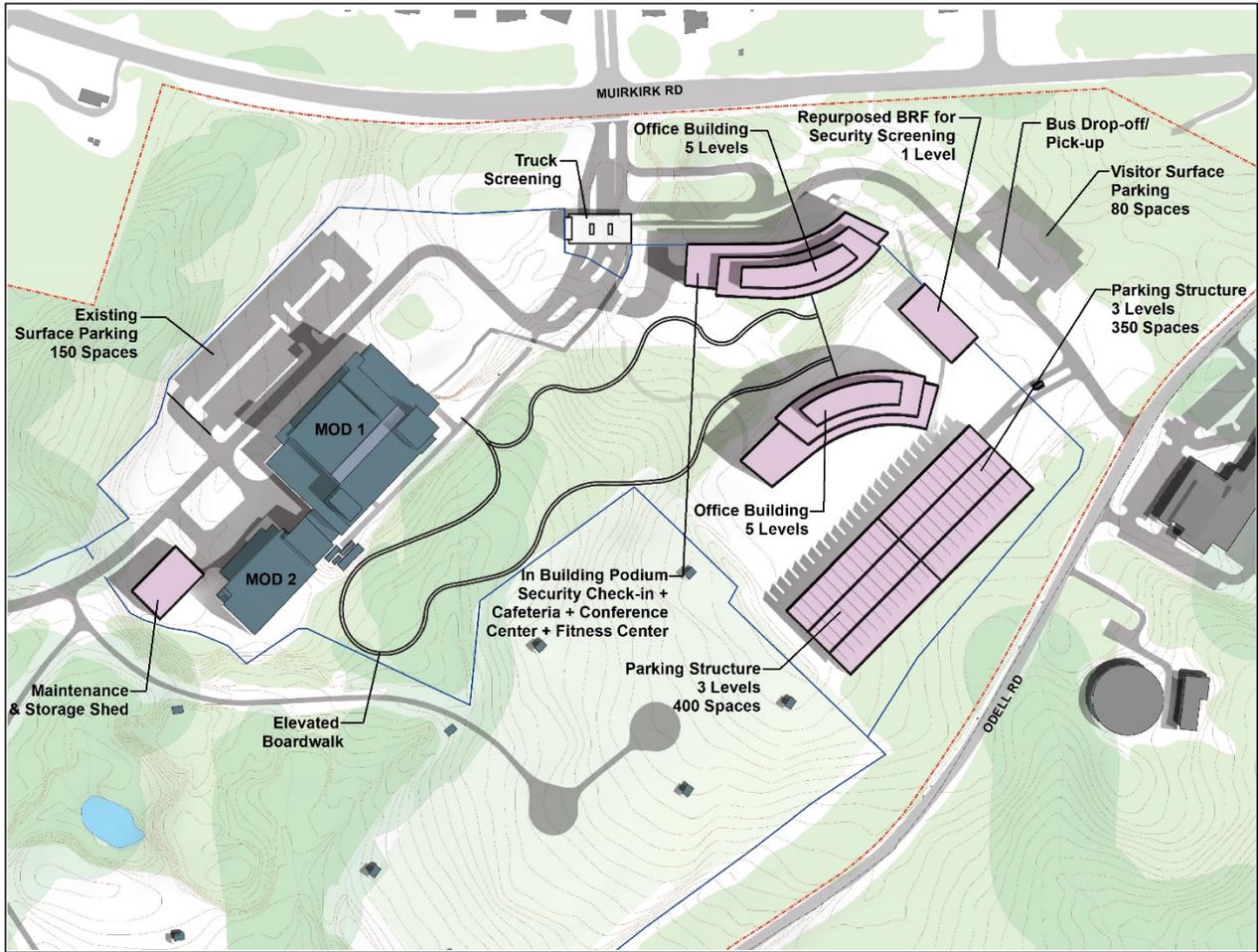


Figure 3-3. Alternative C



3.2 MOBILE SOURCE ANALYSIS

3.2.1 Carbon Monoxide Hot Spot Modeling

The dispersion model used to predict CO concentrations for the traffic study area in this hot spot modeling analysis is the USEPA’s CAL3QHC dispersion model Version 2.0. The study area includes 13 intersections, with the highest activity (vehicle volume during peak hours) intersection, Muirkirk Road and Laurel Bowie Road, displaying some of the lowest levels of service of any intersection within the study area. For this reason, the Muirkirk Road and Laurel Bowie Road intersection was selected to represent a “worst case” intersection for modeling purposes.

The CAL3QHC dispersion model predicts CO (or other photochemically inert) pollutant concentrations from motor vehicles traveling near roadway intersections. The model requires fleet emissions and traffic data (such as volumes, level of service and signal timing) to estimate CO concentrations near air quality receptors near the roadway or intersection of concern. The CAL3QHC model focuses on CO concentrations at intersections because idling vehicles result in the highest localized CO concentrations. Intersections with the worst level of service, slowest average link speed and highest traffic volumes represent the worst-case air pollutant dispersion scenarios. For this analysis, eight discrete receptors were placed at the pedestrian crosswalk corners of the intersection along with an additional sidewalk receptor adjacent to the queue lanes for each vehicle approach direction.

3.2.2 Traffic Data

Traffic data used in this analysis were obtained from the “Traffic Impact Study for U.S. Food and Drug Administration Muirkirk Road Campus Master Plan” (Stantec, 2023). The traffic study included morning and evening peak hour traffic simulation modeling for 13 intersections:

- Maryland 200 West-bound On-Ramp & Virginia Manor Road
- Maryland 200 East-bound Off-Ramp & Virginia Manor Road
- Muirkirk Road & Virginia Manor Road
- Maryland 212 & Virginia Manor Road
- Muirkirk Road & Muirkirk Meadows Drive
- Muirkirk Road & Brickyard Boulevard
- Pasture Road/Snowden Woods Rd. & Muirkirk Road
- Muirkirk Road & Cedarhurst Drive/ Old Baltimore Pike
- Muirkirk Road & Cedarbrook Lane/ Odell Road
- Odell Road & Springfield Road
- Odell Road & Ellington Drive
- Springfield Road & Powder Mill Road
- **Muirkirk Road & Laurel Bowie Road** (selected as “worst case”)

To ensure that worst-case impacts of CO emissions from each project alternative were captured by this analysis, all 13 intersections included in the “Traffic Impact Study for U.S. Food and Drug Administration Muirkirk Road Campus Master Plan, 2023” were evaluated for overall traffic volume and existing levels-



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of-service (LOS).² The intersection with a combination of the highest traffic volume and lowest LOS was selected for dispersion modeling analysis. The intersection selected for this CO hot spot analysis was Muirkirk Road and Laurel Bowie Road. It can reasonably be assumed that the highest impact for any other intersection within the study area will not exceed the maximum impact of CO emissions at this intersection. Traffic data summarized in Tables 3-1 through 3-4 was taken from Synchro traffic simulation model outputs from the draft traffic study (Stantec, 2023).

Table 3-2. Worst Case Intersection – Existing 2021 Traffic Conditions

| Peak Hour | Intersection | Lane Group | 2021 Existing | | | | | | |
|-----------|-------------------------------|--------------|------------------------|-----------|---------------------|-------|-----|-----------------|-----------------|
| | | | Peak Hour Volume (vph) | V/C Ratio | Sat. Flowrate (vph) | Delay | LOS | 50th Queue (ft) | 95th Queue (ft) |
| AM | Laurel Bowie Rd & Muirkirk Rd | EB-L | 124 | 0.59 | 210 | 78.1 | E | 95 | 160 |
| | | EB-LT | 61 | 0.57 | 107 | 76.6 | E | 101 | 165 |
| | | EB-R | 310 | 0.68 | 456 | 42.9 | D | 218 | 317 |
| | | WB-LT | 106 | 0.74 | 143 | 84.5 | F | 149 | 230 |
| | | WB-R | 52 | 0.2 | 260 | 1.7 | A | 0 | 0 |
| | | NB-L | 304 | 1.07 | 284 | 128.5 | F | 348 | 547 |
| | | NB-TR | 1449 | 0.6 | 2415 | 24.8 | C | 381 | 495 |
| | | SB-L | 92 | 0.61 | 151 | 76.8 | E | 104 | 166 |
| | | SB-TR | 1798 | 0.84 | 2140 | 37.5 | D | 628 | 730 |
| | | Intersection | | - | | 43.5 | D | - | - |
| PM | Laurel Bowie Rd & Muirkirk Rd | EB-L | 181 | 0.73 | 248 | 82 | F | 153 | 237 |
| | | EB-LT | 119 | 0.7 | 170 | 78.4 | E | 158 | 243 |
| | | EB-R | 315 | 0.64 | 492 | 38.7 | D | 211 | 311 |
| | | WB-LT | 148 | 0.92 | 161 | 99.3 | F | 243 | 406 |
| | | WB-R | 210 | 0.52 | 404 | 11.3 | B | 0 | 78 |
| | | NB-L | 268 | 1.01 | 265 | 117.3 | F | 283 | 477 |
| | | NB-TR | 1572 | 0.77 | 2042 | 37.8 | D | 531 | 610 |
| | | SB-L | 192 | 0.79 | 243 | 82.6 | F | 194 | 290 |
| | | SB-TR | 1651 | 0.89 | 1855 | 44.8 | D | 637 | 726 |
| | | Intersection | | - | | 50.8 | D | - | - |

² The same worst-case intersection method was employed for estimation of CO, NOx, and VOC for Section 2.4. General Conformity.



