I-64 HAMPTON ROADS BRIDGE TUNNEL

HRBT
Hampton Roads Bridge Tunnel EIS

AIR QUALITY TECHNICAL REPORT

VDOT
Virginia Department of Transportation

U.S. Department of Transportation
Federal Highway Administration

November 15, 2012

AIR QUALITY TECHNICAL REPORT

I-64 Hampton Roads Bridge Tunnel Project

Cities of Hampton and Norfolk, Virginia

HMMH Report No. 305080.2
November 8, 2012

Prepared for:

Virginia Department of Transportation
1401 East Broad Street
Richmond, VA 23219

VDOT Project No. 0064-965-004, P101
UPC No. 99037

Prepared by:

HARRIS MILLER MILLER & HANSON INC.

Harris Miller Miller & Hanson Inc.
77 South Bedford Street
Burlington, MA 01803
T 781.229.0707
F 781.229.7939

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1. EXECUTIVE SUMMARY

The Virginia Department of Transportation (VDOT) is conducting a study of the proposed Hampton Roads Bridge Tunnel (HRBT) Study Alternatives ("Study"). The purpose of the study is to address capacity and roadway deficiencies along Interstate 64 (I-64) in the cities of Hampton and Norfolk, VA, generally between Interstate 664 (I-664) in Hampton to Interstate 564 (I-564) in Norfolk (approximately 11.7 miles). The study is being conducted to support the Environmental Impact Statement of the retained alternatives.

Federal funding is involved with the Study, therefore, compliance with the National Environmental Policy Act (NEPA) and the Clean Air Act is required. Part of the NEPA compliance is to determine the potential operational impacts on air quality from the changes in the roadway and conformity with any State Implementation Plan (SIP) for any U.S. Environmental Protection Agency (US EPA) criteria pollutant in a non-attainment or maintenance area. The Study Area is located in an EPA designated maintenance area for the 1997 eight-hour ozone standard[1] and an attainment area for the 2008 eight-hour ozone standard. The area is designated as attainment for all other National Ambient Air Quality Standards (NAAQS). As such, all reasonable precautions should be taken to limit the emissions of volatile organic compounds (VOCs) and nitrogen oxides (NOx). In addition, the following VDEQ air pollution regulations will be adhered to during the construction: 9 VAC 5-130 et seq., Open Burning restrictions, 9 VAC 5-45, Article 7 et seq., Cutback Asphalt restrictions, 9 VAC 5-50-60 et seq. and Fugitive Dust precautions.

The Hampton Roads Bridge-Tunnel PPTA was included in the Hampton Roads Transportation Planning Organization (HRTPO) FY 2012-2015 Transportation Improvement Program (TIP) and the 2034 Long Range Transportation Plan (LRTP) for Preliminary Engineering (PE) only. It was not included in the regional conformity determination. Once funding is identified through the Construction (CN) Phase cost estimates, the preferred alternative can be added to the LRTP to meet the fiscal constraint requirements and included in the conformity finding consistent with the SIP.

An air quality impact assessment of carbon monoxide (CO) traffic emissions was conducted since the average daily traffic (ADT) is estimated to be above the applicable threshold in the VDOT and Federal Highway Administration (FHWA) Project-Level Carbon Monoxide Air Quality Studies Agreement. The CO ground level impacts were estimated at receptor locations around five of the worst-case intersections/interchanges based on Level of Service (LOS) and traffic volumes. The estimated ground level impacts are expected to remain well below the CO NAAQS at all modeled receptor locations.

The Study area is located in an EPA designated attainment area for $PM_{2.5}$; therefore, EPA Transportation Conformity Rules do not apply. Based on the EPA criteria specified in the Transportation Conformity Rule and associated FHWA guidance, the proposed Alternatives are not considered to be a "project of air quality concern" for particulate matter; therefore, neither a qualitative nor quantitative analysis was performed.

The analysis also evaluated potential impacts from mobile source air toxics (MSATs) in the Study area. Since the Build Alternatives could add significant capacity to this stretch of I-64, the Alternatives fall into the category of High Potential MSAT Effects under the 2009 FHWA interim guidance document, therefore, a quantitative analysis was conducted to address MSAT emissions. The results of the MSAT analysis are consistent with the national MSAT emission trends predicted by MOBILE6.2 as discussed earlier and indicate that no meaningful increases in MSATs have been identified and an adverse effect on human health is not expected as a result of the Study Alternatives.

[1] On June 15, 2005, the USEPA revoked the one-hour ozone standard and the eight-hour ozone standard is now in effect.

The Build Alternatives include the addition of one new tunnel which could accommodate up to six new travel lanes. The ventilation system within the tunnel will be designed to control the level of emissions to acceptable concentrations inside the tunnel during normal operations along with the capacity to remove smoke and gases during emergencies. The proposed tunnel configurations with its currently specified ventilation system will maintain in-tunnel CO concentrations below the 1-hour NAAQS and the 15-minute FHWA/EPA guideline level for both peak hour and idling traffic conditions.

Emissions produced during the construction of the preferred Alternative will be short-term or temporary in nature. In order to mitigate these emissions, construction activities will be performed in accordance with VDOT's current "Road and Bridge Specifications". The specifications conform to the SIP and require compliance with all applicable local, state, and federal regulations.

2. INTRODUCTION

Potential traffic air quality impacts associated with the proposed Hampton Roads Bridge Tunnel Study Alternatives ("Study") along the Interstate 64 (I-64) corridor between Hampton and Norfolk, VA were assessed by Harris Miller Miller & Hanson Inc. (HMMH). The purpose of the Study conducted by VDOT is to address transportation capacity and roadway deficiencies along the I-64 corridor from generally between Interstate 664 in Hampton to Interstate 564 in Norfolk including the Hampton Roads Bridge Tunnel.

Federal funding is involved with the Study Alternatives; therefore, compliance with the National Environmental Policy Act (NEPA) and the Clean Air Act is required. Part of the NEPA compliance is to determine the potential operational impacts on air quality from the changes in the roadway and conformity with any State Implementation Plan (SIP) for any EPA criteria pollutant in a non-attainment or maintenance area. The Study Area is located in an EPA designated maintenance area for the 1997 eight-hour ozone standard[2] and an attainment area for the 2008 eight-hour ozone standard. The area is designated as attainment for all other NAAQS.

3. PROJECT DESCRIPTION

The Virginia Department of Transportation (VDOT), in cooperation with the Federal Highway Administration (FHWA), is proposing improvements to the roadway within the study area encompassing the interstate I-64 HRBT Corridor from I-664 in Hampton to I-564 in Norfolk (approximately 11.7 miles) including the Hampton Roads Bridge Tunnel. The study area is shown in Figure 1. The purpose of the Study is to address insufficient transportation capacity and roadway deficiencies along the I-64 corridor.

Capacity:

- Substantial congestion occurs during lengthy peak travel times (i.e. rush hour and holiday travel)
- Traffic backups typically extend 3-5 miles
- Level of Service (LOS) is failing in many locations
- Average peak hour speed is often well below the posted speed limit
- Incidents exacerbate severe unreliability in travel time

Roadway Deficiencies:

- Substandard vertical clearance in the tunnels
- Reduced number of lanes in the corridor

[2] On June 15, 2005, the USEPA revoked the one-hour ozone standard and the eight-hour ozone standard is now in effect.

- Bridge clearance above water does not meet current standards for storm surge

A total of four proposed Alternatives, one No-Build, and three Build Alternatives were evaluated as part of the Study to alleviate traffic congestion and address roadway deficiencies.

FIGURE 1. STUDY AREA

4. TRAFFIC SUMMARY

The traffic analysis for the Study was conducted by Rummel, Klepper & Kahl (RK&K) for the 2011 base year, anticipated opening/interim year 2020 and the 2040 design year. For the air quality analysis, the relevant traffic components utilized from the traffic study were the level of service (LOS), average daily traffic (ADT), congested speeds, turning movements, and signal timing data for each alternative. A total of thirteen intersections were studied in the traffic analysis along with seven mainline interchanges.

The traffic study consisted of evaluating four Alternatives to alleviate traffic congestion and address roadway deficiencies within the Study area. The four alternatives are described as follows:

- No-Build Alternative: no major improvements to the corridor;
- Build-8 Alternative: proposes 4 travel lanes in each direction on I-64 including adding one travel lane in each direction in Hampton, and two travel lanes in each direction on the bridges, in the tunnel, and in Norfolk;
- Build-8 Managed Alternative: similar to Build-8 but would include traffic management such as High Occupancy Vehicle (HOV) lanes, High Occupancy Toll (HOT) lanes, and/or tolls; and
- Build-10 Alternative: proposes 5 travel lanes in each direction on I-64, and would generally add two travel lanes in each direction in Hampton, and three travel lanes in each direction on the bridges, in the tunnel and in Norfolk.

5. EXISTING CONDITIONS

To characterize the existing air quality conditions of the Cities of Hampton and Norfolk area, HMMH completed a review of the Virginia Air Quality Data Reports prepared by the Virginia Department of Environmental Quality (VDEQ) Office of Air Quality Monitoring and the EPA. The analysis focused on regulated air pollutants contained in the NAAQS; including sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and particulate matter (PM_{10} and $PM_{2.5}$). The results show that the EPA designated both cities as a maintenance area for the 1997 eight-hour ozone standard and an attainment area for the 2008 eight-hour ozone standard. The area is designated as attainment for all other NAAQS.

6. METEOROLOGY CLIMATE

The cities of Hampton and Norfolk are located in the southeastern part of the state bordering the Atlantic Ocean. The climate of the area is influenced by the ocean. Winters are mild with limited snowfall and summers are hot and humid. The average annual temperature for the Virginia Beach-Norfolk area is 73°F. The area typically receives 45 inches of rainfall annually and up to 2.5 inches of snow.

7. REGULATORY STANDARDS

The air quality analysis addressed the EPA National Ambient Air Quality Standards (NAAQS), Mobile Source Air Toxics (MSAT) under the National Environmental Policy Act (NEPA), and Transportation Conformity Rule as required by the Clean Air Act.

A. National Ambient Air Quality Standards

Pursuant to the Federal Clean Air Act of 1970 (CAA), the EPA established National Ambient Air Quality Standards (NAAQS) for major pollutants known as "criteria pollutants." Currently, the EPA regulates six criteria pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter, and lead (Pb). Particulate matter (PM) is organized in two particle size categories:

particles with a diameter less than 10 micrometers (PM_{10}) and those with a diameter of less than 2.5 micrometers ($PM_{2.5}$).

Table 1 shows the primary and secondary NAAQS for the criteria pollutants. The NAAQS are two-tiered. The first tier (primary) is intended to protect public health; the second tier (secondary) is intended to prevent further degradation of the environment.

Section 176(c) of the CAA requires Federal agencies to assure that all of their actions conform to applicable implementation plans for achieving and maintaining the NAAQS. Federal actions must not cause or contribute to any new violation of any standard, increase the frequency or severity of any existing violation, or delay timely attainment of any standard.

