Appendix A1

Technical support document for the development of point source (EGU & Non-EGU) emissions inventories for 2014, 2025, and 2030

Virginia

Attainment Year 2014 Inventories

Point Non-EGU Sector

Base year inventories for all point nonEGU sources are based on emissions reported in the 2014 National Emissions Inventory (NEI), with the exception of six facilities. Emissions from these six facilities in the 2014 NEI do not match submitted values or values included in Virginia's Comprehensive Environmental Data System (CEDS). CEDS data is certified by responsible officials from each facility and is subjected to internal quality assurance processes by compliance staff at DEQ. Therefore, CEDs data is considered to be of high quality, and those six facilities had 2014 emissions data from CEDS substituted in place of the 2014 NEI information. These six facilities are as follows:

- Covanta Alexandria/Arlington
- Glen-Gery Corporation – Manassas Quarry
- US Army – Fort Belvoir
- Dominion – Leesburg Compressor Statin
- Columbia Gas Transmission Corporation
- US Marine Corps – MCB Quantico

Additionally, the NEI point source inventory for 2014 contained emissions from airports, which DEQ typically includes in the Marine, Air, and Rail (MAR) sector inventory. DEQ reviewed the information in the point source inventory for the airports in the region and determined that these emissions were already included in the MAR inventory sector. Therefore, these facilities were not included in the point nonEGU 2014 inventory for the 2008 ozone NAAQS redesignation request and maintenance plan.

Standard inventory practices were used to develop ozone season tons/day (OSt/d) values from annual estimates. Daily emissions calculations are calculated as follows:

Daily Emissions (OSt/d) = Annual Emissions (tpy) * Summer Throughput Percentage/(Yo*Operating Days per Week)

Yo=Summer Throughput Percentage * Operating Hours Per Year/(Operating Hours per Day * Operating Days per Week)

In cases where such data are not available, OSt/d values are based on a summer throughput percentage of 25%; operating days per week equal to 7; operating hours per year equal to 8,760; and operating hours per day equal to 24.

The spreadsheet entitled, "VA_NonEGU Growth File (revised)(No Airports))_08-31-2017_updated.xlsx" contains non-EGU point sector 2014 emissions estimates for the Northern Virginia portion of the Washington DC-MD-VA 2008 ozone NAAQS nonattainment area.

Point EGU Sector

For 2014 emissions of NOx, data supplied under 40 CFR Part 75 from unit-specific continuous emission monitoring (CEM) equipment was used to determine the actual annual and ozone emissions of NOx. To determine emissions of NOx in OSt/d, ozone season emissions of NOx were divided by the number of operating days in the ozone season. Any day with operating time is considered an operating day.

To determine the VOC and CO OSt/d value for each EGU unit, the annual 2014 inventory value for that pollutant was multiplied by a ratio of the 2014 NOx OSt/d value to the 2014 NOx annual emissions in tons:

VOC or CO, OSt/d = $(\text{Emissions}_{2014})*(\text{NOx OSt/d}_{2014})/(\text{NOx tpy}_{2014})$

The spreadsheet entitled, "VA_ Point_EGU_BY2014_2025_2030_Average-OS-Tons-Per-Day_08-31-2017.xlsx" contains the point EGU sector emissions estimates.

Projection Years 2025 & 2030 Inventories

Point NonEGU Sector

All emissions from Northern Virginia point non-EGU facilities, with the exception of data centers, were projected into future years using a no-growth (unity, growth rate equivalent to 1) assumption. Historical point source emission estimates show that emissions from this inventory sector decline over time regardless of factors such as economic expansion or improved outputs. This trend is due to a number of factors, including but not limited to:

- Technological efficiency improvements that reduce emissions and reduce costs,
- Application of Best Available Control Technology in Virginia's minor new source review permitting program,
- Changes in fuel costs that make lower-emitting fuels more attractive to industry and commercial enterprises,
- Continued emphasis on fuel economy for industrial equipment due to both economic and environmental pressures; and
- Advancement of federal regulations, such as tighter New Source Performance Standards and more stringent National Ambient Air Quality Standards.