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Table 3-3. Worst Case Intersection 2030 and 2040 No Action Alternatives Traffic Conditions

| Peak Hour | Intersection | Lane Group | 2030 No-Action | | | | | | | 2040 No-Action | | | | | | |
|-----------|-------------------------------|--------------|------------------------|-----------|---------------------|-------|------|-----------------|-----------------|------------------------|-----------|---------------------|-------|------|-----------------|-----------------|
| | | | Peak Hour Volume (vph) | V/C Ratio | Sat. Flowrate (vph) | Delay | LOS | 50th Queue (ft) | 95th Queue (ft) | Peak Hour Volume (vph) | V/C Ratio | Sat. Flowrate (vph) | Delay | LOS | 50th Queue (ft) | 95th Queue (ft) |
| AM | Laurel Bowie Rd & Muirkirk Rd | EB-L | 132 | 0.61 | 216 | 79.0 | E | 106 | 174 | 138 | 0.63 | 219 | 79.7 | E | 106 | 174 |
| | | EB-LT | 64 | 0.59 | 108 | 76.9 | E | 110 | 178 | 67 | 0.6 | 112 | 77.4 | E | 110 | 178 |
| | | EB-R | 325 | 0.71 | 458 | 45.5 | D | 259 | 371 | 342 | 0.75 | 456 | 48.6 | D | 259 | 371 |
| | | WB-LT | 111 | 0.76 | 146 | 86.2 | F | 166 | 271 | 117 | 0.79 | 148 | 88.3 | F | 166 | 271 |
| | | WB-R | 55 | 0.22 | 250 | 2.2 | A | 0 | 6 | 57 | 0.22 | 259 | 2.8 | A | 0 | 6 |
| | | NB-L | 319 | 1.12 | 285 | 143.4 | F | 417 | 622 | 335 | 1.18 | 284 | 162.4 | F | 417 | 622 |
| | | NB-TR | 1516 | 0.63 | 2406 | 26.2 | C | 456 | 579 | 1593 | 0.67 | 2378 | 28 | C | 456 | 579 |
| | | SB-L | 107 | 0.62 | 173 | 76.9 | E | 113 | 176 | 113 | 0.63 | 179 | 76.7 | E | 113 | 176 |
| | | SB-TR | 1881 | 0.89 | 2113 | 40.7 | D | 755 | 909 | 1977 | 0.94 | 2103 | 45.9 | D | 755 | 909 |
| | | Intersection | | - | | | 46.5 | D | - | - | | - | | 51 | D | - |
| PM | Laurel Bowie Rd & Muirkirk Rd | EB-L | 190 | 0.75 | 253 | 83.6 | F | 161 | 248 | 199 | 0.77 | 258 | 84.4 | F | 167 | 260 |
| | | EB-LT | 124 | 0.73 | 170 | 79.9 | E | 167 | 254 | 131 | 0.75 | 175 | 81.3 | F | 175 | 267 |
| | | EB-R | 331 | 0.67 | 494 | 41.3 | D | 230 | 335 | 348 | 0.7 | 497 | 43.4 | D | 247 | 360 |
| | | WB-LT | 155 | 0.95 | 163 | 104.5 | F | 256 | 432 | 163 | 1 | 163 | 116.1 | F | 272 | 463 |
| | | WB-R | 220 | 0.53 | 415 | 11.2 | B | 0 | 81 | 231 | 0.54 | 428 | 11.2 | B | 0 | 82 |
| | | NB-L | 283 | 1.06 | 267 | 128.5 | F | 319 | 512 | 297 | 1.12 | 265 | 144.5 | F | 349 | 546 |
| | | NB-TR | 1644 | 0.81 | 2030 | 40.2 | D | 575 | 653 | 1728 | 0.87 | 1986 | 43.4 | D | 630 | 705 |
| | | SB-L | 205 | 0.81 | 253 | 84.1 | F | 204 | 318 | 211 | 0.84 | 251 | 86.6 | F | 216 | 343 |
| | | SB-TR | 1726 | 0.94 | 1836 | 49.7 | D | 693 | 824 | 1815 | 0.99 | 1833 | 59.9 | E | 805 | 901 |
| | | Intersection | | - | | | 54.6 | D | - | - | | - | | 61.1 | E | - |



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Table 3-4. Worst Case Intersection 2030 (A-C) and 2030 (B3) Action Alternatives Traffic Conditions

| Peak Hour | Inter-section | Lane Group | 2030 A-C Action | | | | | | | 2030 B3 Action | | | | | | |
|-----------|-------------------------------|--------------|------------------------|-----------|---------------------|-----------|-----|-----------------|-----------------|------------------------|-----------|---------------------|-------|-----|-----------------|-----------------|
| | | | Peak Hour Volume (vph) | V/C Ratio | Sat. Flowrate (vph) | Delay (s) | LOS | 50th Queue (ft) | 95th Queue (ft) | Peak Hour Volume (vph) | V/C Ratio | Sat. Flowrate (vph) | Delay | LOS | 50th Queue (ft) | 95th Queue (ft) |
| AM | Laurel Bowie Rd & Muirkirk Rd | EB-L | 133 | 0.61 | 218 | 79.1 | E | 103 | 170 | 132 | 0.61 | 216 | 79 | E | 102 | 167 |
| | | EB-LT | 64 | 0.59 | 108 | 76.7 | E | 105 | 172 | 64 | 0.59 | 108 | 76.9 | E | 105 | 172 |
| | | EB-R | 328 | 0.72 | 456 | 45.8 | D | 240 | 347 | 327 | 0.72 | 454 | 45.7 | D | 239 | 345 |
| | | WB-LT | 111 | 0.76 | 146 | 86.2 | F | 156 | 249 | 111 | 0.76 | 146 | 86.2 | F | 156 | 249 |
| | | WB-R | 55 | 0.22 | 250 | 2.2 | A | 0 | 4 | 55 | 0.22 | 250 | 2.2 | A | 0 | 4 |
| | | NB-L | 339 | 1.2 | 283 | 166.9 | F | 426 | 632 | 330 | 1.16 | 284 | 155.9 | F | 405 | 610 |
| | | NB-TR | 1516 | 0.63 | 2406 | 26.3 | C | 416 | 532 | 1516 | 0.63 | 2406 | 26.2 | C | 415 | 532 |
| | | SB-L | 107 | 0.62 | 173 | 76.9 | E | 108 | 170 | 107 | 0.62 | 173 | 76.9 | E | 108 | 170 |
| | | SB-TR | 1881 | 0.9 | 2090 | 41.2 | D | 693 | 841 | 1881 | 0.89 | 2113 | 40.9 | D | 689 | 810 |
| | | Intersection | - | - | - | 48.9 | D | - | - | - | - | - | 47.8 | D | - | - |
| PM | Laurel Bowie Rd & Muirkirk Rd | EB-L | 198 | 0.76 | 261 | 83.8 | F | 163 | 249 | 195 | 0.76 | 257 | 83.8 | F | 163 | 249 |
| | | EB-LT | 124 | 0.74 | 168 | 80.7 | F | 170 | 258 | 124 | 0.74 | 168 | 80.7 | F | 170 | 258 |
| | | EB-R | 348 | 0.69 | 504 | 42.4 | D | 240 | 348 | 340 | 0.69 | 493 | 42.4 | D | 240 | 348 |
| | | WB-LT | 155 | 0.95 | 163 | 104.5 | F | 256 | 432 | 155 | 0.95 | 163 | 104.5 | F | 256 | 432 |
| | | WB-R | 220 | 0.53 | 415 | 11.2 | B | 0 | 81 | 220 | 0.53 | 415 | 11.2 | B | 0 | 81 |
| | | NB-L | 286 | 1.07 | 267 | 130.3 | F | 323 | 518 | 285 | 1.07 | 266 | 130.3 | F | 323 | 518 |
| | | NB-TR | 1644 | 0.82 | 2005 | 40.4 | D | 577 | 653 | 1644 | 0.82 | 2005 | 40.4 | D | 577 | 653 |
| | | SB-L | 205 | 0.81 | 253 | 84.1 | F | 204 | 318 | 205 | 0.81 | 253 | 84.1 | F | 204 | 318 |
| | | SB-TR | 1726 | 0.94 | 1836 | 50 | D | 694 | 824 | 1726 | 0.94 | 1836 | 50 | D | 694 | 824 |
| | | Intersection | - | - | - | 55 | D | - | - | - | - | - | 55 | D | - | - |



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Table 3-5. Worst Case Intersection 2040 Action Alternative Traffic Conditions

| Peak Hour | Inter - section | Lane Group | 2040 Action | | | | | | |
|-----------|-------------------------------|--------------|------------------------|-----------|---------------------|-----------|-----|-----------------|-----------------|
| | | | Peak Hour Volume (vph) | V/C Ratio | Sat. Flowrate (vph) | Delay (s) | LOS | 50th Queue (ft) | 95th Queue (ft) |
| AM | Laurel Bowie Rd & Muirkirk Rd | EB-L | 140 | 0.63 | 222 | 80.1 | F | 108 | 177 |
| | | EB-LT | 67 | 0.6 | 112 | 77 | E | 110 | 178 |
| | | EB-R | 346 | 0.76 | 455 | 49 | D | 263 | 378 |
| | | WB-LT | 117 | 0.79 | 148 | 88.3 | F | 266 | 271 |
| | | WB-R | 57 | 0.22 | 259 | 2.8 | A | 0 | 6 |
| | | NB-L | 359 | 1.26 | 285 | 191.4 | F | 468 | 679 |
| | | NB-TR | 1593 | 0.67 | 2378 | 28.1 | C | 457 | 579 |
| | | SB-L | 113 | 0.63 | 179 | 76.7 | E | 113 | 176 |
| | | SB-TR | 1977 | 0.95 | 2081 | 47.1 | D | 766 | 920 |
| | | Intersection | - | - | - | 54.1 | D | - | - |
| PM | Laurel Bowie Rd & Muirkirk Rd | EB-L | 214 | 0.79 | 271 | 86.2 | F | 176 | 286 |
| | | EB-LT | 131 | 0.76 | 172 | 82.1 | F | 183 | 280 |
| | | EB-R | 376 | 0.75 | 501 | 46.9 | D | 278 | 400 |
| | | WB-LT | 163 | 1 | 163 | 116.1 | F | 272 | 463 |
| | | WB-R | 231 | 0.54 | 428 | 11.2 | B | 0 | 82 |
| | | NB-L | 298 | 1.13 | 264 | 146.7 | F | 353 | 550 |
| | | NB-TR | 1728 | 0.87 | 1986 | 44 | D | 633 | 705 |
| | | SB-L | 216 | 0.84 | 257 | 86.6 | F | 216 | 343 |
| | | SB-TR | 1815 | 1 | 1815 | 61.9 | E | 810 | 902 |
| | | Intersection | - | - | - | 62.4 | E | - | - |

3.2.3 Emission Factors

The mobile source emission factors used in the CAL3QHC model for the prediction of ambient CO concentrations were estimated using the USEPA MQtor Vehicle Emission Simulator model version 3.0.4 (MOVES3.0.4) released by USEPA in August 2022. Please note that NOx and VOC emission rates were generated via the same methodology for use in demonstrating General Project Conformity in Section 2.4 of this report.