Table 1. National Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standards [1,2]	Secondary Standards [1,3]	
CO	8- hour	9 ppm (10 mg/m^3)	None	
	1- hour	35 ppm (40 mg/m^3)	None	
Lead[4]	Rolling 3-Month Average[5]	0.15 µg/m^3	Same as Primary	
NO_2	Annual Arithmetic Mean	0.053 ppm (100 µg/m3)	Same as Primary	
	1-hour	0.100 ppm[6]	None	
PM_{10}	Annual Arithmetic Mean	None	None	
	24-hour	150 µg/m^3	Same as Primary	
$PM_{2.5}$	Annual Arithmetic Mean	15 µg/m^3	Same as Primary	
	24-hour	35 µg/m^3	Same as Primary	
O_3	8-hour (2008 standard)	0.075 ppm	Same as Primary	
	8-hour (1997 standard)	0.08 ppm	Same as Primary	
	1-hour	0.12 ppm[7]	Same as Primary	
SO_2	1-hour	75 ppb[8]	None	
			3-hour	0.5 ppm

Notes:
1. National standards (other than ozone, particulate matter, and those based on annual averages) are not to be exceeded more than once per year. The ozone standard is attained when the fourth highest eight-hour concentration in a year, averaged over three years, is equal to or is less than the standard. For PM_{10}, the 24-hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 ug/m^3 is equal to or is less than one. For $PM_{2.5}$, the 24-hour standard is attained when 98% of the daily concentrations, averaged over three years, are equal to or are less than the standard.
2. Primary Standards: Levels necessary to protect public health with an adequate margin of safety.
3. Secondary Standards: Levels necessary to protect the public from any known or anticipated adverse effects.
4. Lead is categorized as a "toxic air contaminant" with no threshold exposure level for adverse health effects determined.
5. National lead standard, rolling three-month average: final rule signed October 15, 2008.
6. To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100 ppm (effective January 22, 2010).
7. EPA revoked the 1-hour ozone standard in all areas; however, some areas have continuing obligations under that standard.
8. Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

The standards in Table 1 apply to the concentration of a pollutant in outdoor ambient air. If the air quality in a geographic area is equal to or is better than the national standard, it is called an attainment area. Areas where air quality does not meet the national standard are called non-attainment areas. Once the air quality in a non-attainment area improves to the point where it meets the standards and the additional redesignation requirements in the CAA [Section 107(d) (3)(E)], EPA redesignates the area as a "maintenance area."

The Clean Air Act Amendments (CAAA) of 1990 requires states to designate the status of all areas within their borders as being in or out of compliance with the NAAQS. The CAAA further defines non-attainment areas for ozone based on the severity of the violation as marginal, moderate, severe, and extreme. In an effort to further improve the nation's air quality, the EPA has classified additional areas as attainment/non-attainment for a new 2008 8-hour ozone standard. The new 2008 eight-hour ozone standard is listed in Table 1, and as previously noted the project is located in an area that was designated as being in attainment with the new standard.

Each state is required to draft a state implementation plan (SIP) to further improve the air quality in non-attainment areas and maintain the air quality in attainment or maintenance areas. The plan outlines the measures that the state will take in order to improve air quality.

B. Mobile Source Air Toxics

In September of 2009, the FHWA issued the *Interim Guidance Update on Mobile Source Air Toxics Analysis in NEPA Documents*[3] to address Mobile Source Air Toxic (MSAT) impacts in a project-level analysis. The EPA identified seven compounds with significant contributions from mobile sources that are among the national and regional scale cancer drivers from their 1999 National Air Toxics Assessment (NATA). The seven compounds identified were acrolein, benzene, 1,3-butadiene, diesel particulate matter plus diesel exhaust organic gases, formaldehyde, naphthalene, and polycyclic organic matter (POM). While FHWA considers these the priority mobile source air toxics, the list is subject to change and may be adjusted in consideration of future EPA rules.

The FHWA guidance developed a tiered approach for assessing MSATs in NEPA documents and identified three levels of analysis. The three levels identified were for projects with no meaningful MSAT effects, low potential MSAT effects, and high potential MSAT effects. The FHWA guidance defines the levels of analysis for each type of MSAT effect:

- No analysis for projects with no potential for meaningful MSAT effects;
- A qualitative analysis for projects with low potential MSAT effects; and
- A quantitative analysis for projects with high potential MSAT effects.

The Alternatives were evaluated against each threshold criteria in order to determine the type of MSAT analysis required to satisfy NEPA.

C. Transportation Conformity

As discussed above, the Cities of Hampton and Norfolk are located in an EPA designated attainment area for all of the NAAQS, although they are designated as a maintenance area for the 1997 eight-hour ozone standard. The state of Virginia has prepared a Maintenance Plan that outlines the adopted control measures for achieving and maintaining compliance with the 1997 eight-hour ozone standard.

[3] "Interim Guidance Update on Mobile Source Air Toxics Analysis in NEPA", dated September 30, 2009.

EPA promulgated the Transportation Conformity Rule (40 CFR Parts 51 and 93) concerning applicability, procedures, and criteria that transportation agencies must use in analyzing and determining conformity of transportation projects. The Transportation Conformity Rule applies to federal funded transportation projects in certain areas that have violated one or more of the NAAQS in EPA designated non-attainment or maintenance areas (40 CFR 93.102(b)).

In March 2010, EPA issued amendments to the Transportation Conformity Rule for PM_{10} and $PM_{2.5}$ along with updated modeling guidance[4] for performing quantitative analyses of $PM_{2.5}$ and PM_{10} emissions. These amendments and updates help clarify the guidance for conforming with the 2006 $PM_{2.5}$ NAAQS for federal-funded or approved transportation projects and provide guidance for assessing projects that are deemed to be projects of air quality concern that are located in $PM_{2.5}$ non-attainment and maintenance areas.

The federal conformity rule requires that a conforming transportation plan and program be in place at the time of the project approval (40 CFR 93.114), and for the project to be included in the conforming plan and program (40 CFR 93.115). The Hampton Roads Bridge-Tunnel PPTA was included in the Hampton Roads Transportation Planning Organization (HRTPO) FY 2012-2015 Transportation Improvement Program (TIP) and the 2034 Long Range Transportation Plan (LRTP) for Preliminary Engineering (PE) only; therefore, it was not included in the fiscally constrained regional emissions analysis. Once funding is identified through the Construction (CN) Phase cost estimates, the preferred Alternative can be added to the LRTP to meet the fiscal constraint requirements and included in the conformity finding consistent with the SIP, if required.

8. PROJECT ASSESSMENT

A. Carbon Monoxide (CO) Analysis

On February 27, 2009, the FHWA and VDOT issued an updated memorandum of understanding (MOU) addressing requirements for project-level CO air quality analyses. Under this agreement, project-level air quality (hot-spot) analyses are conducted for CO for projects that meet traffic and related criteria as specified in the agreement. A hot-spot analysis for CO is required for this analysis as the expected traffic volumes will exceed the qualitative analysis threshold criteria specified in the MOU.

The air quality study utilizes the traffic assessment conducted by the design team for the 2011 base year, 2020 interim year and the 2040 design year conditions. Emissions of CO were estimated using the FHWA Easy Mobile Inventory Tool (EMIT) interface software package which incorporates the EPA MOBILE6.2 emissions generating model. Ambient concentrations at sensitive receptor locations were estimated using the EPA CAL3QHC dispersion model and added to appropriate background concentrations for comparison to the CO NAAQS.

Methodology

The microscale analysis typically examines ground-level CO impacts due to traffic flow in the immediate vicinity of a project intersection/interchange. CO is used in microscale studies to indicate roadway pollutant levels as it is the most abundant pollutant emitted by motor vehicles and can result in so-called "hot-spot" (i.e., high concentration) locations around congested intersections. The NAAQS were developed by the EPA to protect human health against adverse health effects with a margin of safety. These standards do not allow ambient CO concentrations to exceed 35 parts per million ("ppm") for a

[4] "Transportation Conformity Guidance for Qualitative Hot-Spot Analyses in PM2.5 and PM10 Nonattainment and Maintenance Areas, FHWA and US EPA, March 2010.

one-hour averaging period and 9 ppm for an eight-hour averaging period, more than once per year at any location. The widespread use of CO catalysts on late-model vehicles has significantly reduced the occurrences of CO hotspots. Air quality modeling techniques (computer simulation programs) are typically used to predict peak CO levels for both existing and future conditions to evaluate compliance of proposed roadways with the CO NAAQS.

The microscale analysis was conducted using the latest versions of the EPA MOBILE6.2 and CAL3QHC models to estimate CO concentrations at individual receptor (i.e. receiver) locations. CAL3QHC modeling results for each condition were then added to the appropriate background CO concentrations to determine total air quality impacts due to the Study Alternative. These values were then compared to the 1-hour and 8-hour CO NAAQS.

MOBILE 6.2 Emissions Estimation

The MOBILE6.2[5] inputs that were used in this analysis were consistent with Federal guidance and the VDOT Consultant Guide parameters for conducting a hot-spot analysis for CO. As discussed earlier, the FHWA EMIT[6] software package, which incorporates the MOBILE6.2 emissions estimation program, was used to estimate CO emission rates for input into the CAL3QHC dispersion model. Vehicle information for input into the MOBILE6.2 model was provided by VDOT for vehicle miles travelled (VMT) mix and vehicle registration data. The EMIT model was run to generate CO emission rates for 2011, 2020 (interim year), and 2040 (design year).

The study is located in the Cities of Norfolk and Hampton, VA; therefore the Hampton Roads modeling parameters from the VDOT Consultant Guide were used in MOBILE6.2. Moving emissions are calculated based on actual congested speeds at which vehicles travel through the intersections, while idle emissions are used to represent cars queuing. A summary of the MOBILE6.2 inputs are presented in Table 2.

Table 2. Summary of MOBILE 6.2 Inputs

Parameter	Hampton Roads per VDOT Consultant Guide
Min/Max Temperature	32°F - 32°F
Fuel Reid Vapor Pressure (RVP)	13.5
Season	2
Absolute Humidity	75%
Evaluation Month	1

The MOBILE6.2 output files are provided in Appendix B.

CAL3QHC Dispersion Model

The latest version of the CAL3QHC model (04244)[7] was used to predict one-hour CO concentrations from queue and free-flow links using the FHWA CAL3Interface[8]. The CAL3Interface is a software

[5] "Users Guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emission Factor Model", EPA 420-R-03-010, August 2003.

[6] See "The Easy Mobile Inventory Tool-EMIT", Michael Claggett, Ph.D. (Principal Author and Model Designer), Air Quality Modeling Specialist, FHWA, Jeffrey Houk, FHWA, November 2, 2006.

[7] "User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections", EPA-454/R-92-006 (Revised), EPA, September 1995.

package that incorporates the EPA CAL3QHC dispersion model. The CAL3QHC model incorporated default parameters per the VDOT Consultant Guide and the hourly traffic data based on expected growth rates. The one-hour concentrations from CAL3QHC were scaled by a factor of 0.7[9] to estimate 8-hour concentrations. Appropriate signal timing data from the traffic analysis modeling runs were input into the model for the signalized intersections. Travel speeds were estimated based on field observations, traffic data, and queuing at the intersections. The inputs used in the CAL3Interface model are shown in Table 3.

Table 3. Summary of CAL3QHC Inputs

Description	Value
Surface Roughness Coefficient	175 Centimeters
Background CO Concentrations	3.6 ppm 1-hour, 2.5 ppm 8-hour (Hampton Roads)
Wind Speed	1.0 meter per second
Stability Class	Urban D
Mixing Height	1,000 meters
Wind Direction	5 degree increments

An example of the CAL3QHC output files are provided in Appendix C.