Information from permit applications and facility inspections indicates that data centers are the only source category in Northern Virginia where the application of a no-growth projection would not be appropriate. Data centers are facilities that contain computer systems and their associated components and may act as repositories for electronic information. Emissions from these facilities originate from the large amounts of backup power necessary to ensure system reliability. In the Northern Virginia area, such centers have significant backup generation capacity and therefore have relatively large potential emissions. Since the backup generation capacity is only operated for testing and maintenance purposes and very infrequently for the generation of backup power, actual emissions from these facilities are low relative to potential emissions. Based on facility-specific information, overall growth in backup generation for new or expanded data centers is expected to overwhelm any reductions associated with Tier 2 backup engine controls. Therefore, for this source category, Virginia chose to grow the point nonEGU data center facility emissions using a growth factor equivalent to the estimated employment growth rate derived from the COG Cooperative Forecast for the county in which the facility is located. Such growth factors should conservatively predict emissions increases for data centers in the point nonEGU inventory.

Future year daily values are derived from annual values using the following equations:

Daily Emissions (OSt/d) = Annual Emissions (tpy) * Summer Throughput Percentage/(Yo*Operating Days per Week)

Yo=Summer Throughput Percentage * Operating Hours Per Year/(Operating Hours per Day * Operating Days per Week)

In cases where such data are not available, OSt/d values are based on a summer throughput percentage of 25%; operating days per week equal to 7; operating hours per year equal to 8,760; and operating hours per day equal to 24.

The spreadsheet entitled, "VA_NonEGU Growth File (revised)(No Airports))_08-31-2017)_updated.xlsx" contains nonEGU point sector projection year emissions estimates.

Point EGU Sector

Virginia projected emissions from EGUs in OSt/d are based on ERTAC CONUS2.6 results. These results and associated documentation, input files, and other supporting information is available on the MARAMA website at http://www.marama.org/2013-ertac-egu-forecasting-tool-documentation. NO_X emissions in OSt/d were calculated by dividing the estimated future year ozone season NO_X emissions by the number of days operated during the ozone season. Any day with any operating time was considered one day in this calculation.

To determine the VOC and CO OSt/d value for each EGU unit, the annual 2014 inventory value for that pollutant was multiplied by a ratio of the NOx OSt/d value to the NOx annual emissions in tons for that projection year:

VOC or CO, OSt/d = $(\text{Emissions}_{2014})*(\text{NOx OSt/d})/(\text{NOx tpy})$

The spreadsheet entitled, "VA_ Point_EGU_BY2014_2025_2030_Average-OS-Tons-Per-Day_08-31-2017.xlsx" contains the EGU point sector projection year emissions estimates.

Maryland

Attainment Year 2014 Inventories

Methodologies for the attainment year inventories for all point EGU and non-EGU sources are described in detail in Appendix B1b. The spreadsheet entitled, " MD_MWCOG 2014 Daily RR & MP PT_NPT_M-A-R_QPT to MWCOG 4.xlsx" contains the 2014 EGU point sector emissions estimates.

Projection Years 2025 & 2030 Inventories

Point Non-EGU Sector

Emissions from Maryland point non-EGU facilities were projected using Maryland Occupational Projections - 2012-2022 (https://www.dllr.state.md.us/lmi/iandoproj/wiasindustry.shtml). These projections are provided by county or region for different types of industries. Growth factors are presented in the Tab entitled “GF” of the Appendix A2 file (MD_MWCOG 2014 Daily RR & MP PT_NPT_M-A-R_QPT to MWCOG 4.xlsx). The spreadsheet entitled, " MD_MWCOG 2014 Daily RR & MP PT_NPT_M-A-R_QPT to MWCOG 4.xlsx" contains the non-EGU point sector projection year emissions estimates.