MOVES calculates emission factors or emission inventories for both onroad and nonroad vehicles. In the modeling process, the vehicle types, time periods, geographical areas, pollutants, vehicle operating characteristics, and road types are specified. MOVES3.0.4 then uses this information to perform calculations reflecting the vehicle operating processes and ultimately estimate total emissions or emission rates per vehicle or unit of activity. MOVES3.0.4 contains a default database that summarizes the aforementioned relevant information for every county in the U.S.

The assumptions and activity data used for this project were obtained from the national database for Prince George’s County, Maryland, where the study area is located, for the existing conditions (2021), and project horizon years of 2030 for Alternatives A-C, 2030 for Alternative B3 and 2040. MOVES3.0.4 was used to generate link-level grams-per-vehicle hour emission rates for CO, NOx, and VOC for the Muirkirk



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Road and Laurel Bowie Road intersection for morning and evening peak hours for a total of ten MOVES3.0.4 model scenarios. In addition, CO grams-per-vehicle-mile emission rates were generated for each free-flow departure link within the intersection of interest. MOVES3.0.4 emission rates used in each dispersion scenario are included in Table 3-5. Sample MOVES run specification files for the 2021 Existing Conditions morning peak scenario are included in Appendix A.

Table 3-6. Link-Level CO No Action Emission Rates for Worst Case Intersection at Muirkirk Rd. and Laurel Bowie Rd.

| Link Number | Link Type | Link Description | Emission Factor Units | 2021 Existing Conditions AM Peak | 2021 Existing Conditions PM Peak | 2030 No-Action AM Peak | 2030 No-Action PM Peak | 2040 No-Action AM Peak | 2040 No-Action PM Peak |
|-------------|-----------|------------------|-----------------------|----------------------------------|----------------------------------|------------------------|------------------------|------------------------|------------------------|
| 1 | Queue | EB-L | g/veh-hr | 3.27E-02 | 2.27E-02 | 1.65E-02 | 1.15E-02 | 9.77E-03 | 1.56E-02 |
| 2 | Queue | EB-LT | g/veh-hr | 6.66E-02 | 3.45E-02 | 3.41E-02 | 1.76E-02 | 2.01E-02 | 2.37E-02 |
| 3 | Queue | EB-R | g/veh-hr | 1.31E-02 | 1.30E-02 | 6.71E-03 | 6.59E-03 | 3.94E-03 | 8.94E-03 |
| 4 | Queue | WB-LT | g/veh-hr | 8.12E-02 | 5.31E-02 | 5.03E-02 | 3.17E-02 | 2.69E-02 | 4.15E-02 |
| 5 | Queue | WB-R | g/veh-hr | 1.66E-01 | 3.74E-02 | 1.02E-01 | 2.24E-02 | 5.53E-02 | 2.93E-02 |
| 6 | Queue | NB-L | g/veh-hr | 1.06E-02 | 1.33E-02 | 5.53E-03 | 6.86E-03 | 3.26E-03 | 9.27E-03 |
| 7 | Queue | NB-TR | g/veh-hr | 2.22E-03 | 2.27E-03 | 1.16E-03 | 1.18E-03 | 6.86E-04 | 1.59E-03 |
| 8 | Queue | SB-L | g/veh-hr | 4.36E-02 | 2.09E-02 | 2.02E-02 | 1.05E-02 | 1.18E-02 | 1.46E-02 |
| 9 | Queue | SB-TR | g/veh-hr | 2.23E-03 | 2.43E-03 | 1.15E-03 | 1.25E-03 | 6.75E-04 | 1.70E-03 |
| 10 | Free-flow | EB-Thru | g/mi | 4.06E+00 | 4.11E+00 | 2.18E+00 | 2.18E+00 | 1.35E+00 | 1.36E+00 |
| 11 | Free-flow | WB-Thru | g/mi | 8.61E+00 | 7.86E+00 | 5.59E+00 | 4.92E+00 | 3.15E+00 | 4.30E+00 |
| 12 | Free-flow | NB-Thru | g/mi | 3.22E+00 | 3.57E+00 | 1.76E+00 | 1.94E+00 | 1.09E+00 | 1.34E+00 |
| 13 | Free-flow | SB-Thru | g/mi | 4.02E+00 | 4.02E+00 | 2.16E+00 | 2.16E+00 | 1.34E+00 | 1.34E+00 |



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Table 3-7. Link-Level CO Action Emission Rates for Worst Case Intersection at Muirkirk Rd. and Laurel Bowie Rd.

| Link Number | Link Type | Link Description | Emission Factor Units | 2030 A-C Action AM Peak | 2030 A-C Action PM Peak | 2030 B3 Action AM Peak | 2030 B3 Action PM Peak | 2040 Action AM Peak | 2040 Action PM Peak |
|-------------|-----------|------------------|-----------------------|-------------------------|-------------------------|------------------------|------------------------|---------------------|---------------------|
| 1 | Queue | EB-L | g/veh-hr | 1.64E-02 | 1.10E-02 | 1.65E-02 | 1.12E-02 | 9.84E-03 | 6.63E-03 |
| 2 | Queue | EB-LT | g/veh-hr | 3.41E-02 | 1.76E-02 | 3.41E-02 | 1.76E-02 | 2.06E-02 | 1.08E-02 |
| 3 | Queue | EB-R | g/veh-hr | 6.65E-03 | 6.27E-03 | 6.67E-03 | 6.41E-03 | 3.98E-03 | 3.77E-03 |
| 4 | Queue | WB-LT | g/veh-hr | 4.43E-02 | 3.60E-02 | 4.43E-02 | 3.60E-02 | 3.06E-02 | 2.20E-02 |
| 5 | Queue | WB-R | g/veh-hr | 8.95E-02 | 2.54E-02 | 8.95E-02 | 2.54E-02 | 6.28E-02 | 1.55E-02 |
| 6 | Queue | NB-L | g/veh-hr | 5.20E-03 | 6.78E-03 | 5.34E-03 | 6.81E-03 | 3.04E-03 | 4.48E-03 |
| 7 | Queue | NB-TR | g/veh-hr | 1.16E-03 | 1.18E-03 | 1.16E-03 | 1.18E-03 | 6.86E-04 | 7.73E-04 |
| 8 | Queue | SB-L | g/veh-hr | 2.02E-02 | 1.05E-02 | 2.02E-02 | 1.05E-02 | 1.18E-02 | 6.18E-03 |
| 9 | Queue | SB-TR | g/veh-hr | 1.15E-03 | 1.25E-03 | 1.15E-03 | 1.25E-03 | 6.75E-04 | 7.36E-04 |
| 10 | Free-flow | EB-Thru | g/mi | 2.18E+00 | 2.18E+00 | 2.18E+00 | 2.18E+00 | 1.38E+00 | 1.42E+00 |
| 11 | Free-flow | WB-Thru | g/mi | 4.92E+00 | 5.59E+00 | 4.92E+00 | 5.59E+00 | 3.58E+00 | 3.58E+00 |
| 12 | Free-flow | NB-Thru | g/mi | 1.76E+00 | 1.94E+00 | 1.76E+00 | 1.94E+00 | 1.09E+00 | 1.34E+00 |
| 13 | Free-flow | SB-Thru | g/mi | 2.16E+00 | 2.16E+00 | 2.16E+00 | 2.16E+00 | 1.34E+00 | 1.34E+00 |

3.2.4 CAL3QHC Analysis

The CAL3QHC program requires modeling roadways as segments known as links. Links can be either free-flow links for vehicles moving at a constant speed or queue links for idling vehicles. Each can be one of four types of links based on the roadway geometry – at-grade, fill, bridge, or depressed. A free-flow link is defined as a straight segment of roadway having a constant width, height, traffic volume, travel speed, and vehicle emission factor. The required inputs for free-flow links are the endpoints, traffic volume, the emission factor, source height, and mixing zone width. A queue link is defined as a straight segment of roadway with a constant width and emission source strength, where vehicles are idling for a specified time period. Required inputs for queue links are the endpoints, approach traffic volume, emission factor, average cycle length, average red time length, number of travel lanes (i.e. source width), clearance lost time, source height, signal type (pre-timed, actuated, or semi-actuated), and arrival rate. Sample CAL3QHC input and output files for the 2021 morning peak hour scenario are included in Appendix B. These data are average timing, surface roughness coefficient, settling velocity, deposition velocity, wind speed, mixing height, and stability class. The CAL3QHC receptor descriptions and model inputs are summarized in Tables 3-7 and 3-8, respectively.