Intersection Studies

As discussed above, a LOS analysis was completed for the existing, interim and design years for each Alternative. Based on the traffic analysis, a quantitative air quality analysis was required for CO since traffic volumes are predicted to exceed the threshold criteria specified in the VDOT-FHWA Project-Level Carbon Monoxide Air Quality Studies Agreement. An analysis of the Build-8 and Build-8 Managed traffic volumes and LOS were evaluated for comparison to the Build-10 Alternative to establish the worst-case Alternatives for inclusion in the CO hot-spot analysis. Table 4 provides the total AM and PM peak traffic volumes along with the LOS for each signalized intersection for the Build-10 and Build-8 Alternatives. A comparison of the two Alternatives for 2020 shows that the traffic volumes are greater for the Build-10 Alternative for every intersection except at North Armistead Avenue at LaSalle, I-64 WB Ramps at Settlers Landing Road and the I-64 EB Ramps at 4th view street. For the 2040 conditions, the Build-10 Alternative traffic volumes are greater at all intersections except the I-64 WB on-ramp at North Armistead Avenue, I-64 EB and WB Ramps at Settlers Road and the I-64 EB Ramps at South Mallory Street. The intersection with the worst LOS of F along with the highest traffic volumes where the Build-8 was greater than the Build-10 is expected to occur at North Armistead Avenue at LaSalle Avenue and was considered worst-case for the 2020 condition.

Similarly, Table 5 presents the Build-8 Managed Alternatives compared to the Build-10 Alternative for 2020 and for 2040 in order to evaluate potential diversion effects. The results of the comparison show that the total Build-8 Managed Alternatives AM and PM peak hour traffic volumes for 2020 are lower for all intersections except I-64 EB ramps at Bayville Street which shows a slight increase (ranging from 50 to 115 vehicles), however the LOS is expected to remain at an A and the total volumes are expected to be low compared to the other intersections evaluated. A comparison of the 2040 Build-8 Managed shows that peak volumes are lower for all intersections except five when compared to the Build-10 Alternative.

[8] See CAL3Interface – A Graphical User Interface for the CALINE3 and CAL3QHC Highway Air Quality Models", Michael Claggett, Ph.D., FHWA Resource Center, 2006.

[9] EPA guidance for estimating 8-hour concentrations from 1-hour concentrations.

Table 4. Peak-Hour Volumes and LOS Summary for Build 10 and Build 8 Alternatives

Intersection	Peak	Existing	Existing LOS	2020 No-Build	2020 No-Build LOS	2020 Build-10	2020 Build-10 LOS	Percent Change	2040 No-Build	2040 No-Build LOS	2040 Build-10	2040 Build-10 LOS	Percent Change	2020 Build-8 LOS	2020 Build-8 Volumes	2020 delta Build 8-Build 10	2040 Build-8 LOS	2040 Build-8 Volumes	2040 delta Build 8-Build 10
WB I-64 On-Ramp at N Armistead Ave	AM	2200	B	3625	C	3025	C	-19.8	2650	B	2525	B	-5.0	C	3025		B	2650	
	PM	2915	C	4000	E	4000	E	0.0	3425	C	3350	C	-2.2	E	4000		B	3425	
Total		5115		7625		7025			6075		5875			Total	7025	0		6075	200
N Armistead Ave at LaSalle Ave	AM	2720	B	3875	C	3875	C	0.0	3275	C	2950	C	-11.0	C	3900		E	3025	
	PM	3545	C	5475	F	5475	F	0.0	4700	F	4625	F	-1.6	F	5500		F	4300	
Total		6265		9350		9350			7975		7575			Total	9400	50		7325	-250
I-64 EB Off-Ramp at Rip Rap Road	AM	1150	C	1200	C	1350	D	11.1	1125	C	1125	C	0.0	D	1250		C	925	
	PM	1390	D	1575	E	1675	F	6.0	1500	D	1675	F	10.4	E	1600		C	1300	
Total		2540		2775		3025			2625		2800			Total	2850	-175		2225	-575
I-64 EB Off-Ramp at Settlers Landing Rd	AM	2035	E	2625	F	2575	F	-1.9	2350	E	2700	F	13.0	F	2550		F	2750	
	PM	1980	D	2600	D	2575	D	-1.0	2250	D	2300	D	2.2	D	2500		E	2575	
Total		4015		5225		5150			4600		5000			Total	5050	-100		5325	325
I-64 WB Ramps at Settlers landing Rd	AM	2030	B	2450	B	2150	C	-14.0	2200	B	2250	C	2.2	C	2200		C	2725	
	PM	2200	C	2625	C	2600	C	-1.0	2350	C	2350	C	0.0	C	2600		C	2575	
Total		4230		5075		4750			4550		4600			Total	4800	50		5300	700
I-64 EB Ramps at S Mallory St	AM	1290	C	1475	D	1475	C	0.0	2200	F	2325	F	5.4	B	1450		F	2525	
	PM	1011	D	1675	F	1800	F	6.9	1775	F	1800	F	1.4	F	1750		F	1775	
Total		2301		3150		3275			3975		4125			Total	3200	-75		4300	175
I-64 WB Ramps at S Mallory St	AM	1520	B	1800	F	1825	F	1.4	2925	F	2950	F	0.8	F	1825		F	3025	
	PM	1355	C	1950	C	1950	E	0.0	2550	F	2550	F	0.0	D	1900		F	2475	
Total		2875		3750		3775			5475		5500			Total	3725	-50		5500	0
Granby St at E Admiral Taussig Blvd	AM	2085	B	4050	B	4125	B	1.8	3525	C	4075	C	13.5	B	4125		B	3500	
	PM	2655	B	2300	B	2835	B	18.9	2700	B	4075	B	33.7	B	2750		E	3600	
Total		4740		6350		6960			6225		8150			Total	6875	-85		7100	-1050
I-64 EB Ramps at E Little Creek Rd	AM	1841	A	3825	B	3815	B	-0.3	3125	A	4025	B	22.4	B	3915		B	3950	
	PM	2635	A	3300	B	4575	C	27.9	3200	B	5125	D	37.6	C	4410		D	4525	
Total		4476		7125		8390			6325		9150			Total	8325	-65		8475	-675
I-64 WB Off-Ramp at E Little Creek Rd	AM	1620	B	3725	C	3650	C	-2.1	2725	B	3875	C	29.7	C	3650		C	3850	
	PM	2295	B	2475	C	4450	B	44.4	2500	B	4950	B	49.5	D	2050		E	4500	
Total		3915		6200		8100			5225		8825			Total	5700	-2400		8350	-475
EB I-64 Ramps at Bayville St	AM	100	A	50	A	50	A	0.0	75	A	100	A	25.0	A	50		A	125	
	PM	155	A	50	A	200	A	75.0	50	A	100	A	50.0	A	200		A	75	
Total		255		100		250			125		200			Total	250	0		200	0
WB I-64 Ramps at W Ocean View Ave	AM	60	A	150	A	150	A	0.0	175	A	250	A	30.0	A	150		B	175	
	PM	85	A	200	A	175	A	-14.3	175	A	375	A	53.3	A	150		A	175	
Total		145		350		325			350		625			Total	300	-25		350	-275
EB I-64 Ramps at 4th View St	AM	1095	F	1550	F	1525	F	-1.6	1925	F	1850	F	-4.1	F	1550		F	1675	
	PM	1030	F	1775	F	1875	F	5.3	2175	F	1675	F	-29.9	F	1950		F	1700	
Total		2125		3325		3400			4100		3525			Total	3500	100		3375	-150

Table 5. Peak-Hour Volumes and LOS Summary for Build 10 and Build 8 Managed Alternatives

Intersection		2020 Build-8 Managed 2 GP + 2 HOV	2020 delta Build 8 Managed 2 GP + 2 HOV- Build 10	LOS	2020 Build-8 Managed 3 GP + 1 HOT	2020 delta Build-8 Managed 3 GP + 1 HOT - Build 10	LOS	2020 Build-8 Managed 3 GP + 1 HOV	2020 delta Build-8 Managed 3 GP + 1 HOV - Build 10	LOS	2020 Build-8 Managed $2 Toll	2020 delta Build-8 Managed $2 Toll - Build 10	LOS
WB I-64 On-Ramp at N Armistead Ave		2425			2430			2425			2420		
		3190			3195			3190			3185		
	Total	5615	-1410		5625	-1400		5615	-1410		5605	-1420	
N Armistead Ave at LaSalle Ave		3005		B	3010		B	3005		B	3005		B
		3910		B	3925		B	3910		B	3900		B
	Total	6915	-2435		6935	-2415		6915	-2435		6905	-2445	
I-64 EB Off-Ramp at Rip Rap Road		1160			1175			1180			1170		
		1660			1440			1430			1440		
	Total	2820	-205		2615	-410		2610	-415		2610	-415	
I-64 EB Off-Ramp at Settlers Landing Rd		2135			2155			2135			2075		
		2025			2025			2025			1990		
	Total	4160	-990		4180	-970		4160	-990		4065	-1085	
I-64 WB Ramps at Settlers landing Rd		2100		C	2095		C	2105		C	2035		C
		2310		C	2320		C	2310		C	2215		C
	Total	4410	-340		4415	-335		4415	-335		4250	-500	
I-64 EB Ramps at S Mallory St		1525			1555			1535			1495		
		1180			1215			1180			1175		
	Total	2705	-570		2770	-505		2715	-560		2670	-605	
I-64 WB Ramps at S Mallory St		1780			1815			1790			1745		
		1620			1665			1620			1605		
	Total	3400	-375		3480	-295		3410	-365		3350	-425	
Granby St at E Admiral Taussig Blvd		2460			2510			2460			2390		
		3090			3110			3100			3015		
	Total	5550	-1410		5620	-1340		5560	-1400		5405	-1555	
I-64 EB Ramps at E Little Creek Rd		2220			2240			2220			2125		
		3155			3180			3155			3025		
	Total	5375	-3015		5420	-2970		5375	-3015		5150	-3240	
I-64 WB Off-Ramp at E Little Creek Rd		2285			2290			2285			2200		
		3445			3455			3445			3375		
	Total	5730	-2370		5745	-2355		5730	-2370		5575	-2525	
EB I-64 Ramps at Bayville St		155			155			155			150		
		200			210			200			150		
	Total	355	105		365	115		355	105		300	50	
WB I-64 Ramps at W Ocean View Ave		65			70			65			70		
		115			120			115			70		
	Total	180	-145		190	-135		180	-145		140	-185	
EB I-64 Ramps at 4th View St		1285			1320			1285			1265		
		1215			1260			1205			1310		
	Total	2500	-900		2580	-820		2490	-910		2575	-825	

Intersection		2040 Build-8 Managed 2 GP + 2 HOV	2040 delta Build 8 Managed 2 GP + 2 HOV- Build 10	LOS	2040 Build-8 Managed 3 GP + 1 HOV	2040 delta Build-8 Managed 3 GP + 1 HOV - Build 10	LOS	2040 Build-8 Managed 3 GP + 1 HOT	2040 delta Build-8 Managed 3 GP + 1 HOT - Build 10	LOS	2040 Build-8 Managed $2 Toll	2040 delta Build-8 Managed $2 Toll - Build 10	LOS
WB I-64 On-Ramp at N Armistead Ave		2925		B	2925		B	2950		B	2925		B
		3800		C	3800		C	3825		C	3800		C
	Total	6725	850		6725	850		6775	900		6725	850	
N Armistead Ave at LaSalle Ave		3700			3700			3725			3700		
		4725			4725			4775			4700		
	Total	8425	850		8425	850		8500	925		8400	825	
I-64 EB Off-Ramp at Rip Rap Road		1150			1175			1225			1200		
		1500			1525			1550			1550		
	Total	2650	-150		2700	-100		2775	-25		2750	-50	
I-64 EB Off-Ramp at Settlers Landing Rd		2125			2325			2350			2150		
		1950			2125			2125			1950		
	Total	4075	-925		4450	-550		4475	-525		4100	-900	
I-64 WB Ramps at Settlers landing Rd		2125		C	2250		D	2250		D	2025		C
		2350		C	2550		D	2575		D	2200		C
	Total	4475	-125		4800	200		4825	225		4225	-375	
I-64 EB Ramps at S Mallory St		1925			2075			2150			1950		
		1575			1600			1700			1575		
	Total	3500	-625		3675	-450		3850	-275		3525	-600	
I-64 WB Ramps at S Mallory St		2800			2375			2450			2250		
		2210			2200			2325			2250		
	Total	5010	-490		4575	-925		4775	-725		4500	-1000	
Granby St at E Admiral Taussig Blvd		3066			3300			3354			3066		
		3813			4052			4112			3813		
	Total	6879	-1271		7352	-798		7466	-684		6879	-1271	
I-64 EB Ramps at E Little Creek Rd		2950			3075			3150			2775		
		4075			4300			4375			3875		
	Total	7025	-2125		7375	-1775		7525	-1625		6650	-2500	
I-64 WB Off-Ramp at E Little Creek Rd		2750			2825			2875			2500		
		3775			2825			3975			3425		
	Total	6525	-2300		5650	-3175		6850	-1975		5925	-2900	
EB I-64 Ramps at Bayville St		275			275			275			250		
		325			300			325			275		
	Total	600	400		575	375		600	400		525	325	
WB I-64 Ramps at W Ocean View Ave		100			75			100			100		
		175			175			200			175		
	Total	275	-350		250	-375		300	-325		275	-350	
EB I-64 Ramps at 4th View St		1626			1725			1825			1575		
		1550			1625			1775			1600		
	Total	3176	-349		3350	-175		3600	75		3175	-350	