Point EGU Sector

Emissions from Maryland point EGU facilities were projected using Annual Energy Outlook (AEO) 2014 total electricity generation and import projections for 2025 and 2030. Growth factors are presented in the Tab entitled “FacID_NAICS_GF” of the Appendix A2 file (MD_MWCOG 2014 Daily RR & MP PT_NPT_M-A-R_QPT to MWCOG 4.xlsx). The spreadsheet entitled, " MD_MWCOG 2014 Daily RR & MP PT_NPT_M-A-R_QPT to MWCOG 4.xlsx" contains the EGU point sector projection year emissions estimates.

District of Columbia

Attainment Year 2014 Inventories

Point EGU Sector
There are no EGUs in the District of Columbia.

Point Non-EGU Sector
Non-electrical generation units (Non-EGU) consist of any type of stationary point source that does not generate electricity. The District has 37 major Non-EGU sources that require Title V Permits. According to the Air Emissions Reporting Requirements Rule (AERR), emissions from all Title V sources must be reported to EPA annually. The facilities are listed below with the Site ID, name of the facility, and the North American Industry Classification System (NAICS) and Standard Industrial Classification (SIC) codes.

Annual emission estimates are calculated from annual inspection of the Title V facilities through the Compliance and Enforcement branch of the Air Quality Division at Department of Energy and Environment.

Emission comparisons between the facility's estimates and the inspector's estimates are made to resolve any differences in the calculations. Depending on the outcome, DOEE will send an invoice to the facility. The emissions are then updated internally.

The annual certifications provide each facility's total pollutant emissions estimates of NOx, CO, PM, PM_{10}, SO_2, VOC, lead, NH_3, and other hazardous air pollutants. The certifications also list the fuel use, fuel type, and pollutant emissions produced from each boiler, generator, and miscellaneous unit at the facility. The fuel use is also broken up by monthly usage. By using the monthly fuel use and recorded emissions, ozone season day values were then calculated for each pollutant from each facility using monthly data from May-September.

Site ID	Facility	NAICS	SIC
0057	American University	611310	8221
0049	Anacostia Annex	928110	9711
0011	Armed Forces Retirement Home	623311	8361
0134	Bureau of Engraving and Printing	323111	2759
0061	Bolling Air Force Base	928110	9711
0053	Catholic University	622110	8221
0006	Capitol Power Plant	221330	4961
11004	Children's National Medical Center	622110	8062
0008	DC General Hospital	622110	8062
0037	Fort Lesley J. Mcnair/Joint Base Myer-Henderson Hall	928110	9711
5007	Fort Myer Construction Plant #1	324121	2951
00029	Fort Myer Construction Plant #2	324121	2951
0021	Gallaudet University	611310	8221
0010	George Washington University	611310	8221
0059	Georgetown University	622110	8221
0122	Government Publishing Office	323117	2732
0025	General Services Administration CHRP	221330	4961
0022	Howard University and Howard Hospital	611310	8224
0048	L'Enfant Plaza	813920	6722
0102	Marriott Wardman Park Hotel	721110	7011
11002	National Museum of American Indian	712110	8412
0136	National Zoological Park	712130	8422
0013	Navy Yard	928110	9711
0033	Naval Research Laboratory	928110	9711
0103	Omni Shoreham Hotel	721110	7011
0001	Pepco Benning Road Generating Station	221112	4911
0052	Providence Hospital	622110	8062
0009	St. Elizabeth's Hospital East Campus	622210	8063
11003	St. Elizabeth's Hospital West Campus	921190	9199
0054	Sibley Memorial Hospital	622110	8062
12003	VEPCO Dominion Virginia Power Joint Base Myer-Henderson Hall/Fort Lesley J. McNair	221112	4911
8001	Walter E. Washington Convention Center	531120	6512
0150	Washington Hilton and Towers	721110	7011
0014	Washington Hospital Center	622110	8062

0146	Watergate Central Plant	721110	4961
9001	WMATA Bladensburg Facility	485111	4111
0032	Walter Reed Army Medical Center	921190	9199

The spreadsheet entitled, " DC_2014 NEGU_Quasi-Point Emissions_Updated 17May2017.xlsx" contains the 2014 non-EGU point sector emissions estimates.