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Table 3-8. CAL3QHC Receptor Descriptions and Locations

| Receptor Number | Receptor Type | Description | Easting X (m) | Northing Y (m) | Height ¹ (m) | Zone |
|-----------------|---------------|--|---------------|----------------|-------------------------|------|
| 1 | Discrete | Immediately NW of Intersection at Ped Stop | 340827 | 4325570 | 1.8 | 18S |
| 2 | Discrete | West of SB Laurel Bowie Rd North of Intersection | 340831 | 4325595 | 1.8 | 18S |
| 3 | Discrete | Immediately SW of Intersection at Ped Stop | 340829 | 4325550 | 1.8 | 18S |
| 4 | Discrete | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 1.8 | 18S |
| 5 | Discrete | Immediately NE of Intersection at Ped Stop | 340868 | 4325578 | 1.8 | 18S |
| 6 | Discrete | East of NB Laurel Bowie Rd Departure Link | 340865 | 4325599 | 1.8 | 18S |
| 7 | Discrete | Immediately SE of Intersection at Ped Stop | 340873 | 4325557 | 1.8 | 18S |
| 8 | Discrete | East of NB Laurel Bowie Rd South of Intersection | 340872 | 4325532 | 1.8 | 18S |

¹ Receptor heights set to 1.8 meters to simulate the approximate point of entry to the human respiratory tract with respect to ground level i.e., average human height.

Table 3-9. CAL3QHC Input Assumption Summary - Muirkirk Rd and Laurel Bowie Rd Intersection Approaches

| Input Variable | NB Laurel Bowie Rd | SB Laurel Bowie Rd | EB Muirkirk Rd | WB Muirkirk Rd |
|--|--------------------------------------|--------------------------------------|--|--|
| Averaging Time | 60 minutes | | | |
| 1-Hour CO Background | 0.921 ppm | | | |
| 8-Hour CO Background | 0.800 ppm | | | |
| Surface Roughness | 0.001 meters | | | |
| Settling & Deposition Velocity | 0.0 m/s | | | |
| Source Height (tailpipe release point) | 0.25 meters | | | |
| Signal Type | Pretimed ("3" in CAL3QHC Input File) | Pretimed ("3" in CAL3QHC Input File) | Fully Actuated ("1" in CAL3QHC Input File) | Fully Actuated ("1" in CAL3QHC Input File) |
| Average Cycle Length | 150 seconds | | | |



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| Input Variable | NB Laurel Bowie Rd | SB Laurel Bowie Rd | EB Muirkirk Rd | WB Muirkirk Rd |
|---|-------------------------------------|--------------------|----------------|----------------|
| Average Red Phase Length – AM Peak | 71 seconds | 71 seconds | 123 seconds | 123 seconds |
| Average Red Phase Length – PM Peak | 77 seconds | 77 seconds | 119 seconds | 120 seconds |
| Lost Time for Clearance of Intersection | 1.5 seconds | | | |
| Arrival Rate | Average (“3” in CAL3QHC Input File) | | | |
| Wind Speed | 1.0 m/s | | | |
| Atmospheric Stability Class | D (“4” in CAL3QHC Input File) | | | |
| Mixing Height | 1000 meters | | | |
| Multiple Wind Directions Employed? | Yes | | | |
| Wind Direction Increment Angle | 10° | | | |

3.2.5 Analysis Results

Table 3-9 presents the results of the 1-hour and 8-hour CO analysis at the “worst case” intersection of Muirkirk Dr and Laurel Bowie Road. The table presents the receptor number and location where the predicted maximum CO concentrations occurred for each of the ten scenarios examined: Morning and evening peak hours for 2021 (existing conditions), 2030 A-C Action Alternative, 2020 B3 Action Alternative and 2040 Action Alternative, and the 2030 and 2040 No Action Alternatives. CO concentrations at all receptor locations are included as CAL3QHC Output files in Appendix B. The CAL3QHC modeling results indicate that the predicted maximum CO concentrations for the No-Action Alternative would result in no exceedances of the NAAQS for CO, which is 35 ppm for the 1-hour standard and 9.0 ppm for the 8-hour standard. Under the Action Alternatives examined, there would be no exceedances of the CO 1-hour NAAQS.



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Table 3-10. CAL3QHC Analysis Results for Each Modeled Scenario

| Model Scenario | Receptor Location Description | Location of Highest Receptor | | Receptor CO Concentration (ppm) | 1-Hr CO Background (ppm) | CO 1-Hour NAAQS (ppm) | In Compliance with 1-Hour CO NAAQS? | 8-Hr CO Background (ppm) | CO 8-Hour NAAQS (ppm) | In Compliance with 8-Hour CO NAAQS ¹ |
|-------------------------|---|------------------------------|----------------|---------------------------------|--------------------------|-----------------------|-------------------------------------|--------------------------|-----------------------|---|
| | | Easting X (m) | Northing Y (m) | | | | | | | |
| 2021 Existing AM Peak | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 0.40 | 0.921 | 35 | Yes | 0.8 | 9.0 | Yes |
| 2021 Existing PM Peak | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 0.40 | | | Yes | | | Yes |
| 2030 No-Action AM Peak | East of NB Laurel Bowie Rd Departure Link | 340865 | 4325599 | 0.20 | | | Yes | | | Yes |
| 2030 No-Action PM Peak | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 0.30 | | | Yes | | | Yes |
| 2040 No-Action AM Peak | East of NB Laurel Bowie Rd Departure Link | 340865 | 4325599 | 0.20 | | | Yes | | | Yes |
| 2040 No-Action PM Peak | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 0.10 | | | Yes | | | Yes |
| 2030 A-C Action AM Peak | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 0.20 | | | Yes | | | Yes |
| 2030 A-C Action PM Peak | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 0.30 | | | Yes | | | Yes |
| 2030 B3 Action AM Peak | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 0.20 | | | | | | |
| 2030 B3 Action PM Peak | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 0.30 | | | | | | |
| 2040 Action AM Peak | East of NB Laurel Bowie Rd Departure Link | 340865 | 4325599 | 0.20 | | | Yes | | | Yes |
| 2040 Action PM Peak | West of SB Laurel Bowie Rd Departure Link | 340838 | 4325527 | 0.10 | | | Yes | | | Yes |

¹ Assumed persistence factor of 0.7 as per FHWA default.



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3.2.6 Fine Particulate Matter (PM_{2.5})

The Washington DC-MD-VA Region is in attainment of the NAAQS for PM_{2.5}. A maintenance plan was prepared in May 2013, and a project hot spot analysis is required for all qualifying projects located within non-attainment and maintenance areas. Projects that require hot spot analysis for PM_{2.5} (i.e., qualifying projects) are those projects that are Projects of Air Quality Concern as defined in 40 CFR 93.123(b)(1) and restated below:

- New or expanded highway projects that have a significant number of or significant increase in diesel-fueled traffic;
- Projects affecting intersections that are at Level-of-Service D, E, or F with a significant number of diesel vehicles, or those that will change to Level-of-Service D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project;
- New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location;
- Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location; and
- Projects in or affecting locations, areas, or categories of sites which are identified in the PM₁₀ or PM_{2.5} applicable implementation plan or implementation plan submission, as appropriate, as sites of violation or possible violation.

The following analysis concerning PM_{2.5} has been developed for the Proposed Action:

- The Proposed Action does not meet the criteria set forth in 40 CFR 93.123(b)(1) as amended to be considered a Project of Air Quality Concern primarily because the Proposed Action does not include improvements to project area roadways or highways, and vehicles added to area roadways would primarily be commuter-style gasoline-fueled vehicles rather than diesel powered vehicles.
- The Proposed Action does not have a significant increase in diesel vehicles due to construction of the project. In accordance with FHWA guidance, *“40 CFR 93.123(b)(1)(i) should be interpreted as applying only to projects that would involve a significant increase in the number of diesel transit busses and diesel trucks on the facility”*. The percent of trucks is not expected to change between any of the Master Plan Alternatives.

Based on the preceding review and analysis, the Proposed Action fulfills the requirements of the CAA and 40 CFR 93.109. These requirements are met for particulate matter without a project level hot-spot analysis since the project has not been found to be a Project of Air Quality Concern as defined by 40 CFR 93.123(b)(1). Since the project meets the CAA and 40 CFR 93.109 requirements, the project will not cause or contribute to a new violation of the PM_{2.5} NAAQS or increase the frequency or severity of a violation.



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3.2.7 Mobile Source Air Toxic (MSAT) Analysis

The Federal Highway Administration (FHWA) Interim Guidance on Air Toxic Analysis in NEPA Documents requires analysis of MSATs under specific conditions (FHWA, 2016). The following language is taken from this guidance. The USEPA has designated nine prioritized MSATs, which are known or probable carcinogens or can cause chronic respiratory effects. These prioritized MSATs are: *1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter (diesel PM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter*. The Proposed Action would slightly increase capacity on local roadways, but is not likely to meaningfully increase emissions of air pollutants. Therefore, the project would be considered a Project with Low Potential MSAT Effects as defined by the FHWA.

This qualitative assessment was prepared in accordance with the FHWA Updated Interim Guidance on Mobile Source Air Toxic Analysis (FHWA, 2021). FHWA guidance provides specific language to use for Projects with Low Potential MSAT effects which is used here, amended with project specific data.

A qualitative analysis provides a basis for identifying and comparing the potential differences among MSAT emissions, if any, from the various project alternatives. The qualitative assessment presented herein is derived, in part, from a study conducted by FHWA entitled A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives (FHWA, 2021a).

3.2.7.1 MSAT Exposure Levels and Health Effects

Shortcomings in current techniques for exposure assessment and risk analysis preclude reaching meaningful conclusions about project-specific health impacts. Exposure assessments are difficult because it is difficult to accurately calculate annual concentrations of MSATs near roadways, and to determine the portion of a year that people are actually exposed to those concentrations at any specific location.

These difficulties are magnified for 70-year cancer assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over a 70-year period. There are also considerable uncertainties associated with the existing estimates of toxicity of the various MSATs, because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population. Because of these shortcomings, any calculated difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with calculating the impacts. Consequently, the results of such assessments would not be useful to decision-makers, who would need to weigh this information against other project impacts that are better suited for quantitative analysis.