The intersection at I-64 WB Ramps at Settlers Landing shows a predicted increase in traffic volumes for two of the Build-8 Managed Alternatives; however this intersection is still expected to operate at LOS of D or better. The intersection at I-64 EB Ramps at Bayville also shows an increase compared to the Build-10 Alternative for all alternatives, however the LOS is expected to remain at A and the total volumes at the intersection are low compared to other intersections evaluated. Lastly, the intersection at I-64 WB Ramps at 4th View Street shows a slight increase for the Build-8 Managed 3 GP +1 HOT Alternative compared to the Build-10 Alternative, however even though the intersection is expected to operate at an LOS F, the total volume at the intersection is lower compared to other intersections evaluated with similar LOS of F (i.e. I-64 WB Ramps at S. Malloy Street). The intersections with the greatest increase are predicted to occur at the I-64 WB On-ramp at N. Armistead Ave and the N. Armistead Ave at LaSalle Ave intersections. The I-64 WB On-ramp intersection is still predicted to operate at an LOS of B or C while the N. Armistead Ave. and LaSalle intersection is predicted to operate at an LOS of F for the Build-8 Managed Alternatives and was considered as worst-case for the 2040 condition.

It is apparent through this comparison that the diversion effects associated with the Build-8 and Build-8 Managed Alternatives are not significant for most intersections; however there are some intersections where peak volumes will be appreciably higher when compared to the Build-10 Alternative. Therefore, a combination of the Build-10, Build-8, and Build-8 Managed Alternatives and associated traffic volumes were used for 2020 and 2040 in the CO hot-spot analysis to represent worst-case conditions (i.e. higher traffic volumes and LOS) that would be expected to yield the maximum ground level CO concentrations when compared to each of the other Alternatives studied.

Table 6 provides a summary of the LOS and average vehicle delay for each intersection studied for the Build-10 interim year 2020 and design year 2040 conditions. The peak hour volumes are provided in Table 4 and Table 5 along with the LOS for each intersection.

Appendix A contains the traffic analysis results for each condition used in the air quality analysis.

Table 6. LOS Summary of Worst Case Intersections for CO Hot-Spot Analysis

		2020 Build 10				2040 Build 10			
Intersection	**Control Type**	**AM**	**Delays (sec)**	**PM**	**Delays (sec)**	**AM**	**Delays (sec)**	**PM**	**Delays (sec)**
I-64 WB On-Ramp at N Armistead Ave	Signalized	C	23.5	E	56.6	B	18	C	30.1
N Armistead Ave at LaSalle Ave	Signalized	C	27.9	F	125.9	C	31	F	96.9
I-64 EB Off-Ramp at Rip Rap Rd	Signalized	D	51.1	F	82.4	C	30.3	F	82.8
I-64 EB Off-Ramp at Settlers Landing Rd	Signalized	F	97.2	D	47.2	F	120.1	D	39.9
I-64 WB Ramps at Settlers Landing Rd	Signalized	C	24.8	C	30.5	C	24	C	28.1
I-64 EB Ramps at S Mallory St	Signalized	C	24.3	F	256.4	F	290.3	F	228.2
I-64 WB Ramps at S Mallory St	Signalized	F	110.2	E	60.7	F	167.6	F	310.3
Granby St at E Admiral Taussig Blvd	Signalized	B	16.5	B	14.9	C	22.2	B	12.2
I-64 EB Ramps at E	Signalized	B	10.6	C	25.7	B	11.4	D	48.2

		2020 Build 10				2040 Build 10			
Intersection	**Control Type**	**AM**	**Delays (sec)**	**PM**	**Delays (sec)**	**AM**	**Delays (sec)**	**PM**	**Delays (sec)**
Little Creek Rd									
I-64 WB Off-Ramp at E Little Creek Rd	Signalized	C	30.1	B	10.7	C	31.5	B	14.1
I-64 EB Ramps at Bayville St	Stop 1	A	8.6	A	8.7	A	8.7	A	8.7
I-64 WB Ramps at W Ocean View Ave	Stop 1	A	9	A	9.1	A	9.1	A	9.6
I-64 EB Ramps at 4th View St	Stop 1	F	600+	F	600+	F	600+	F	600+

Table 7 provides estimated ADT volumes for the affected interchanges for the 2020 and 2040 Build-10 Alternative. The Build-10 Alternative was considered worst-case for the interchange analysis. A review of the 2040 ADT shows the highest traffic volumes are expected to occur at the I-64 and I-664 interchange, followed by the I-64 and LaSalle Ave and I-64 at West Ocean Ave interchanges. These three interchanges were also included in the CO Hot-Spot analysis along with the two intersections identified above.

Table 7. Estimated ADT at the Interchanges for the Build-10 2020 and 2040 Alternative Conditions

Location on I-64	**2020 Build-10 Lanes* Daily Volumes**			**2040 Build-10 Lanes* Daily Volumes**		
	Eastbound	**Westbound**	**Total**	**Eastbound**	**Westbound**	**Total**
I-664 and I-64 (Exit 264)	79,900	91,000	170,900	83,700	103,100	186,800
I-64 and LaSalle Ave (Route 167, Exit 265A)	67,700	79,900	147,600	73,200	83,700	156,900
I-64 and Settlers Landing (Exit 267)	68,600	67,700	136,300	75,100	73,200	148,300
I-64 and Mallory Street (Route 169, Exit 268)	73,200	68,600	141,800	75,100	75,100	150,200
I-64 and 4th View Street (Exit 273)	65,000	70,600	135,600	70,700	73,900	144,600
I-64 and West Ocean Ave (Exit 274)	75,100	65,000	140,100	82,200	70,700	152,900
I-64 and Granby Street/ I-564 (Exit 276)	63,400	59,700	123,100	78,400	73,000	151,400

* Indicates total number of lanes on future HRBT crossing (existing plus new construction).

The traffic analysis summarized above has demonstrated that the five intersections/interchanges chosen for evaluation in the CO hot-spot analysis have the worst-case LOS and/or highest traffic volumes within the project corridor, and are therefore representative of the locations where peak CO concentrations would be expected to occur. It is assumed that if these intersections/interchanges show peak ground level CO concentrations below the CO NAAQS, then all other locations in the study area will also be below the CO NAAQS.

Receptors

For the modeling analysis, receptor locations were placed in the vicinity of the five intersections/interchanges at public access locations such as sidewalks, property lines, and parking lots. Consistent with EPA modeling guidelines10, the receptors were located a minimum of 3 meters from the edge of the roadway and positioned at a height of 1.8 meters above the ground. Figures 2 through 6 show the receptor locations input into CAL3QHC for each intersection/interchange.

CAL3QHC Modeling Results

The results of the one-hour and eight-hour CO concentrations from CAL3QHC for each interchange/intersection and each build and no-build condition are provided in Table 8. The table includes the overall worst-case modeled concentrations for each of the five intersections/interchanges for the AM and PM peak periods, including the modeled receptor number in parenthesis, plus the one-hour and eight-hour background concentrations of 3.6 ppm and 2.5 ppm, respectively, for comparison to the CO NAAQS. The highest one-hour predicted concentration from the five interchanges/intersections, including background, for the existing, interim and design no build conditions are 9.1 ppm, 8.3 ppm, and 8.2 ppm, respectively. The highest one-hour predicted concentrations for the interim and design build conditions are 8.6 ppm and 8.7 ppm, respectively. The maximum one-hour predicted concentration of 9.1 ppm was predicted to occur at the I-64/I-664 interchange along with the maximum build concentration of 8.7 ppm for 2040. The maximum predicted one-hour no-build concentration of 8.3 ppm was predicted to occur at the North Armistead Avenue at LaSalle Avenue Intersection for 2020. All predicted 1-hour CO concentrations are well below the one-hour CO NAAQS of 35 ppm.

The one-hour values generated by CAL3QHC were then scaled by a persistence factor of 0.7 to generate eight-hour CO concentrations for comparison to the CO NAAQS. The highest eight-hour concentrations predicted plus background concentrations for the existing, interim and design no-build condition are 6.4 ppm, 5.8 ppm and 5.7 ppm, respectively. The highest eight hour concentrations for the interim and design build conditions are 6.0 ppm and 6.1 ppm, respectively. Similar to the one-hour concentrations, the maximum eight-hour predicted CO concentrations occurred at I-64/I-664 interchange for the existing, interim build and design build and no-build conditions. The maximum predicted eight-hour interim no-build concentration occurred at the North Armistead Avenue and LaSalle Avenue intersection. All predicted 8-hour CO concentrations are also well below the eight-hour CO NAAQS standard of 9 ppm.

Particulate Matter

The Cities of Hampton and Norfolk are designated by EPA as an attainment area for fine particulate matter ($PM_{2.5}$) and is in compliance with the NAAQS; therefore, a $PM_{2.5}$ hot-spot analysis will not be required for transportation conformity. Even so, the project was still evaluated for potential impacts on $PM_{2.5}$. The EPA has established a list of criteria (40 CFR 93.123(b) (1)) in determining whether a project is of "air quality concern" for $PM_{2.5}$, and the project was evaluated against each of these criteria below;

(i) New highway projects that have a significant number of diesel vehicles, and expanded highway projects that have a significant increase in the number of diesel vehicles;

The proposed improvements are designed to relieve AM and PM traffic congestion and improve deficiencies on the Hampton Roads Bridge Tunnel roadway. Total traffic along I-64

[10] "Guidelines for Modeling Carbon Monoxide from Roadway Intersections", EPA-454/R-92-005, US EPA, 1992.