Projection Years 2025 & 2030 Inventories

Point Non-EGU Sector
Emissions from the District of Columbia point non-EGU facilities were not assumed to grow in the future.

Point EGU Sector
There are no EGUs in the District of Columbia.

Appendix B1

Technical support document for the development of quasi-point, area, and commercial marine diesel vessels, aircraft, and railroad source (non-nonroad model, MOVES2014a sources) emissions inventories for 2014, 2025, and 2030

Attainment Year 2014 Inventories

Methodologies for developing the attainment year 2014 emissions inventories for the quasi-point (Maryland only), area, and commercial diesel marine vessels, aircraft, and railroad sources for the District of Columbia, Maryland, and Virginia are described in detail in Appendices B1a, B1b, and B1c respectively. Methodologies to develop nonroad and on-road emissions described in Appendix B1b apply only to the areas in Maryland, which are not part of the 2008 ozone NAAQS Washington DC-MD-VA nonattainment area. Appendix C1 and Appendix D1 of this plan describe methodologies for developing nonroad and on-road emissions for Maryland counties, which are part of the above nonattainment area.

Refueling emissions are generated by the MOVES2014a on-road model as part of the on-road mobile emission modeling process. The Metropolitan Washington Council of Governments (MWCOG) staff used the above model to generate refueling emissions for 2014. However, refueling emissions are considered part of the area source inventory and included as such in that source category here. The methodology to develop refueling emissions along with other on-road mobile emissions is described in Appendix D1.

Projection Years 2025 & 2030 Inventories

The 2025 and 2030 projected inventories were derived by applying the appropriate growth factors to the 2014 attainment year emissions inventories. The USEPA guidance describes four typical indicators of growth. In order of priority, these are product output, value added, earnings, and employment. Surrogate indicators of activity, for example population growth, are also acceptable methods.

Emissions from the quasi-point sources at the Andrews Air Force Base in Maryland were projected to be the same as the 2014 attainment year.

Round 9.0 Cooperative Forecasts (population, household and employment projections), Ground Support Equipment (GSE) growth rates, and Vehicle Miles Traveled (VMT) and lane mile projections for 2025 and 2030 were used to project area and commercial diesel marine vessels, aircraft, and railroad sources emissions. Round 9.0 Cooperative Forecasts were prepared by the MWCOG staff and officially adopted by its Board of Directors on September 9, 2016. VMT and lane mile projections were developed by the National Capital Region Transportation Planning Board (TPB) staff as part of the on-road mobile emission analysis for the 2008 ozone redesignation request and maintenance plan and the 2016 Constrained Long-Range Plan and 2017-2022 Transportation Improvement Program (TIP) respectively. GSE growth rates for 2025 and 2030 were developed by the MWCOG staff using the MOVES2014a nonroad model for use in projecting the 2014 GSE emissions provided by Virginia. The methodology to develop GSE along with other nonroad emissions (except for commercial diesel marine vessels, aircraft, and railroad emissions) are described in Appendix C1.

The 2025 and 2030 emissions were calculated by multiplying the 2014 attainment year emissions by the above growth factors for 2025 and 2030 for each jurisdiction. Each area and commercial diesel marine vessel, aircraft, and railroad source category (Source Classification Code or SCC) was matched to an appropriate growth surrogate based on the activity used to generate the attainment year 2014 emissions estimates. The surrogates are listed in the file named "Area_MAR SCC List.xls" and provided as part of Appendix B2.