Research into the health impacts of MSAT is ongoing. For the different MSAT emission types, there are a variety of studies that show that some either are statistically associated with adverse health outcomes through epidemiological studies (frequently based on emissions levels found in occupational settings) or that animals demonstrate adverse health outcomes when exposed to large doses. Exposure to toxics has been a focus of a number of USEPA efforts. Most notably, the agency conducted the National Air Toxics Assessment (NATA) in 2014 to evaluate modeled estimates of human exposure applicable to the county level. While not intended for use as a measure of or benchmark for local exposure, the modeled estimates in the NATA database best illustrate the levels of various toxics when aggregated to a national or state



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level. The USEPA is engaged in ongoing research into the risks of various kinds of exposures to these pollutants.

The USEPA Integrated Risk Information System (IRIS) is a database of human health effects that may result from exposure to various substances found in the environment (USEPA, 2021a). The following toxicity information for the nine prioritized MSATs was taken from the IRIS toxic chemical assessment database. This information represents the Agency's most current evaluations of the potential hazards and toxicology of these chemicals or mixtures.

- **1,3-butadiene** is characterized as carcinogenic to humans by inhalation.
- **Acetaldehyde** is a probable human carcinogen based on sufficient evidence of carcinogenicity in animals.
- **Benzene** is characterized as a known human carcinogen.
- The potential carcinogenicity of **acrolein** cannot be confidently determined because the existing data are inadequate for an assessment of human carcinogenic potential for either the oral or inhalation route of exposure.
- **Diesel exhaust (DE)** is likely to be carcinogenic to humans by inhalation from environmental exposures. Diesel exhaust as reviewed in this document is defined as the diesel tailpipe organic gases from crankcase and running exhaust. Diesel exhaust is also a suspected contributor to chronic respiratory effects, possibly the primary noncancer hazard from MSATs. Prolonged exposures may impair pulmonary function and could produce symptoms, such as cough, phlegm, and chronic bronchitis. Exposure relationships have not been developed from these studies.
- The potential carcinogenicity of **ethylbenzene** cannot be confidently determined at this time as USEPA suspended assessment of this pollutant in December 2018 prior to obtaining adequate data for assessment.
- **Formaldehyde** is a possible human carcinogen, based on limited evidence in humans and animals.
- **Naphthalene** is a probable human carcinogen, based on limited evidence in humans, and sufficient evidence in animals.
- The potential carcinogenicity of **polycyclic organic matter (POM)** cannot be confidently determined at this time as USEPA suspended assessment of this pollutant in December 2018 prior to obtaining adequate data for assessment.

There have been other studies that address MSAT health impacts in proximity to roadways. The Health Effects Institute, a non-profit organization funded by USEPA, FHWA, and industry, has undertaken a major series of studies to research near-roadway MSAT hot spots, the health implications of the entire mix of mobile source pollutants, and other topics. The final summary of the series is not expected for several



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years at the time of this writing. Some recent studies have reported that proximity to roadways is related to adverse health outcomes -- particularly respiratory problems. Much of this research is not specific to MSATs, instead surveying the full spectrum of both criteria and toxic/ potentially toxic pollutants. The FHWA cannot evaluate the validity of these studies, but more importantly, they do not provide information that would be useful to alleviate the uncertainties listed above and enable us to perform a more comprehensive evaluation of the health impacts specific to this project.

3.2.7.2 Incomplete or Unavailable Information for Project-Specific MSAT Health Impact Analysis

In FHWA's view, information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in mobile source air toxic MSAT emissions associated with a proposed set of project alternatives. 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 USEPA 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 Clean Air Act and its amendments and have specific statutory obligations with respect to hazardous air pollutants and MSAT. The USEPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. As previously discussed, USEPA maintains the IRIS, which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects" (USEPA, Integrated Risk Information System). 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.

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, Mobile-Source Air Toxics: A Critical Review of the Literature on 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 unsupported 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



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location; and to establish the extent attributable to a proposed action, especially given that some of the information needed is unavailable.

There is also lack of a national consensus on an acceptable level of risk. The current context is the process used by the USEPA as allowed by the Clean Air Act and its Amendments in 1990 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 USEPA 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 U.S. Court of Appeals for the District of Columbia Circuit upheld USEPA's approach to addressing risk in its two-step decision framework. Information required to establish that even the largest of highway projects would result in levels of risk greater than deemed acceptable is incomplete or unavailable (Source: Integrated Risk Information System - Diesel engine exhaust).

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.

3.2.7.3 Relevance of Unavailable or Incomplete Information to Evaluating Reasonably Foreseeable Significant Adverse Impacts on the Environment, and Evaluation of Impacts Based Upon Theoretical Approaches or Research Methods Generally Accepted in the Scientific Community

Because of the uncertainties outlined in Section 3.2.7.2, a quantitative assessment of the effects of air toxic emissions impacts on human health cannot be made at the project level. While available tools do allow us to reasonably predict relative emissions changes between alternatives for larger projects, the amount of MSAT emissions from each of the project alternatives and MSAT concentrations or exposures created by each of the project alternatives cannot be predicted with enough accuracy to be useful in estimating health impacts. (As noted above, the current emissions model is not capable of serving as a meaningful emissions analysis tool for smaller projects.) Therefore, the relevance of the unavailable or incomplete information is that it is not possible to decide whether any of the alternatives would have "significant adverse impacts on the human environment."



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3.2.7.4 Project Specific MSAT Discussion

As discussed above, technical shortcomings of emissions and dispersion models and uncertain science with respect to health effects prevent meaningful or reliable estimates of MSAT emissions and effects of this project. However, even though reliable methods do not exist to accurately estimate the health impacts of MSAT at the project level, it is possible to qualitatively assess the levels of future MSAT emissions under the project. Although a qualitative analysis cannot identify and measure health impacts from MSAT, it can give a basis for identifying and comparing the potential differences among MSAT emissions, if any, from the proposed Action Alternatives.

The MRC project falls into the category of a project that facilitates new development that may generate additional MSAT emissions from new trips, truck deliveries, and parked vehicles. Many of these activities will be attracted from elsewhere in the Washington DC metropolitan region. Thus, on a regional scale, there will be a minimal net change in emissions. Moreover, USEPA regulations for vehicle engines and fuels will cause overall MSATs to decline significantly by this project's 2040 horizon year.

Based on regulations that, at the time of this report, have been promulgated at the federal level, an analysis of national trends with USEPA's MOVES2014a model forecasts a combined reduction of over 90 percent in the total combined annual emissions rate for the priority MSAT between 2010 and 2050 while vehicle-miles of travel are projected to increase by over 45 percent during the same time period. This will both reduce the background level of MSAT as well as the possibility of even slightly elevated MSAT emissions from this project in the near-term.

3.3 STATIONARY SOURCE ANALYSIS

Development of the MRC under the four Alternatives would increase air pollutant emissions and other on-site facilities to accommodate projected demands. Under Action Alternatives A, B and C, the MRC would be developed to include approximately 438,000 gsf of office and special use space to support FDA's mission for a total of up to 918,000 gsf. Alternative B3 would include approximately 383,336 gsf of office, laboratory, and special use space. Although the operational energy requirements of proposed buildings included in each of the three Action Alternatives has not been developed, increases in electrical generation, cooling, and heating would be required. Based on the projected square footage of the proposed buildings for each alternative, the climate zone of Maryland and assumed new insulation/windows, the estimated heating capacity was calculated.

The stationary source analyses also include a New Source Review Applicability, potential greenhouses gas emissions and construction impacts. The analyses considered current emissions from point sources on the MRC, such as boilers and generators. New sources include natural gas heaters for the new buildings and fugitive dust emissions from the construction.

3.3.1 Emissions Calculations

Current stationary emissions are 10 Caterpillar engine/generators of various sizes and one Cummins unit. All generators are used for backup power and are assumed to operate no more than 100 hour/year each. Some units are USEPA Tier 2 certified and others are not certified. Additionally, ten natural gas boilers are



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included. The sizes range from 0.532 million British Thermal units per hour (MMBtu/hr) to 16.73 MMBtu/hr.

Proposed new air emission sources are the expected natural gas usage for heating in the newly constructed buildings and the worst-case construction related fugitive dust emissions amongst the four alternatives discussed above. The table below outlines the total emissions of current and proposed new along with the net increase. It should also be noted that dispersion modeling of the proposed stationary sources was not conducted because the new natural gas heaters emissions are minimal and will not cause a NAAQS exceedance.

Table 3-11. Pollutant Emissions

| Pollutants | Current Ton/yr* | Proposed Ton/yr** | Total Ton/yr |
|----------------------------|-----------------|-------------------|--------------|
| NO _x | 6.73 | 7.62 | 14.35 |
| VOC | 0.17 | 0.42 | 0.59 |
| PM _{2.5/10} | 0.18 | 0.58 | 0.76 |
| Fugitive PM _{2.5} | N/A | 1.34 | 2.23 |
| Fugitive PM ₁₀ | N/A | 13.41 | 22.35 |
| CO | 1.57 | 6.40 | 7.97 |
| SO ₂ | 6.56E-03 | 0.05 | 5.23E-02 |
| GHG | 346 | 8,237 | 8,583 |

* Note that the greenhouse gas value is in metric tons per year.

** The total natural fuel consumption is based on the assumed worst-case square footage of 438,000 for each alternative. This equates to 17.74 MMBtu/hr and to provide a conservative, worst case scenario, the heaters are assumed to operate continuously (8,760 hr/yr). Fugitive construction emissions are based on the worst case disturbed area of 22.7 acres (Alternative A) and 70% control via water sprays.

3.3.2 New Source Review Applicability

The purpose of New Source Review (NSR) Analysis is to determine whether any of the Action Alternatives would be considered a new source of emissions. The proposed emission sources of fugitive dust are not beholden to any NSR requirements. Secondly, the proposed natural gas heaters are operated in a manner similar to boilers. Therefore, 40 CFR Part 60, Subparts Db and Dc were reviewed. As illustrated above, the expected maximum heat rating of *all* potential heaters would be approximately 11.88 MMBtu/hr. Therefore, subpart Db does not apply because units of greater than 100 MMBtu/hr are subject. Secondly, the likelihood of one unit being greater than 10 MMBtu/hr is very minimal because there will be more than one building constructed amongst the various alternatives. Therefore, it is expected that none of the proposed heaters will be greater than 10 MMBtu/hr. As a result, Subpart Dc is not applicable either. It should be noted that current generators are applicable to 40 CFR Part 60, Subpart IIII or 40 CFR Part 63, Subpart ZZZZ, where applicable. MRC is maintaining the units in accordance with those requirements. However, no proposed new units require further NSR Analysis.