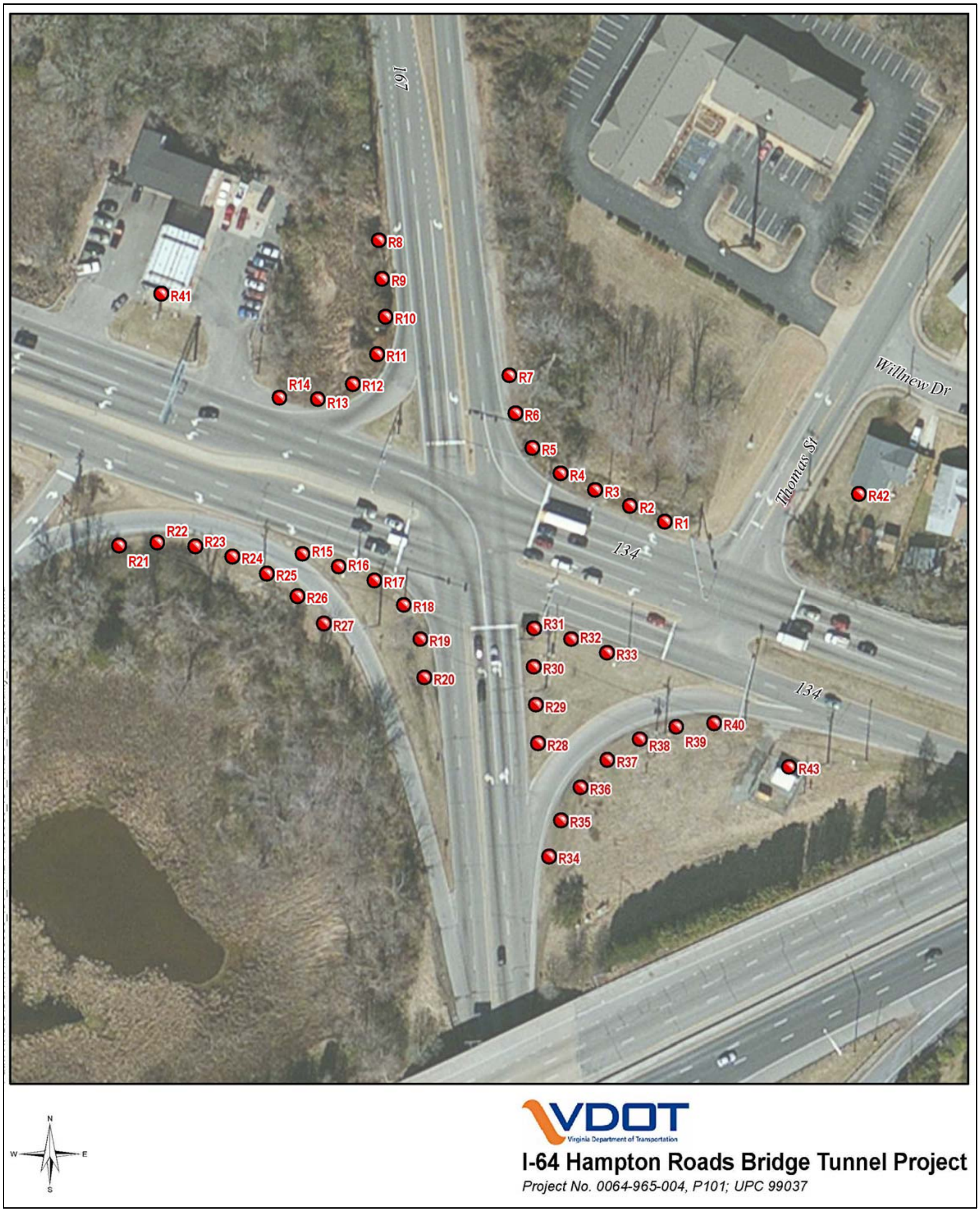

FIGURE 2. CAL3QHC RECEPTOR LOCATIONS: NORTH ARMISTEAD AVENUE AT LASALLE AVENUE

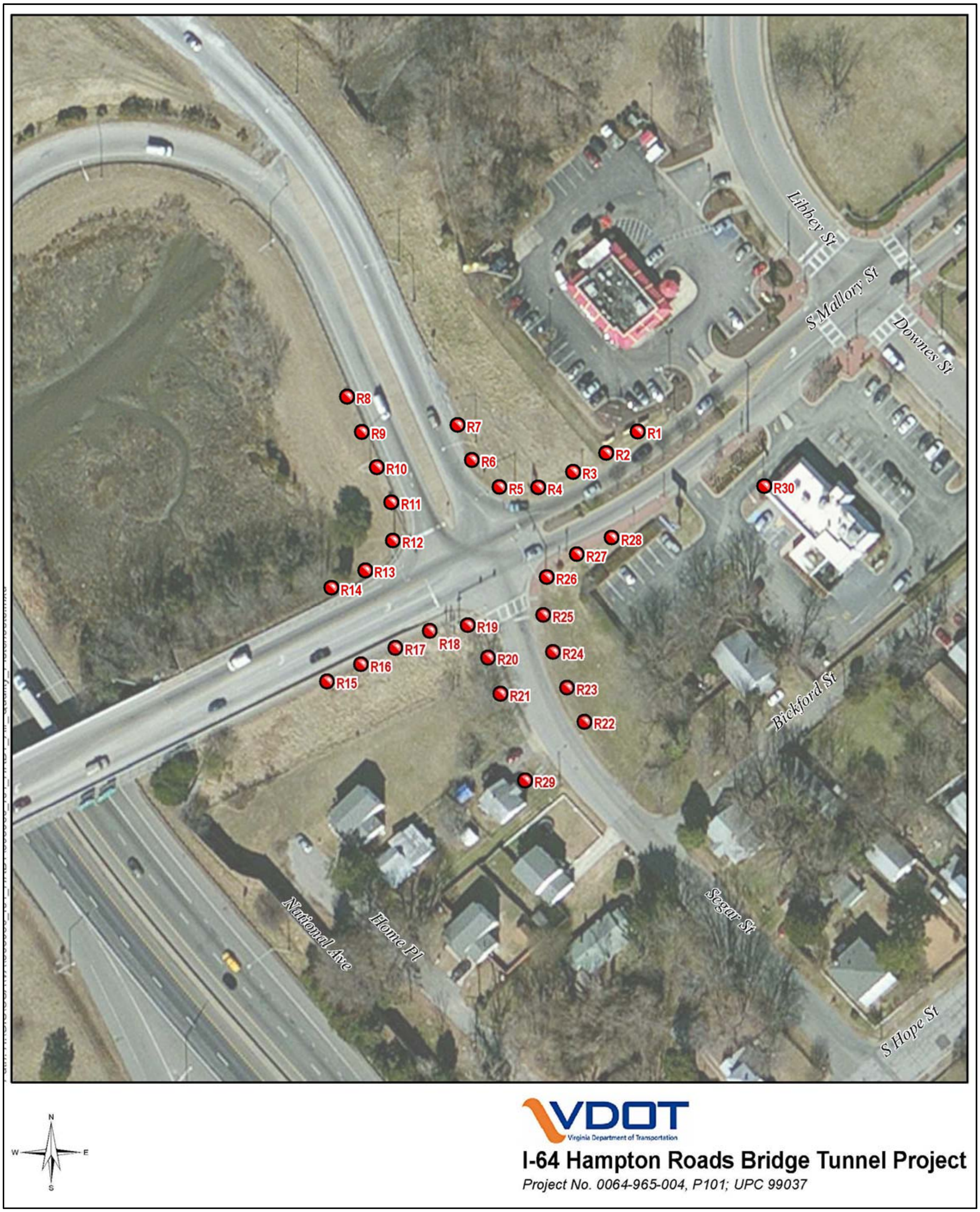

FIGURE 3. CAL3QHC RECEPTOR LOCATIONS: I-64 EB RAMPS AT SOUTH MALLORY STREET

FIGURE 4. CAL3QHC RECEPTOR LOCATIONS: I-64 AND I-664

FIGURE 5. CAL3QHC RECEPTOR LOCATIONS AT I-64 AND LASALLE AVENUE

FIGURE 6. CAL3QHC RECEPTOR LOCATIONS AT I-64 AND WEST OCEAN VIEW

Table 8. CAL3QHC Modeling Results for Each Intersection/Interchange

		Existing 2011[1,2]		2020[1,2]				2040[1,2]				
				No-Build		Build		No-Build		Build		
Intersection/Interchange	Averaging Period	Peak AM (ppm)	Peak PM (ppm)	Peak AM (ppm)	Peak PM (ppm)	Peak AM (ppm)	Peak PM (ppm)	Peak AM (ppm)	Peak PM (ppm)	Peak AM (ppm)	Peak PM (ppm)	NAAQS (PPM)
N. Armistead Ave at LaSalle Ave	1-hour	8.1 (17)	8.9 (16)	8.1 (16)	8.3 (16)	8.1 (16)	8.3 (16)	7.4 (16)	7.6 (16)	7.6 (16)	7.6 (16)	35
	8-hour	5.7 (17)	6.2 (16)	5.7 (16)	5.8 (16)	5.7 (16)	5.8 (16)	5.2 (16)	5.3 (16)	5.3 (16)	5.3 (16)	9
I-64 WB Ramps at S. Mallory Street	1-hour	5.6 (2)	5.5 (2)	5.3 (3)	5.3 (3)	5.3 (3)	5.3 (17)	5.7 (17)	5.6 (3)	5.8 (15)	5.3 (10)	35
	8-hour	3.9 (2)	3.8 (2)	3.7 (3)	3.7 (3)	3.7 (3)	3.7 (17)	4.0 (17)	3.9 (3)	4.0 (15)	3.7 (10)	9
I-64 and I-664	1-hour	9.1 (21)	8.7 (21)	7.8 (21)	7.7 (21)	8.6 (21)	7.9 (21)	8.2 (21)	7.8 (21)	8.7 (21)	8.4 (10)	35
	8-hour	6.4 (21)	6.1 (21)	5.4 (21)	5.4 (21)	6.0 (21)	5.5 (21)	5.7 (21)	5.4 (21)	6.1 (21)	5.9 (10)	9
I-64 and LaSalle Ave	1-hour	6.5 (18)	6.5 (18)	6.3 (1)	6.2 (18)	7.2 (1)	7.4 (18)	6.2 (18)	6.2 (18)	7.2 (18)	7.3 (18)	35
	8-hour	4.5 (18)	4.5 (18)	4.4 (1)	4.3 (18)	5.0 (1)	5.2 (18)	4.3 (18)	4.3 (18)	5.0 (18)	5.1 (18)	9
I-64 and West Ocean Ave	1-hour	6.1 (3)	6.1 (7)	5.6 (10)	5.6 (10)	6.9 (10)	6.9 (10)	5.6 (10)	5.6 (7)	7.6 (10)	7.3 (10)	35
	8-hour	4.3 (3)	4.3 (7)	3.9 (10)	3.9 (10)	4.8 (10)	4.8 (10)	3.9 (10)	3.9 (7)	5.3 (10)	5.1 (10)	9

Notes:

1. Total concentration is the sum of the modeled concentration plus background concentrations.
2. Number in parenthesis represents the modeled receptor number of maximum modelled concentration. Please refer to Figures 2 through 6.

in this region is forecast to reach up to 208,800 ADT for the 2040 Build-10 condition at the northern extent of the study area west of I-664, exit 264. The forecasted traffic in this area will result in a slight increase (6.3 percent) compared to the 2040 No-build condition of 195,800 ADT.

The diesel truck percentages in the study area are expected to be low, currently ranging between 3 to 4 percent of existing traffic volume based on the VDOT 2009 ADT Traffic Volume Estimates by Section of Route in this region. The Hampton Roads tunnel corridor is mostly used by commuters to travel to and from Hampton and Norfolk. The Study Alternatives are not expected to generate any significant growth in diesel truck traffic and the total truck traffic is expected to remain around 4 percent on a daily basis. Based on the 4 percent assumption, the diesel truck ADT is conservatively estimated to be 8,352 at the I-664 interchange for the 2040 Build-10 condition. It should be noted this interchange represents the highest ADT for the study area; other areas along the study area will have a lower ADT in comparison. When compared to the No-build condition, this project is anticipated to result in an increase of only 520 diesel vehicles in the project corridor, which is considered a relatively insignificant increase. EPA guidance suggests that a project of air quality concern be one that has 125,000 or greater ADT and 8% diesel trucks, which corresponds to a total ADT of at least 10,000 diesel trucks. The total estimated diesel truck ADT of 8,352 (of which the project as studied is only adding 520 vehicles in this area) falls well below the 10,000 ADT diesel truck level suggested by EPA for consideration as a project of air quality concern.