Refueling emissions for 2025 and 2030 were generated by the MWCOG staff using the MOVES2014a on-road model as described above.

The projected emissions inventories are contained in Appendix B2 along with the growth factors for population, household, employment, VMT, and lane miles.

Emissions inventories for the attainment and projection years are contained in Appendix B2. Following are the names of the emissions files provided as part of Appendix B2. These emissions files also contain growth factors for population, household, employment, VMT, and lane miles in different tabs with self-explanatory names.

Distract of Columbia – DC_Area.MAR_OSD_Emiss 12Sep2017 for COG.xlsx
Maryland - MD_PT_NPT_M-A-R_QPT_OSD_Emiss.xlsx
Virginia - VA_NP_MAR_OSD_Emiss.xlsx

Appendix C1

Technical support document for the development of MOVES2014a nonroad mobile (except marine, airport, and railroad) emissions inventories for 2014, 2025, and 2030

Attainment Year 2014 and Projection Years 2025 & 2030 Inventories

Emissions inventories for the nonroad sources for 2014, 2025 and 2030 were created using EPA's MOVES2014a model (ver. 20151201) except for locomotives, marine diesel vessels, and aircrafts.

Model runs were made for the metropolitan Washington region for July/Weekday for all three milestone years, which represented an average ozone season weekday.

Methodology to prepare inputs for the ozone season weekday runs is provided below.

Meteorology

Meteorology data was acquired from the National Climatic Data Center (NCDC). Hourly average temperature and dew point temperature data were collected from the Dulles airport (IAD) weather station for July 2014. Hourly relative humidity data was calculated using these two parameters. This data was also used for the 2025 and 2030 runs.

Fuel Parameters

Fuel parameters were supplied by the District of Columbia, Virginia, and Maryland. The District of Columbia decided to use the model default values for fuel parameters. Maryland and Virginia supplied local data for the three milestone years.

The same meteorology and fuel parameters were also used to develop on-road mobile emissions for 2014, 2025, and 2030 using the MOVES2014a on-road model. The MOVES2014a nonroad input, output, and runspec files are being provided in Appendix C2.

Appendix D1

Technical support document for the development of MOVES2014a on-road mobile emissions inventories for 2014, 2025, and 2030

DEVELOPMENT OF OZONE ON-ROAD MOBILE EMISSIONS INVENTORIES

Prepared for the 2008 Ozone National Ambient Air Quality Standards Redesignation Request and Maintenance Plan for the Washington, D.C. metropolitan region.

June 2017

DEVELOPMENT OF OZONE ON-ROAD MOBILE EMISSIONS INVENTORIES
June 2017

ABOUT THE TPB
The National Capital Region Transportation Planning Board (TPB) is the federally designated metropolitan planning organization (MPO) for metropolitan Washington. It is responsible for developing and carrying out a continuing, cooperative, and comprehensive transportation planning process in the metropolitan area. Members of the TPB include representatives of the transportation agencies of the states of Maryland and Virginia and the District of Columbia, 24 local governments, the Washington Metropolitan Area Transit Authority, the Maryland and Virginia General Assemblies, and nonvoting members from the Metropolitan Washington Airports Authority and federal agencies. The TPB is staffed by the Department of Transportation Planning at the Metropolitan Washington Council of Governments (COG).

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1. INTRODUCTION

This report documents the development of on-road emissions inventories used in the 2008 Ozone National Ambient Air Quality Standards (NAAQS) Redesignation Request and Maintenance Plan for the Washington, D.C. metropolitan region. The inventories were developed by Transportation Planning Board (TPB) staff at the request of the Metropolitan Washington Air Quality Committee (MWAQC). The on-road inventories will later be combined with emissions estimates developed for other sources to formulate a complete accounting of ground-level ozone in the region. This report summarizes the planning assumptions and technical methods supporting the on-road inventory development and presents results at the jurisdiction level. The inventory addresses three pollutants: Carbon Monoxide (CO), Nitrogen Oxides (NOx), and Volatile Organic Compounds (VOC). Pollutant estimates were prepared for three analysis years: 2014, 2025, and 2030. A summary of results is included at the end of the report.