3.3.3 Greenhouse Gas Analysis

The primary natural and synthetic greenhouse gases (GHGs) in the Earth's atmosphere are water vapor, carbon dioxide (CO₂), methane, nitrous oxide, and fluorinated gases. GHGs allow heat from the sun to pass through the upper atmosphere and warm the earth by blocking some of the heat that is radiated from the earth back into space. As GHG concentrations increase in our atmosphere they impact the global



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climate by further decreasing the amount of heat that is allowed to escape back into space. Many GHGs are naturally occurring in the environment; however, human activity has contributed to increased concentrations of these gases in the atmosphere. Carbon dioxide is emitted from the combustion of fossil fuels (i.e., oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Methane results from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills. Methane is also emitted during the production and transport of coal, natural gas, and oil. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Fluorinated gases, while not abundant in the atmosphere, are powerful GHGs that are emitted from a variety of industrial processes and are often used as substitutes for ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons).

NAAQS do not exist for GHGs. In its Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the CAA (FR EPA-HQ-OAR-2009-0171), the USEPA determined that GHGs are air pollutants subject to regulation under the CAA. GHGs' status as pollutants is due to the added long-term impacts they have on the climate because of their increased concentrations in the earth's atmosphere. Ongoing scientific research has identified that anthropogenic GHG emissions impact the global climate. Industrialization and the burning of fossil fuels have contributed to increased concentrations of GHGs in the atmosphere. GHGs are produced from both the direct process of coal mining as well as from the combustion of the mined coal. The amount of GHG emissions associated with both of these processes varies greatly based on mining techniques and combustion methodologies used.

The USEPA has taken action to regulate six key GHGs - CO₂, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Because CO₂ is the most prevalent of the regulated GHGs, the USEPA references the potential impact of GHG emissions in terms of their equivalence to CO₂ or CO₂e.

The USEPA has promulgated rules to regulate GHG emissions and the industries responsible under the Mandatory Reporting Rule (74 FR 56260, 40 CFR 98) and the Tailoring Rule (70 FR 31514, 40 CFR 51, 52, 70, 71). Under the USEPA's GHG Mandatory Reporting Rule, coal mines subject to the rule are required to report emissions in accordance with the requirements of Subpart FF. Subpart FF is applicable only to underground coal mines and is not applicable to surface coal mines. Under the provisions of the Tailoring Rule (and a subsequent Supreme Court decision³), a facility would be subject to PSD permitting if it has the potential to emit GHGs in excess of 100,000 tpy of CO₂e and the facility exceeded the PSD major source threshold for a criteria pollutant.

Table 3-1 above provides the estimated emissions of GHGs. Greenhouse gas emissions are calculated by adding the carbon dioxide equivalent (CO₂e) of each of the component greenhouse gases (CO₂, CH₄, and N₂O). The increases in GHG emissions from vehicles traveling on the roads around the MRC are anticipated to be minimal under each Action Alternative. Therefore, the implementation of the Master Plan would result in a slight increase in stationary and mobile source GHG emissions.

³ *Utility Air Regulatory Group v. EPA*, U.S., 134 S. Ct. 2427 (June 23, 2014)



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Environmental Consequences

3.3.4 Construction Impacts

Air quality may be temporarily impacted by construction activities. Fugitive dust would be generated during site grading, construction, wind erosion, and vehicular activities. Emissions from construction equipment including earth-moving equipment, demolition equipment, and paving equipment, would generate criteria pollutants and hazardous pollutants. The intensity, duration, location, and type of construction activity would vary over time. These impacts could be considered significant, even on a temporary basis, if the local construction regulations and best management practice (BMP) control measures are not implemented. MRC would comply with BMPs outlined in the Maryland regulations during construction, ensuring that there would be minimal temporary construction-related impacts.

3.3.5 Indirect and Cumulative Impacts

Air pollutant emissions associated with the development on the MRC are not anticipated to affect the overall health, welfare, or financial base of the communities within the vicinity of the campus. Therefore, no indirect impacts to air quality would occur under the development alternatives.

Past, present, and future development within the Washington, DC metropolitan region would continue to produce additional traffic and new emission sources, which would cumulatively affect air quality. Development of any of the Proposed Action Alternatives would result in additional emissions. However, newer vehicles and building mechanical equipment operate with cleaner systems reducing overall emissions and the potential effect new sources of emissions would have on air quality.



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Environmental Consequences

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References

4.0 REFERENCES

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References

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Appendix A Sample MOVES3.0.0 Run Specification Files

Appendix A SAMPLE MOVES3.0.0 RUN SPECIFICATION FILES

2021 AM Peak Project-Level MOVES3.0.0 Run Specification for CO

```
<runspec version="MOVES3.0.0">
  <description><![CDATA[Emission Factor Generation for Muirkirk FDA Facility Expansion
2021 Existing Conditions Run
7-8AM]]></description>
  <models>
    <model value="ONROAD"/>
  </models>
  <modelscale value="Inv"/>
  <modeldomain value="PROJECT"/>
  <geographicselections>
    <geographicselection type="COUNTY" key="24033" description="Prince George's
County, MD (24033)"/>
  </geographicselections>
  <timespan>
    <year key="2021"/>
    <month id="1"/>
    <day id="5"/>
    <beginhour id="8"/>
    <endhour id="8"/>
    <aggregateBy key="Hour"/>
  </timespan>
  <onroadvehicleselections>
    <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="62"
sourcetype="Combination Long-haul Truck"/>
    <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="61" sourcetype="Combination Short-haul Truck"/>
    <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="61"
sourcetype="Combination Short-haul Truck"/>
    <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="61"
sourcetype="Combination Short-haul Truck"/>
    <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="32"
sourcetype="Light Commercial Truck"/>
    <onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="32"
sourcetype="Light Commercial Truck"/>
    <onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="32"
sourcetype="Light Commercial Truck"/>
    <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="32"
sourcetype="Light Commercial Truck"/>
    <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="54" sourcetype="Motor Home"/>
    <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="54"
sourcetype="Motor Home"/>
    <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="54"
sourcetype="Motor Home"/>
  </onroadvehicleselections>
</runspec>
```



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix A Sample MOVES3.0.0 Run Specification Files

```
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="11"
sourcetyponame="Motorcycle"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="41" sourcetyponame="Other Buses"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="41"
sourcetyponame="Other Buses"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="41"
sourcetyponame="Other Buses"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="21"
sourcetyponame="Passenger Car"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="21"
sourcetyponame="Passenger Car"/>
<onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="21"
sourcetyponame="Passenger Car"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="21"
sourcetyponame="Passenger Car"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="31"
sourcetyponame="Passenger Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="31"
sourcetyponame="Passenger Truck"/>
<onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="31"
sourcetyponame="Passenger Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="31"
sourcetyponame="Passenger Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="51" sourcetyponame="Refuse Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="51"
sourcetyponame="Refuse Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="51"
sourcetyponame="Refuse Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="43" sourcetyponame="School Bus"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="43"
sourcetyponame="School Bus"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="43"
sourcetyponame="School Bus"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="53" sourcetyponame="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="53"
sourcetyponame="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="53"
sourcetyponame="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="52" sourcetyponame="Single Unit Short-haul Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="52"
sourcetyponame="Single Unit Short-haul Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="52"
sourcetyponame="Single Unit Short-haul Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="42" sourcetyponame="Transit Bus"/>
```



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix A Sample MOVES3.0.0 Run Specification Files

```

    <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="42"
sourcetypername="Transit Bus"/>
    <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="42"
sourcetypername="Transit Bus"/>
  </onroadvehicleselections>
  <offroadvehicleselections>
  </offroadvehicleselections>
  <offroadvehiclesccs>
  </offroadvehiclesccs>
  <roadtypes>
    <roadtype roadtypeid="5" roadtypername="Urban Unrestricted Access"
modelCombination="M1"/>
  </roadtypes>
  <pollutantprocessassociations>
    <pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)"
processkey="1" processname="Running Exhaust"/>
    <pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)"
processkey="15" processname="Crankcase Running Exhaust"/>
  </pollutantprocessassociations>
  <databaseselections>
  </databaseselections>
  <internalcontrolstrategies>
  </internalcontrolstrategies>
  <inputdatabase servername="" databasename="" description=""/>
  <uncertaintyparameters uncertaintymodeenabled="false" numberofrunspersimulation="0"
numberofsimulations="0"/>
  <geographicoutputdetail description="LINK"/>
  <outputemissionsbreakdownselection>
    <modelyear selected="false"/>
    <fueltype selected="false"/>
    <fuelsubtype selected="false"/>
    <emissionprocess selected="true"/>
    <onroadoffroad selected="false"/>
    <roadtype selected="true"/>
    <sourceusertype selected="false"/>
    <movesvehicletype selected="false"/>
    <onroadsc selected="false"/>
    <estimateuncertainty selected="false" numberofiterations="2" keepSampledData="false"
keepIterations="false"/>
    <sector selected="false"/>
    <engtechid selected="false"/>
    <hpclass selected="false"/>
    <regclassid selected="false"/>
  </outputemissionsbreakdownselection>
  <outputdatabase servername="" databasename="2021_existing_am_out" description=""/>
  <outputtimestep value="Hour"/>
  <outputvmtdata value="true"/>
  <outputsho value="false"/>
  <outputsh value="false"/>
  <outputshp value="false"/>
  <outputshidling value="false"/>