(ii) 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, F because of increased traffic volumes from a significant number of diesel vehicles related to the project;

See above. Both the total diesel truck volumes and the anticipated increase in diesel trucks are not considered to be significant.

(iii) New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location;

The project does not involve bus or rail terminals.

(iv) Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location; and

This project does not involve bus or rail terminals

(v) Projects in or affecting locations, areas, or categories of sites which are identified in the PM_{10} or $PM_{2.5}$ applicable implementation plan or implementation plan submissions, as appropriate, as sites of violation or possible violation.

This project is not located in such an area.

Based on the criteria specified in the Transportation Conformity Rule and associated guidance, the Study Alternative is not considered to be a “project of air quality concern” for particulate matter; therefore, neither a qualitative nor quantitative analysis was performed.

B. Mobile Source Air Toxics Analysis Methodology

In September of 2009, the FHWA issued an interim guidance update regarding Mobile Source Air Toxic (MSAT) impacts and the levels of analysis required to address MSATs in a NEPA analysis. The levels addressed were for projects with no meaningful MSAT effects, low potential MSAT effects, and high potential MSAT effects. A qualitative analysis is required for projects which meet the low potential MSAT effects criteria while a quantitative analysis is required for projects meeting the high potential MSAT effects criteria.

Projects with Low Potential MSAT Effects are described as:

- The type of projects included in this category are those that serve to improve operations of highway, transit, freight without adding substantial new capacity or without creating a facility that is likely to significantly increase emissions. This category covers a broad range of project types including minor widening projects and new interchanges, such as those that replace a signalized intersection on a surface street or where design year traffic is not projected to meet the 140,000 to 150,000 AADT criteria.

Projects with High Potential MSAT Effects must:

- Create or significantly alter a major intermodal freight facility that has the potential to concentrate high levels of diesel particulate matter in a single location;
- Create new or add significant capacity to urban highways such as interstates, urban arterials, or urban collector-distributor routes with traffic volumes where the AADT is projected to be in the range of 140,000 to 150,000 or greater by the design year; and
- Proposed to be located in proximity to populated areas.

The Study Alternatives will add capacity to this stretch of I-64 and daily volumes in the 2040 Build condition are expected to be above the 140,000 to 150,000 threshold for projects with High Potential MSAT effects, therefore a quantitative analysis was performed. Table 9 shows the projected daily volumes for the Build-10 Alternative for 2020 and 2040 along I-64 within the study corridor.

Table 9. Projected ADT for the Build-10 Alternative for 2020 and 2040

Location on I-64	2020 Build 10 Lanes* Daily Volumes			2040 Build 10 Lanes* Daily Volumes		
	Eastbound	Westbound	Total	Eastbound	Westbound	Total
West of (I-664, Exit 264)	91,000	91,000	182,000	104,400	104,400	208,800
I-664 To LaSalle Ave (Route 167, Exit 265A)	79,900	79,900	159,800	92,000	92,000	184,000
LaSalle Ave To Settlers Landing Road (US 60/Route 143, Exit 267)	67,700	67,700	135,400	78,200	78,200	156,400
Settlers Landing Road To South Mallory Street (Route 169, Exit 268)	68,600	68,600	137,200	79,400	79,400	158,800
South Mallory Street To 15th View Street (Exit 272) Hampton	73,200	73,200	146,400	77,700	77,700	155,400

Location on I-64	2020 Build 10 Lanes* Daily Volumes			2040 Build 10 Lanes* Daily Volumes		
Roads Bridge Tunnel						
15th View Street To 4th View Street (Exit 273)	70,700	70,600	141,300	76,300	76,500	152,800
4th View Street To West Ocean Ave and West Bay Ave (Exit 274)	65,000	65,000	130,000	76,400	76,400	152,800
West Ocean/West Bay Ave To Granby Street (US 460)	75,100	75,100	150,200	89,700	89,700	179,400
Granby Street to I-564 (Exit 276)	78,900	59,700	138,600	93,600	78,000	171,600
East of I-564, Mainline	63,400	63,400	126,800	80,900	80,900	161,800
East of I-564, HOV	10,000	10,000	20,000	10,000	10,000	20,000

* Indicates total number of lanes on future HRBT crossing (existing plus new construction).

MSAT Background

Controlling air toxic emissions became a national priority with the passage of the Clean Air Act Amendments (CAAA) of 1990, when Congress mandated that the EPA regulate 188 air toxics, also known as hazardous air pollutants (HAPs). The EPA assessed this expansive list in their 2007 rule on the *Control of Hazardous Air Pollutants from Mobile Sources* and identified a group of 93 compounds emitted from mobile sources that are listed in their *Integrated Risk Information System (IRIS).* In addition, EPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from their 1999 National Air Toxics Assessment (NATA). The seven compounds identified were:

- acrolein;
- benzene;
- 1,3 butadiene;
- diesel particulate matter;
- formaldehyde;
- naphthalene; and
- polycyclic organic matter.

The 2007 EPA rule requires controls that will dramatically decrease MSAT emissions through cleaner fuels and cleaner engines. According to a FHWA analysis using EPA's MOBILE6.2 emissions model, even if vehicle activity (defined as vehicle miles traveled) increases by 145 percent as assumed, a reduction in the total annual emission rate for the priority MSAT is projected from 1999 to 2050.

Between 2000 and 2020, FHWA forecasts that, even with 145 percent increase in VMT, these programs will reduce on-highway emissions for the priority MSATs by 72 percent, as illustrated in Figure 7.

As a result, EPA concluded that no further motor vehicle emissions standards or fuel standard were necessary to control MSATs. The agency is preparing another rule under authority of the CAA Section 202(1) that will address these issues and could make adjustments to the full 21 and the primary six MSATs.

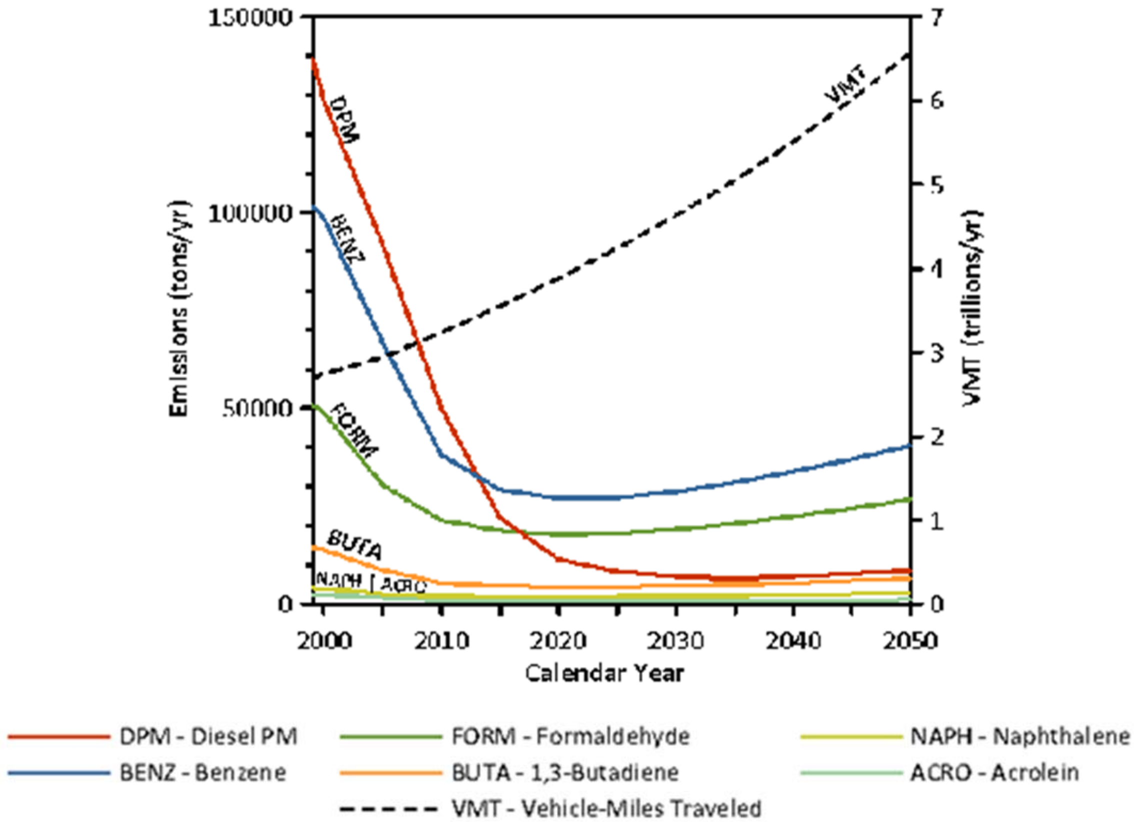

FIGURE 7. FHWA HIGHWAY EMISSION FORECASTS
Source: US EPA MOBILE6.2 Model Run, August 20, 2009.

The qualitative assessment is based in part from the FHWA study entitled *A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives*[11]. For each alternative in this study, the amount of MSAT emitted would be proportional to the VMT, assuming that other variables such as fleet mix are the same for each alternative. The VMT estimated for each build alternative are essentially the same as the No-build because the Project is not adding capacity, but adding efficiency to the roadway network. Any slight increase in VMT would lead to slightly higher MSAT emissions for the preferred action alternative along the highway corridor along with corresponding decrease in MSAT emissions along the parallel routes. Any potential emissions increase is offset somewhat by lower MSAT emission rates due to increased speeds according to EPA's MOBILE6.2 model. Emissions of all of the priority MSAT, except for diesel particulate matter, decrease as speed increases. The extent to which these speed-related emissions decreases will offset VMT-related emissions increases cannot be reliably projected due to the inherent deficiencies of technical models.

Because the estimated VMT under each alternative are essentially the same, it is expected there would be no appreciable difference in overall MSAT emissions among the various alternatives. Also, regardless of the alternatives chosen, emissions will likely be lower than present levels in the design year as a result of EPA's national control programs which are projected to reduce annual MSAT emissions by 72 percent between 1999 and 2050. Local conditions may differ from national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected

[11] "A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives", Michael Claggett, Ph.D., Terry L. Miller, Ph.D., P.E., May 2006.

reductions is so great (even after accounting for VMT growth) that MSAT emissions in the study area are likely to be lower in the future in nearly all cases.

<u>Health Impact Analysis</u>

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

The EPA is responsible for protecting the public health and welfare from any known or anticipated effect of an air pollutant. It is the lead authority for administering the Clean Air Act and has specific statutory obligations with respect to hazardous air pollutants and MSAT. The EPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. They maintain the IRIS, which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects" (see EPA, http://www.epa.gov/ncea/iris/index.html). 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, such as the Health Effects Institute (HEI), are also active in the research and analyses of the human health effects of MSAT. Two HEI studies are summarized in Appendix D of FHWA's Interim Guidance Update 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 or in the future as vehicle emissions substantially decrease.

The methodologies for forecasting health impacts include emissions modeling; dispersion modeling; exposure modeling; and then final determination of health impacts - each step in the process building on the model predictions obtained in the previous step. All are encumbered by technical shortcomings or uncertain science that prevents a more complete differentiation of the MSAT health impacts among a set of project alternatives. These difficulties are magnified for lifetime (i.e., 70 year) assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over that time frame due to a lack of information. The results produced by the EPA's MOBILE6.2 model, the California EPA's Emfac2007 model, and the EPA's DraftMOVES2009 model in forecasting MSAT emissions are highly inconsistent. Indications from the development of the MOVES model are that MOBILE6.2 significantly underestimates diesel particulate matter (PM) emissions and significantly overestimates benzene emissions.