2. BACKGROUND

In 2012 EPA designated the Metropolitan Washington, DC-MD-VA region as a "moderate" nonattainment area for the 2008 Ozone NAAQS. In 2015, the region attained the 2008 standard, based on the readings from ambient air quality monitors. In 2016 the region began development of a Redesignation Request and Maintenance Plan, which includes Motor Vehicle Emissions Budgets (MVEBs or mobile budgets) for NOx and VOC.

3. OVERVIEW OF METHODS AND PLANNING ASSUMPTIONS

Mobile emission inventories are developed on a year-by–year basis using the regional travel demand model and the EPA MOVES model. Several sequential steps are undertaken for each year that is analyzed. First, the Transportation Planning Board's (TPB's) adopted travel demand model is used to formulate vehicle-miles-of-travel (VMT) at the network link level of analysis. The modeled VMT outputs are developed at the network link level by vehicle type and by four time periods. Next, a post processor is used to further refine link-level VMT link speeds into Vehicle-Hours-of-Travel (VHT) by facility type, hourly periods and speed "bins." Finally, several data preparation steps are undertaken before the MOVES mobile emissions model is executed on a jurisdictional basis in order to compute mobile emissions. An overview of the travel model, post processor and MOVES data preparation steps is presented below.

The TPB staff developed 2014 travel-related data specifically for the 2008 Ozone Maintenance Plan. The 2025 and 2030 travel demand-related inputs were identical to those used in the recent air quality conformity analysis of the 2016 CLRP,[1] which was approved by the Transportation Planning Board on November 16, 2016. The key planning assumptions and methods are listed in Table 1. The modeling methods include the TPB's currently adopted travel demand model, Version 2.3.66[2][3][4], and the EPA

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[1] Air Quality Conformity Analysis of the 2016 Constrained Long Range Plan Amendment and the FY2017-2022 Transportation Improvement Program for the Washington Metropolitan Region, MWCOG/TPB, November 16, 2016

[2] Calibration Report for the TPB Travel Forecasting Model, Version 2.3, on the 3722-Zone Area System. Final Report. Washington DC: National Capital Region Transportation Planning Board, January 20, 2012. http://www.mwcog.org/transportation/activities/models/files/FY2012/V2.3_Calibration_Report_v14.pdf

[3] "2010 Validation of the Version 2.3 Travel Demand Model", Technical Memorandum from Ronald Milone - June 30, 2013. http://www.mwcog.org/transportation/activities/models/files/2010_Validation_Memo_v3.pdf

[4] User's Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.66, Volume 1 of 2: Main Report and Appendix A (Flowcharts). Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region

MOVES2014a emissions model. The land activity projections used in the travel demand modeling are based on the Round 9.0 Cooperative Forecasts.

Table 1 Travel-Related Assumptions/Methods Used in the Inventories

Land Activity:	COG Round 9.0 Cooperative Forecasts
Travel Demand Model:	Version 2.3.66
Mobile Emissions Model:	MOVES2014a
Vehicle Registration Data:	2014 Vehicle Registration Inventories

The non-travel related inputs to the MOVES2014a model, relating to meteorology, inspection and maintenance programs, and fuel formulation and supply, were provided by state air agencies in coordination with COG's Department of Environmental Programs (DEP). DEP staff provided modeling assumptions and guidance in a December 12, 2016 e-mail (Attachment A). All of the non-travel-related inputs were identical to those used in the 2016 CLRP with the exception of meteorology[5] and Inspection/Maintenance (I/M) inputs. With regard to meteorology differences, the hourly temperature used in the 2008 ozone Maintenance Plan inventory development was lower and the relative humidity was generally higher than that assumed in the 2016 Air Quality Conformity analysis. The State of Maryland I/M inputs were updated for the 2008 Ozone Maintenance Plan to reflect the current requirements, while they remain the same for Virginia and District of Columbia. The non-travel related assumptions and methods underlying the ozone emissions inventories are listed in Table 2.