```



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Appendix A Sample MOVES3.0.0 Run Specification Files

```
<outputstarts value="true"/>
<outputpopulation value="true"/>
<scaleinputdatabase servername="localhost" databasename="2021_existing_am_in"
description=""/>
<pmsize value="0"/>
<outputfactors>
  <timefactors selected="true" units="Hours"/>
  <distancefactors selected="true" units="Miles"/>
  <massfactors selected="true" units="Grams" energyunits="Joules"/>
</outputfactors>
<savedata>

</savedata>

<donotexecute>

</donotexecute>

<generatordatabase shouldsave="false" servername="" databasename="" description=""/>
  <donotperformfinalaggregation selected="false"/>
  <lookupableflags scenarioid="2021_Existing" truncateoutput="true" truncateactivity="true"
truncatebaserates="true"/>
</runspec>
```

2021 AM Peak Project-Level MOVES3.0.0 Run Specification for NOx and VOC

```
<runspec version="MOVES3.0.0">
  <description><![CDATA[Emission Factor Generation for Muirkirk FDA Facility Expansion
2021 Existing Conditions Run
April Selected as Representative Month]]></description>
  <models>
    <model value="ONROAD"/>
  </models>
  <modelscale value="Inv"/>
  <modeldomain value="PROJECT"/>
  <geographicselections>
    <geographicselection type="COUNTY" key="24033" description="Prince George's
County, MD (24033)"/>
  </geographicselections>
  <timespan>
    <year key="2021"/>
    <month id="4"/>
    <day id="5"/>
    <beginhour id="8"/>
    <endhour id="8"/>
    <aggregateBy key="Hour"/>
  </timespan>
  <onroadvehicleselections>
    <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="62"
sourcetypername="Combination Long-haul Truck"/>
  </onroadvehicleselections>
</runspec>
```



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix A Sample MOVES3.0.0 Run Specification Files

```
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="61" sourcetype="Combination Short-haul Truck"/>
  <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="61"
sourcetype="Combination Short-haul Truck"/>
    <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="61"
sourcetype="Combination Short-haul Truck"/>
      <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="32"
sourcetype="Light Commercial Truck"/>
        <onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="32"
sourcetype="Light Commercial Truck"/>
          <onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="32"
sourcetype="Light Commercial Truck"/>
            <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="32"
sourcetype="Light Commercial Truck"/>
              <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="54" sourcetype="Motor Home"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="54"
sourcetype="Motor Home"/>
                  <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="54"
sourcetype="Motor Home"/>
                    <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="11"
sourcetype="Motorcycle"/>
                      <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="41" sourcetype="Other Buses"/>
                        <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="41"
sourcetype="Other Buses"/>
                          <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="41"
sourcetype="Other Buses"/>
                            <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="21"
sourcetype="Passenger Car"/>
                              <onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="21"
sourcetype="Passenger Car"/>
                                <onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="21"
sourcetype="Passenger Car"/>
                                  <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="21"
sourcetype="Passenger Car"/>
                                    <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="31"
sourcetype="Passenger Truck"/>
                                      <onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="31"
sourcetype="Passenger Truck"/>
                                        <onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="31"
sourcetype="Passenger Truck"/>
                                          <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="31"
sourcetype="Passenger Truck"/>
                                            <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="51" sourcetype="Refuse Truck"/>
                                              <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="51"
sourcetype="Refuse Truck"/>
                                                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="51"
sourcetype="Refuse Truck"/>
```



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Appendix A Sample MOVES3.0.0 Run Specification Files

```
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="43" sourcypename="School Bus"/>
  <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="43"
sourcypename="School Bus"/>
  <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="43"
sourcypename="School Bus"/>
  <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="53" sourcypename="Single Unit Long-haul Truck"/>
  <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="53"
sourcypename="Single Unit Long-haul Truck"/>
  <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="53"
sourcypename="Single Unit Long-haul Truck"/>
  <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="52" sourcypename="Single Unit Short-haul Truck"/>
  <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="52"
sourcypename="Single Unit Short-haul Truck"/>
  <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="52"
sourcypename="Single Unit Short-haul Truck"/>
  <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)"
sourcetypeid="42" sourcypename="Transit Bus"/>
  <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="42"
sourcypename="Transit Bus"/>
  <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="42"
sourcypename="Transit Bus"/>
</onroadvehicleselections>
<offroadvehicleselections>
</offroadvehicleselections>
<offroadvehiclesccs>
</offroadvehiclesccs>
<roadtypes>
  <roadtype roadtypeid="5" roadtypename="Urban Unrestricted Access"
modelCombination="M1"/>
</roadtypes>
<pollutantprocessassociations>
  <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane
Hydrocarbons" processkey="1" processname="Running Exhaust"/>
  <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane
Hydrocarbons" processkey="15" processname="Crankcase Running Exhaust"/>
  <pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (Nox)"
processkey="1" processname="Running Exhaust"/>
  <pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (Nox)"
processkey="15" processname="Crankcase Running Exhaust"/>
  <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous
Hydrocarbons" processkey="1" processname="Running Exhaust"/>
  <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous
Hydrocarbons" processkey="15" processname="Crankcase Running Exhaust"/>
  <pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic
Compounds" processkey="1" processname="Running Exhaust"/>
  <pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic
Compounds" processkey="15" processname="Crankcase Running Exhaust"/>
</pollutantprocessassociations>
```



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix A Sample MOVES3.0.0 Run Specification Files

```
<databaseselections>
</databaseselections>
<internalcontrolstrategies>
</internalcontrolstrategies>
<inputdatabase servername="" databasename="" description=""/>
<uncertaintyparameters uncertaintymodeenabled="false" numberofrunspersimulation="0"
numberofsimulations="0"/>
<geographicoutputdetail description="LINK"/>
<outputemissionsbreakdownselection>
  <modelyear selected="false"/>
  <fueltype selected="false"/>
  <fuelsubtype selected="false"/>
  <emissionprocess selected="true"/>
  <onroadoffroad selected="false"/>
  <roadtype selected="true"/>
  <sourceusetype selected="false"/>
  <movesvehicletype selected="false"/>
  <onroadsc selected="false"/>
  <estimateuncertainty selected="false" numberofiterations="2" keepSampledData="false"
keepiterations="false"/>
  <sector selected="false"/>
  <engtechid selected="false"/>
  <hpclass selected="false"/>
  <regclassid selected="false"/>
</outputemissionsbreakdownselection>
<outputdatabase servername="" databasename="2021_existing_nox_voc_out" description=""/>
<outputtimestep value="Hour"/>
<outputvmtdata value="true"/>
<outputsho value="false"/>
<outputsh value="false"/>
<outputshp value="false"/>
<outputshidling value="true"/>
<outputstarts value="true"/>
<outputpopulation value="true"/>
<scaleinputdatabase servername="localhost" databasename="2021_existing_nox_voc_am_in"
description=""/>
<pmsize value="0"/>
<outputfactors>
  <timefactors selected="true" units="Hours"/>
  <distancefactors selected="true" units="Miles"/>
  <massfactors selected="true" units="Grams" energyunits="Joules"/>
</outputfactors>
<savedata>

</savedata>

<donotexecute>

</donotexecute>

<generatordatabase shouldsave="false" servername="" databasename="" description=""/>
```



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix A Sample MOVES3.0.0 Run Specification Files

```
      <donotperformfinalaggregation selected="false"/>  
    <lookupflags scenarioid="2021_Existing" truncateoutput="true" truncateactivity="true"  
truncatebaserates="true"/>  
</runspec>
```



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix B Sample CAL3QHC Input and Output Files

Appendix B SAMPLE CAL3QHC INPUT AND OUTPUT FILES

2021 Existing Conditions AM Peak Scenario CAL3QHC Input File

```
'2021 EXISTING AM' 60.0 0.1 0.0 0.0 8 1 0 0 'PPM'  
'IMMEDIATELY NW OF INTERSECTION AT PED STOP' 340827.0 4325570.0 1.8  
'WEST OF SB LAUREL BOWIE RD NORTH OF INTERSECTION' 340831.0 4325595.0 1.8  
'IMMEDIATELY SW OF INTERSECTION AT PED STOP' 340829.0 4325550.0 1.8  
'WEST OF SB LAUREL BOWIE RD SOUTH OF INTERSECTION' 340838.0 4325527.0 1.8  
'IMMEDIATELY NE OF INTERSECTION AT PED STOP' 340868.0 4325578.0 1.8  
'EAST OF NB LAUREL BOWIE RD NORTH OF INTERSECTION' 340865.0 4325599.0 1.8  
'IMMEDIATELY SE OF INTERSECTION AT PED STOP' 340873.0 4325557.0 1.8  
'EAST OF NB LAUREL BOWIE RD SOUTH OF INTERSECTION' 340872.0 4325532.0 1.8  
' 13 1 1 'C'  
2 1  
'EB-L' 'AG' 340823.0 4325561.0 340794.0 4325558.0 0.25 3.0 1  
150 123 1.5 124 0.0327 210 3 3  
2 1  
'EB-LT' 'AG' 340823.0 4325557.0 340795.0 4325555.0 0.25 3.0 1  
150 123 1.5 61 0.0666 107 3 3  
2 1  
'EB-R' 'AG' 340823.0 4325554.0 340796.0 4325551.0 0.25 3.0 1  
150 116 1.5 310 0.0131 456 3 3  
2 1  
'WB-LT' 'AG' 340875.0 4325569.0 340838.0 4325605.0 0.25 3.0 1  
150 123 1.5 106 0.0812 143 3 3  
2 1  
'WB-R' 'AG' 340874.0 4325573.0 340845.0 4325605.0 0.25 3.0 1  
150 123 1.5 52 0.166 260 3 3  
2 1  
'NB-L' 'AG' 340857.0 4325547.0 340897.0 4325572.0 0.25 3.0 1  
150 116 1.5 304 0.0106 284 1 3  
2 1  
'NB-TR' 'AG' 340863.0 4325548.0 340895.0 4325576.0 0.25 9.5 1  
150 71 1.5 1449 0.00222 2415 1 3  
2 1  
'SB-L' 'AG' 340848.0 4325578.0 340860.0 4325518.0 0.25 3.0 1  
150 116 1.5 92 0.0436 151 1 3  
2 1  
'SB-TR' 'AG' 340841.0 4325578.0 340866.0 4325518.0 0.25 9.5 1  
150 71 1.5 1798 0.00223 2140 1 3  
1 1  
'EB-THRU' 'AG' 340848.0 4325561.0 340903.0 4325564.0 124 4.06 0.25 3.0  
1 1  
'WB-THRU' 'AG' 340853.0 4325571.0 340794.0 4325561.0 106 8.61 0.25 3.0  
1 1  
'NB-THRU' 'AG' 340861.0 4325566.0 340852.0 4325633.0 1449 3.22 0.25 9.5  
1 1  
'SB-THRU' 'AG' 340842.0 4325564.0 340849.0 4325495.0 1798 4.02 0.25 9.5  
1.0 0 4 1000.0 0.0 'Y' 10 0 35  
** BREEZE  
** PROJECTN 0 104 7 -177 0 0.9996 500000 0  
** OUTFILE "C:\Desktop\CAL3QHC\2021_Existing_AM\2021 Existing AM.lst"  
** RAWFILE
```