Regarding air dispersion modeling, an extensive evaluation of EPA's guideline CAL3QHC model was conducted in a National Cooperative Highway Research Program (NCHRP) study, which documents poor model performance at ten sites across the country - three with intensive monitoring and seven with less intensive monitoring. The study indicates a bias of the CAL3QHC model to overestimate concentrations near highly congested intersections and underestimate concentrations near uncongested intersections. The consequence of this is a tendency to overstate the air quality benefits of mitigating congestion at intersections. Such poor model performance is less important to demonstrating compliance with National Ambient Air Quality Standards for relatively short time frames compared to forecasting individual exposure over an entire lifetime, especially given that some information needed for estimating 70-year lifetime exposure is unavailable. It is particularly difficult to reliably forecast MSAT exposure near roadways, and to determine the portion of time that people are actually exposed at a specific location.

There are considerable uncertainties associated with the existing estimates of toxicity of the various MSAT, because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by HEI. As a result, there is no national consensus on air dose-response values assumed to protect the public health and welfare for MSAT compounds, and in particular for diesel PM. The EPA and the HEI have not established a basis for quantitative risk assessment of diesel PM in ambient settings.

There is also the lack of a national consensus on an acceptable level of risk. The current context is the process used by the EPA as provided by the Clean Air Act to determine whether more stringent controls are required in order to provide an ample margin of safety to protect public health. A relevant example is preventing an adverse environmental effect for industrial sources by applying the maximum achievable control technology standards to reduce benzene emissions from refineries. The decision framework is a two-step process. The first step requires EPA to determine a "safe" or "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 has resulted 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 EPA's approach to addressing risk in its two step decision framework. Information is incomplete or unavailable to establish that even the largest of highway projects would result in levels of risk greater than safe or acceptable.

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, and improving access for emergency response, that are better suited for quantitative analysis.

MSAT Quantitative Analysis

The MSAT quantitative analysis was conducted consistent with the latest guidance developed by FHWA and recommended in the *Interim Guidance Update* mentioned earlier and also as outlined in the *FHWA Web Conference on Project-Level Mobile Source Air Toxics (MSAT) Analysis* (August 20, 2008). The following describes the approach and methodology used for conducting the MSAT analysis.

- The 2011 and 2020 travel demand forecasts were developed by Cambridge Systematics using the Hampton Roads Travel Demand Forecast Model as provided by VDOT. The Hampton Roads Transportation Planning Organization (HRTPO) provided land use data for the year 2034. A growth factor of 4.7 percent was applied to the 2034 forecast year volumes to account for traffic growth in the region to obtain 2040 volumes. Data from the traffic demand model used for this analysis is consistent with the TDM runs used in the CO analysis. The "affected network" was defined as the geographic area that surrounds the study corridor that might see realized differing traffic volumes with and without the Study Alternatives. A map depicting the general location of the "affected network" can be found in Figure 8. The "affected network" extends approximately 30 miles in the east and west directions and 26 miles in the north-south direction including the cities of Hampton and Norfolk with the HRBT approximately located in the middle of the network.

FIGURE 8. AFFECTED NETWORK FOR INCLUSION IN THE MSAT ANALYSIS

- In the affected network, an evaluation of the travel links that experience a five percent difference (i.e. increase or decrease) between the No-Build and Build conditions for each analysis year was performed. Only those links that experience a five percent or greater increase or decrease were evaluated in the MSAT inventory.
- The FHWA Easy Mobile Inventory Tool (EMIT) was utilized with the appropriate modifications in order to obtain air toxic emission rates for acrolein, benzene, 1,3-butadiene, diesel PM and formaldehyde. Since the EMIT Tool does not calculate emission rates for naphthalene and polycyclic organic matter, these pollutant emission rates were estimated using MOBILE6.2.
- Winter and summer emission rates from EMIT/MOBILE6.2 were averaged together for vehicle speeds ranging from idle to 65 mph in 5 mph increments. Winter was defined as the months from October to March and summer was defined as the months from April to September.
- Other gasoline parameters such as gas aromatics%, gas olefin%, gas benzene%, E200, E300, MTBE % volume, TAME% volume and ETBE% volume were obtained from the EPA's website with RFG property and performance averages for the Norfolk-Virginia Beach area (http://www.epa.gov/otaq/regs/fuels/rfg/properf/norf-va.htm) and included in the modeling runs. A summary of the MOBILE6.2 MSAT Gasoline Parameters are presented in Table 10.

Table 10. MOBILE6.2 MSAT Gasoline Parameters

PARAMETER	SUMMERTIME VALUE	WINTERTIME VALUE
Gas Aromatic %	19.17 (average)	20.63 (average)
Gas Olefin %	9.75 (average)	9.70 (average)
Gas Benzene %	0.596 (average)	0.637 (average)
E200	47.9 (average)	56.4 (average)
E300	84.0 (average)	84.6 (average)
MTBE % Volume	0.07 (average)	5.12 (average)
TAME % Volume	0.01 (average)	0.24 (average)
ETBE % Volume	0.0 (average)	0.01 (average)
Average Min/Max Temperature[1]	79.7/63.6	56.8/40.4

[1.] Climatological data derived from National Weather Service for Norfolk, VA based on temperature records from 1874-present.

- For each link that experiences a five percent or greater increase or decrease in traffic volumes compared to the No-Build condition, MSAT emissions were calculated by multiplying the appropriate emission rate (based on a rounded average daily speed limit) by the average daily traffic volume and link length.
- Annual emissions were calculated by multiplying the daily emissions for the existing, 2020 and 2040 Build and No-Build conditions by 365 days per year.

The results of the MSAT quantitative analysis are presented in Table 11 and show that MSAT emissions are expected to decline for all Retained Build Alternatives compared to the No-Build. In general, the results show that for most MSAT pollutants, emissions are expected to decline during the interim and design year when compared to the existing conditions (i.e. 2011).

More specifically, MSAT emissions for the Retained Build Alternatives are expected to decline between 2.4 percent and 9 percent during the 2020 interim year and between 2.0 percent and 16.3 percent during the 2040 design year when compared to the respective No-Build Alternative. The reduction in MSAT emissions is mainly attributed to the regional reduction in congestion associated with the Retained Build Alternatives, although a small percentage of VMT is expected to decrease due to the more efficient movement of vehicles from the Monitor Memorial Bridge-Tunnel (MMBT) to the HRBT. The HRBT alternatives are expected to attract traffic from the MMBT where the total traffic may increase with the widening of the HRBT; however, the individual trip lengths are expected to be shorter, thus possibly accounting for the slight decrease in VMT under the Retained Build Alternatives. Therefore, with more efficient movement of vehicles, the Retained Build Alternatives are expected to improve congestion and vehicle speed which should result in lower MSAT emissions compared to the No-Build Alternative.

In addition, all MSAT emissions for both the Retained Build and No-Build Alternatives during the interim year are predicted to be lower than existing conditions. MSAT emissions for the interim build condition are expected to decrease between 5.9 percent and 78.0 percent compared to the existing conditions, even though a small increase in VMT is anticipated on the “affected network” which includes all roadway links that are expected to experience a change in VMT by 5% or more as a result of the project.

Table 11. Projected Annual MSAT Emissions in tons per year (TPY) on "Affected Network"

		VEHICLE MILES TRAVELED (VMT)	ACROLEIN (TPY)	BENZENE (TPY)	1,3 BUTADIENE (TPY)	DIESEL PM (TPY)	FORMALDEHYDE (TPY)	NAPHTHALENE (TPY)	POLYCYCLIC ORGANIC MATTER (TPY)
2011	Existing	14,384,650	3.14	158.38	20.89	86.75	61.64	4.37	0.342
2020 Interim Year	Build	14,759,990	2.21	108.88	14.53	19.05	44.13	3.44	0.322
	No-Build	14,905,098	2.42	119.72	15.79	19.52	48.21	3.76	0.330
	Difference (Build-No Build)	-145,108	-8.7%	-9.0%	-8.0%	-2.4%	-8.5%	-8.5%	-2.44%
	Difference (Build-Existing)	2.6%	-29.6%	-31.2%	-30.5%	-78.0%	-28.4%	-21.3%	-5.9%
2040 Design Year	Build	49,684,507	2.54	123.87	16.61	10.75	51.39	4.13	0.390
	No-Build	49,727,723	2.99	147.92	19.37	11.17	60.40	4.85	0.398
	Difference (Build-No Build)	-43,216	-15.0%	-16.3%	-14.3%	-3.8%	-14.9%	-14.9%	-2.0%
	Difference (Build-Existing)	71.1%	-19.1%	-21.8%	-20.5%	-87.7%	-16.6%	-5.5%	14.0%

In addition, with the exception of POM, all MSAT emissions in the Build Alternative for the 2040 design year are expected to be lower than the existing condition even though the VMT on the "affected network" is expected to increase more than threefold. Other than for POM, MSAT emissions for the Build Alternative in the 2040 design year are expected to decrease between 5.5 percent and 87.7 percent compared to existing conditions. A small increase is predicted in POM emissions for the Build Alternative when compared to existing conditions, although this is mainly attributable to the growth in VMT on the "affected network" and is therefore not considered meaningful, especially when compared to regional emission levels. Of most significance is that the Retained Build Alternatives are expected to show reductions in all MSATs compared to the No-Build Alternative for all conditions in both the interim and design years.

Overall, the results of the MSAT analysis are consistent with the national MSAT emission trends predicted by MOBILE6.2 as discussed earlier and indicate that no meaningful increases in MSATs have been identified and that the Retained Build Alternatives are not expected to cause an adverse effect on human health as a result of the Study Alternatives.

The MSAT emission rates associated with this quantitative MSAT analysis are presented in Appendix D.

MSAT analysis is a continuing area of research. While much work has been done to assess the overall health risks of MSAT, many questions remain unanswered. In particular, the tools and techniques for assessing project-specific health outcomes as a result of lifetime MSAT exposure remain limited. These limitations impede the ability to evaluate how the potential health risks posed by MSAT exposure should be factored into project-level decision-making within the context of NEPA. Although it can be acknowledged that human populations could be exposed to MSAT under the Build Condition, with possible health-related consequences, those same populations would also be exposed to MSAT under Existing Conditions and under the No-Build Condition.

This analysis has considered current available information on MSATs, including regulatory requirements, modeling applications, and the associated health effects. Based on the supplied information, the predicted reductions in MSAT emissions from the Build conditions in comparison to both the No-Build conditions and Existing conditions, the uncertainty regarding emissions estimates, and the difficulty of assessing exposure at the project level and associated health impacts, there does not appear to be significant adverse impacts on air quality or human health from MSAT that could be attributed to the proposed project.

9. TUNNEL ASSESSMENT

Included in the Study evaluation is the addition of one new tunnel under the Chesapeake Bay to accommodate additional traffic. The tunnel would be constructed generally adjacent to the existing HRBT and could accommodate up to six new travel lanes (one westbound and five eastbound lanes).

The new tunnel would be approximately 7,760 feet long (1.47 miles) and equipped with longitudinal jet fans ventilation system to move the air either during peak hour conditions or in the event of an accident or emergency. The ventilation system within the tunnel will be designed consistent with the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) Handbook, Chapter 13, Enclosed Vehicular Facilities - Tunnels. The ventilation system design is based on controlling the level of emissions to acceptable concentrations inside the tunnel during normal operations along with the capacity to remove smoke and gases during emergencies; and to assure both the traveling public as well as highway worker/emergency personal safety that air quality within the tunnel will be met consistent with normal ventilation air quantities as described in the referenced ASHRAE standard.