Table 2 Non-Travel Related Assumptions and Methods Used in the Inventories

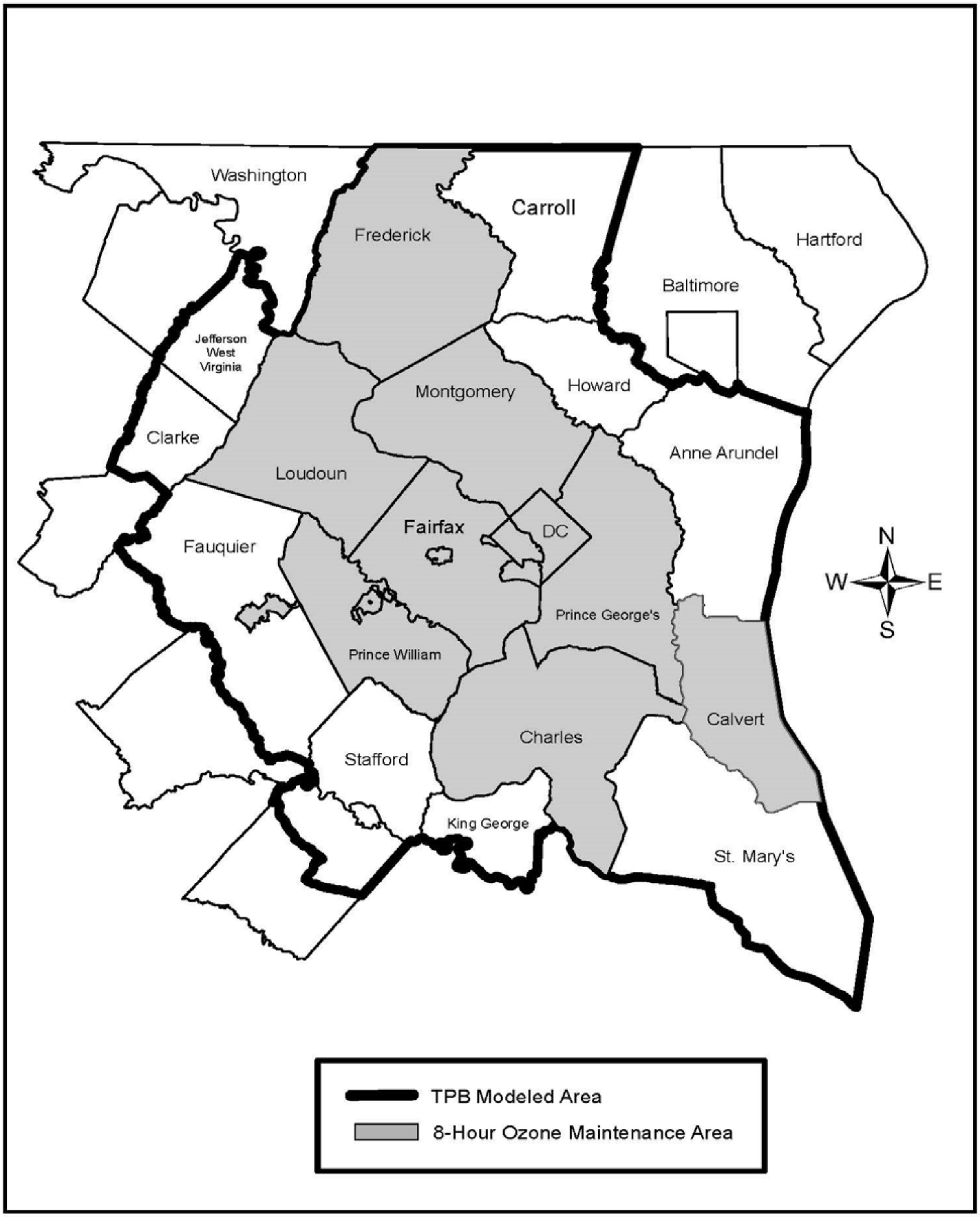
Inspection& Maintenance Programs:	Year-specific programs/MOVES2014a format
Fuel Programs:	Year-specific programs/MOVES2014a format
Meteorology:	July 2014 data from Dulles Airport