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix B Sample CAL3QHC Input and Output Files

2021 Existing Conditions AM Peak Scenario CAL3QHC List (Output) File

```

1                CAL3QHC - (DATED 95221)

                CAL3QHC PC (32 BIT) VERSION 3.0.0
                (C) COPYRIGHT 1993-2000, TRINITY CONSULTANTS

Run Began on  3/09/2021 at 12:57:55

JOB: 2021 EXISTING AM                                RUN:

DATE : 03/09/  0
TIME : 12:57:55

    The MODE flag has been set to C for calculating CO averages.

SITE & METEOROLOGICAL VARIABLES
-----
VS =  0.0 CM/S      VD =  0.0 CM/S      Z0 =  0. CM
U  =  1.0 M/S      CLAS =  4 (D)      ATIM = 60. MINUTES      MIXH = 1000. M
AMB = 0.0 PPM

LINK VARIABLES
-----
LINK DESCRIPTION      *      LINK COORDINATES (M)      *      LENGTH BRG
TYPE  VPH  EF  H  W  V/C QUEUE      *      Y1      X2      Y2      *      (M)  (DEG)
(G/MI)  (M)  (M)      (VEH)
-----*-----*-----*-----*-----*-----*-----*-----*-----*-----*
1.  EB-L      * 340823.0 ***** 340490.6 ***** * 334. 264. AG
0. 100.0  0.2  3.0  3.88  55.7
2.  EB-LT     * 340823.0 ***** 340653.1 ***** * 170. 266. AG
0. 100.0  0.2  3.0  3.81  28.4
3.  EB-R      * 340823.0 ***** 340065.6 ***** * 762. 264. AG
0. 100.0  0.2  3.0  3.37 127.0
4.  WB-LT     * 340875.0 ***** 340654.6 ***** * 307. 314. AG
0. 100.0  0.2  3.0  4.82  51.2
5.  WB-R      * 340874.0 ***** 340834.4 ***** * 59. 318. AG
0. 100.0  0.2  3.0  1.30  9.8
6.  NB-L      * 340857.0 ***** 341586.1 ***** * 860. 58. AG
0. 100.0  0.2  3.0  5.33 143.3
7.  NB-TR     * 340863.0 ***** 341566.5 ***** * 935. 49. AG
0. 100.0  0.2  9.5  1.19 155.8
8.  SB-L      * 340848.0 ***** 340892.9 ***** * 229. 169. AG
0. 100.0  0.2  3.0  3.07  38.1
9.  SB-TR     * 340841.0 ***** 341785.8 ***** * 2457. 157. AG
0. 100.0  0.2  9.5  1.67 409.4
10. EB-THRU   * 340848.0 ***** 340903.0 ***** * 55. 87. AG
124. 4.1  0.2  3.0
11. WB-THRU   * 340853.0 ***** 340794.0 ***** * 60. 260. AG
106. 8.6  0.2  3.0
12. NB-THRU   * 340861.0 ***** 340852.0 ***** * 68. 352. AG
1449. 3.2  0.2  9.5
13. SB-THRU   * 340842.0 ***** 340849.0 ***** * 69. 174. AG
1798. 4.0  0.2  9.5
    
```



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix B Sample CAL3QHC Input and Output Files

PAGE 2

JOB: 2021 EXISTING AM

RUN:

DATE : 03/09/ 0

TIME : 12:57:55

ADDITIONAL QUEUE LINK PARAMETERS

| SIGNAL | LINK DESCRIPTION | * CYCLE | RED | CLEARANCE | APPROACH | SATURATION | IDLE |
|--------|------------------|----------|-------|-----------|----------|------------|---------|
| TYPE | ARRIVAL | * LENGTH | TIME | LOST TIME | VOL | FLOW RATE | EM FAC |
| | RATE | (SEC) | (SEC) | (SEC) | (VPH) | (VPH) | (gm/hr) |
| 3 | 1. EB-L 3 | * 150 | 123 | 1.5 | 124 | 210 | 0.03 |
| 3 | 2. EB-LT 3 | * 150 | 123 | 1.5 | 61 | 107 | 0.07 |
| 3 | 3. EB-R 3 | * 150 | 116 | 1.5 | 310 | 456 | 0.01 |
| 3 | 4. WB-LT 3 | * 150 | 123 | 1.5 | 106 | 143 | 0.08 |
| 3 | 5. WB-R 3 | * 150 | 123 | 1.5 | 52 | 260 | 0.17 |
| 1 | 6. NB-L 3 | * 150 | 116 | 1.5 | 304 | 284 | 0.01 |
| 1 | 7. NB-TR 3 | * 150 | 71 | 1.5 | 1449 | 2415 | 0.00 |
| 1 | 8. SB-L 3 | * 150 | 116 | 1.5 | 92 | 151 | 0.04 |
| 1 | 9. SB-TR 3 | * 150 | 71 | 1.5 | 1798 | 2140 | 0.00 |

RECEPTOR LOCATIONS

| RECEPTOR | * X | COORDINATES (M) | Z | * |
|-------------------------|------------|-----------------|-----|---|
| | | Y | | |
| 1. IMMEDIATELY NW OF IN | * 340827.0 | ***** | 1.8 | * |
| 2. WEST OF SB LAUREL BO | * 340831.0 | ***** | 1.8 | * |
| 3. IMMEDIATELY SW OF IN | * 340829.0 | ***** | 1.8 | * |
| 4. WEST OF SB LAUREL BO | * 340838.0 | ***** | 1.8 | * |
| 5. IMMEDIATELY NE OF IN | * 340868.0 | ***** | 1.8 | * |
| 6. EAST OF NB LAUREL BO | * 340865.0 | ***** | 1.8 | * |
| 7. IMMEDIATELY SE OF IN | * 340873.0 | ***** | 1.8 | * |
| 8. EAST OF NB LAUREL BO | * 340872.0 | ***** | 1.8 | * |



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix B Sample CAL3QHC Input and Output Files

PAGE 3

JOB: 2021 EXISTING AM

RUN:

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-350.

| WIND ANGLE (DEGR) | REC1 | REC2 | REC3 | REC4 | REC5 | REC6 | REC7 | REC8 |
|-------------------|------|------|------|------|------|------|------|------|
| 0. | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10. | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 20. | 0.0 | 0.0 | 0.1 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 30. | 0.1 | 0.1 | 0.1 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40. | 0.1 | 0.1 | 0.2 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 50. | 0.1 | 0.1 | 0.3 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 60. | 0.1 | 0.1 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 70. | 0.1 | 0.1 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 80. | 0.1 | 0.1 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 90. | 0.1 | 0.1 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 100. | 0.1 | 0.1 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 110. | 0.1 | 0.1 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 120. | 0.1 | 0.1 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 130. | 0.2 | 0.1 | 0.2 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 140. | 0.2 | 0.0 | 0.2 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 150. | 0.2 | 0.0 | 0.2 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 160. | 0.2 | 0.2 | 0.1 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 170. | 0.0 | 0.2 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 180. | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| 190. | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 |
| 200. | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.3 | 0.1 | 0.0 |
| 210. | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.3 | 0.1 | 0.1 |
| 220. | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.1 | 0.1 |
| 230. | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.1 | 0.1 |
| 240. | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.1 | 0.1 |
| 250. | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| 260. | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| 270. | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| 280. | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| 290. | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 |
| 300. | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 |
| 310. | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.1 | 0.1 |
| 320. | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.1 | 0.0 |
| 330. | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.2 | 0.0 |
| 340. | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.2 | 0.1 |
| 350. | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 |
| MAX | 0.2 | 0.2 | 0.3 | 0.4 | 0.2 | 0.3 | 0.2 | 0.1 |
| DEGR. | 130 | 160 | 50 | 10 | 200 | 190 | 330 | 210 |

THE HIGHEST CONCENTRATION OF 0.40 PPM OCCURRED AT RECEPTOR REC4 .



MUIRKIRK ROAD CAMPUS MASTER PLAN

Appendix B Sample CAL3QHC Input and Output Files

PAGE 4

JOB: 2021 EXISTING AM

RUN:

DATE : 03/09/ 0

TIME : 12:57:55

RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

| LINK # | * CO/LINK (PPM) | | | | | | | |
|--------|-------------------|------|------|------|------|------|------|------|
| | * ANGLE (DEGREES) | | | | | | | |
| | REC1 | REC2 | REC3 | REC4 | REC5 | REC6 | REC7 | REC8 |
| | 130 | 160 | 50 | 10 | 200 | 190 | 330 | 210 |
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.0 |
| 13 | 0.2 | 0.2 | 0.2 | 0.3 | 0.1 | 0.1 | 0.0 | 0.1 |