The tunnel assessment will demonstrate that air quality in the tunnel will be controlled consistent with current federal standards as well as FHWA/US EPA guidelines for CO concentrations in tunnels. According to the ASHRAE standard, tests and operating experience have shown that when CO is adequately controlled, the other vehicle emission pollutants are likewise adequately controlled. Therefore, the analysis will demonstrate that the one-hour CO NAAQS of 35 ppm along with the FHWA/EPA 15-minute exposure level of 120 ppm will be met inside the tunnel. Given the tunnel length of less than 1.5 miles, the typical in tunnel residence time will be under 15 minutes for most vehicle speeds down to 5.5 mph; therefore, conservatively speeds less than 5.5 mph will be represented by the idling condition as described below. If the 35 ppm standard and the 120 ppm guideline are being met inside the tunnel, it can be concluded that emissions from the portals would also be below the CO standard and guideline levels in the ambient air outside the tunnel.

The methodology and assumptions for assessing the tunnel air quality analysis were consistent with the most recent Federal Highway Administration (FHWA) guidance (*Revised Guidelines for the Control of Carbon Monoxide (CO) Levels in Tunnels* and the *Draft Summary Teleconference To Discuss Tunnel Air*

Quality Analysis[12]. The methodology included a series of calculations using the tunnel dimensions, ventilation system data, and traffic emissions and assumptions to estimate the CO concentration inside the tunnel. The analysis incorporated key inputs assuming the 2040 Build 10 Alternative traffic conditions as presented in Table 12.

Table 12. Model Parameters and Inputs

Parameter	Westbound Lane	Eastbound Lane (2 Lanes)	Eastbound Lane (3 Lanes)
Length of Tunnel	7,760 feet	7,760 feet	7,760 feet
Average Daily Traffic (ADT)	15,540	31,080	46,620
Peak Hour Traffic	1,190	2,600	3,900
Idle Traffic	388	776	1,164
Worst-Case Peak Hour Speeds	Idle, 10 mph	Idle, 10 mph	Idle, 10 mph
CO Emission Factor (10 mph)	17.95 g/mile	17.95 g/mile	17.95 g/mile
CO Emission Factor (idle)	95.3 g/veh-hr	95.3 g/veh-hr	95.3 g/veh-hr
Flow Rate (cfm)	650,000	1,500,000	2,000,000

The analysis was conducted for two worst-case scenarios: 1) peak-hour conditions in order to address the worst-case worst-case conditions associated with routine peak hour traffic operations; and 2) an incident (idling) that stops traffic such as an accident or vehicle breakdown. The incident scenario may be the worst-case of the two scenarios, since this scenario is characterized by idling vehicles in bumper to bumper conditions where pollutant emissions are at their highest under idling conditions.

Table 13 shows the calculations for the tunnel air quality analysis associated with the 2040 Build-10 Alternative. The calculations are presented for the six proposed travel lanes along with the worst-case peak hour and incident (i.e. idling) conditions.

The results of the analysis show that CO levels are estimated to be below the one-hour CO NAAQS of 35 ppm and below the 15-minute FHWA/EPA guideline level of 120 ppm for both the peak hour and incident (idling) condition. For the peak hour condition, the estimated CO concentration is 29.9 ppm and is 85 percent of the CO NAAQS and 25 percent of the FHWA/EPA guideline level. For the incident idling condition, the estimated CO concentration is 33.0 ppm and is 93 percent of the CO NAAQS and 27 percent of the FHWA/EPA guideline level. The calculation includes the one-hour CO ambient background level of 3.6 ppm and was assumed to exist the in the tunnel ventilation supply air.

In addition to the CO compliance calculation, the FHWA/EPA guidelines requires that tunnel incident management techniques be addressed as part of the environmental analysis to ensure CO exposure levels are kept to minimum during accidents and breakdowns. Since the Project is still in the study phase, no formal technical requirements or specifications have been developed by VDOT for operations and maintenance within the tunnel. Once the final Alternative is chosen and the design stage of the Project commences, technical specifications will be prepared by VDOT and adhered to for operating and maintaining the tunnel including tunnel management techniques.

[12] Draft Summary, Teleconference To Discuss Tunnel Air Quality Analysis. Downtown Tunnel-Midtown Tunnel – Martin Luther King Freeway Extension (DT-MT_MLK) PPTA Project, Cities of Norfolk and Portsmouth. August 30, 2010: 3:00 p.m.

Table 13. In-Tunnel Emission Analysis

Tunnel Data	Westbound Lanes	Eastbound Lane 1	Eastbound Lane 2	Notes
Number of Lanes	1	2	3	
Tunnel Length (ft)	7,760	7,760	7,760	
Tunnel Length (miles)	1.47	1.47	1.47	
Tunnel Height (ft)	18.5	18.5	18.5	
Tunnel Width (ft)	28.5	35.5	47.5	
Tunnel Volume (cf3)	4,091,460.00	5,096,380.00	6,819,100.00	
Tunnle Volume (m3)	115,857	144,313	193,095	

Ventilation System Data

Type of System	Jet Longitudinal	Jet Longitudinal	Jet Longitudinal
Supply Air Capacity (cfm)	650,000	1,500,000	2,000,000
Air exchanges over 60-min	10	18	18

Traffic Assumptions

				Notes
AADT	12,950	25,900	38,850	Based on estimated AADT from traffic analysis of 77,700 ADT in each direction.
Worst Case Speeds	0 and 10 mph	0 and 10 mph	0 and 10 mph	
Peak Hour Fraction of ADT	0.07	0.08	0.08	
CO Emission Factor -idle (g/veh-hour)	95.3	95.3	95.3	MOBILE6.2
CO Emission Factor - Peak Traffic (g/mile)	17.95	17.95	17.95	MOBILE6.2

Calculations for Peak Hour

				Notes	
Peak Hour ADT from Traffic Report	1,190	2,600	3,900	vehicles	Based on worst case peak hour AM or PM from traffic analysis
Vehicle Miles Travled	1,748.9	3,821.2	5,731.8	VMT	Based on Peak Hour ADT x Tunnel Length
Emission rate mg/hr	31,393,462	68,590,758	102,886,136	mg/hr	Based on Peak Hour ADT VMT x Peak Traffic CO emission factor x 1000 mg/g
Static 60-min emission rate	271.0	475.3	532.8	mg/m^3	Based on (CO emission rate in mg/hr)/(Tunnel Volume in m^3)
Diluted CO emission rate	28.4	26.9	30.3	mg/m^3	Based on (CO concentration in $mg/^3$)/Air exchanges per hour
Converted to PPM	24.7	23.4	26.3	ppm	Converted mg/m^3 to PPM
Add ambient background values from VDOT	28.3	27.0	29.9	ppm	PPM concentration plus 1-hour VDOT CO background value of 3.6 ppm
Percent of 120 ppm Tunnel Standard	23.60%	22.50%	24.94%		
Percent of 35 ppm 1-hr CO NAAQS	80.91%	77.15%	85.51%		

Calculations for Incident Idling

				Notes	
Idle Vehicle Capacity	388	776	1164	Assumes 20 feet per vehicle per lane	
Emission Rate mg/hr	36,976,400	73,952,800	110,929,200	mg/hr	Based on Idle VMT x Peak Traffic CO emission factor x 1000 mg/g
Static 60-minute CO concentration	319	512	574	mg/m^3	Based on (CO emission rate in mg/hr)/(Tunnel Volume in m^3)
Diluted CO Concentration over 60 minutes	33	29	33	mg/m^3	Based on (CO concentration in mg/3)/Air exchanges per hour
Convert to ppm	29	25	28	ppm	Converted mg/m^3 to PPM
Add ambient background values from VDOT	33	29	32	ppm	PPM concentration plus 1-hour VDOT CO background value of 3.6 ppm
Percent of 120 ppm Tunnel Standard	27%	24%	27%		
Percent of 35 ppm 1-hr CO NAAQS	93%	82%	91%		

10. CONSTRUCTION EMISSION ANALYSIS

The temporary air quality impacts from construction activities are not expected to be significant. Construction activities will be performed in accordance with VDOT's current "Road and Bridge Specifications". The specifications conform to the SIP and require compliance with all applicable local, state, and federal regulations.

The study is located in an EPA designated maintenance area for ozone. The following VDEQ air pollution regulations will be adhered to during the construction of this project: 9 VAC 5-130 et seq., Open Burning restrictions; 9 VAC 5-45, Article 7 et seq., Cutback Asphalt restrictions; and 9 VAC 5-50-60 et seq., Fugitive Dust precautions.

11. MITIGATION

Mitigation measures will be taken to minimize environmental impacts during construction activities to comply with all federal, state, and local regulations.

12. CONCLUSION

The cities of Hampton and Norfolk are designated by the EPA as an attainment area for all criteria pollutants, except for the 1997 ozone standard for which the region is designated as a maintenance area. The traffic analysis conducted by the design team showed ADT levels in the study area are projected to be above the VDOT/FHWA CO quantitative hot-spot analysis thresholds for the interim and design year conditions. As such, CO impacts were analysed at the five worst-case intersections/interchanges located in the Study area. The results of the quantitative analysis show maximum modeled CO levels fall well below the CO NAAQS for all conditions.

Since the area is designated as an attainment area for $PM_{2.5}$ and is in compliance with the NAAQS, a $PM_{2.5}$ hot-spot analysis was not required for conformity. Even so, the project was still evaluated for $PM_{2.5}$ impacts and was found not to be a project of air quality concern for $PM_{2.5}$ based on EPA criteria, therefore, neither a qualitative nor quantitative analysis was performed.

The Study Alternatives were also evaluated for compliance with the FHWA guidance for addressing MSATs in a NEPA analysis. The Study was identified as one with High Potential MSAT Effects; therefore, a quantitative analysis was conducted consistent with the FHWA guidance for the worst-case Alternative (Build-10). The results of the MSAT analysis were found to be consistent with the national MSAT emission trends as documented in FHWA guidance, and indicated that no meaningful increases in MSATs were identified and therefore the project is not expected to cause an adverse effect on human health as a result of the Study Alternatives.

An air quality assessment was conducted for the proposed tunnel to estimate in-tunnel concentrations of CO for peak hour and incident (idle) condition. The analysis demonstrated that predicted in-tunnel concentrations of CO will be below the one-hour CO NAAQS of 35 ppm and also below the 15-minute FHWA/EPA guideline of 120 ppm for both the peak hour and incident condition.

The Hampton Roads Bridge-Tunnel PPTA was included in the Hampton Roads Transportation Planning Organization (HRTPO) FY 2012-2015 Transportation Improvement Program (TIP) and the 2034 Long Range Transportation Plan (LRTP) for Preliminary Engineering (PE) only. Therefore, it was not included in the regional conformity determination. Once funding is identified through the Construction (CN) Phase cost estimates, the preferred alternative can be added to the LRTP to meet the fiscal constraint requirements and included in the conformity finding consistent with the state implementation plan (SIP), if required.

Lastly, construction activities will be performed in accordance with VDOT's "Road and Bridge Specifications." These specifications conform to the SIP and require compliance with all applicable federal, state, and local regulations.

In conclusion, this study has demonstrated that the Study Alternatives are not expected to cause or contribute to any new violation of any standard, increase the frequency or severity of any existing violation, or delay timely attainment of any standard.

APPENDIX A. TRAFFIC ANALYSIS (AVAILABLE UPON REQUEST)

APPENDIX B. MOBILE6.2 OUTPUT FILES (AVAILABLE UPON REQUEST)

APPENDIX C. CAL3QHC OUTPUT FILES (AVAILABLE UPON REQUEST)

APPENDIX D. MSAT EMISSION RATES (AVAILABLE UPON REQUEST)