The Washington, D.C region Ozone Maintenance Area includes the following jurisdictions: Washington, D.C., Montgomery County, Prince George's County, Frederick County, Charles County, Calvert County, the City of Alexandria, Arlington County, Fairfax County, Loudoun County, and Prince William County. The cities and towns within each jurisdiction are also included. The Ozone Maintenance Area and the area associated with travel modeling is shown in Figure 1.

Transportation Planning Board, February 13, 2017.
https://www.mwcog.org/assets/1/6/mwcog_tpb_travel_model_v2.3.66_user_guide_v14_with_app_a.pdf

[5] Meteorology data in the 2016 CLRP is based on the 1997 Ozone NAAQS attainment SIP, which was developed based on the average temperature and relative humidity data from Dulles and National airports for the top 10 highest ozone level days during 2002-2004; 2008 Ozone Maintenance Plan temperature and humidity data were developed using the July 2014 meteorology data from Dulles airport.

Figure 1 Washington DC-MD-VA Ozone Maintenance Area Map



4. TRAVEL DEMAND MODEL AND INPUTS

The Version 2.3.66 travel model is a trip-based (or four-step) forecasting process that operates on a 3,722 Transportation Analysis Zone (TAZ) system. The model was initially calibrated using the 2007/08 Household Travel Survey and several on-board transit surveys.[6] The model was subsequently revised and re-validated using 2010 data, including traffic counts, Metrorail electronic counts, the American Community Survey, and the Geographically Focused Household Travel Survey[7]. The model also includes a long-standing policy feature that constrains peak period Metrorail trips to and through the regional "core." This feature ensures that forecasted ridership is reasonably consistent with expected capacity of the Metrorail system. The Version 2.3.66 model is documented in the most recent User's Guide[8].

The COG Round 9.0 Cooperative Forecasts are projections of households, population, and employment (by type), prepared at the TAZ level. Household and employment summaries by jurisdiction for the specific Ozone Maintenance Plan analysis years are provided in Tables 3 and 4, respectively.

Table 3 Household Data by Jurisdiction by Year

Jurisdiction	2014	2025	2030
District of Columbia	291,038	341,019	362,524
Montgomery Co., MD	371,608	405,562	422,342
Prince George's Co., MD	317,731	343,865	355,494
Arlington Co., VA	102,523	115,238	120,666
City of Alexandria, VA	70,573	80,779	84,118
Fairfax Co., VA	415,156	461,293	485,201
Loudoun Co., VA	117,776	150,760	158,568
Prince William Co., VA	157,001	184,406	194,239
Frederick Co., MD	88,528	107,934	115,066
Charles Co., MD	53,176	65,529	72,911
Calvert Co., MD	31,958	36,125	37,350
Total	2,017,068	2,292,510	2,408,479

Source: Round 9.0 Cooperative Forecasts

[6] TPB, Calibration Report for the TPB Travel Forecasting Model, Version 2.3, on the 3722-Zone Area System.

[7] Milone, "2010 Validation of the Version 2.3 Travel Demand Model"

[8] TPB, User's Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.66, Volume 1 of 2: Main Report and Appendix A (Flowcharts).

Table 4 Employment Data by Jurisdiction and Year

Jurisdiction	2014	2025	2030
District of Columbia	787,878	895,120	937,854
Montgomery Co., MD	514,849	572,521	604,491
Prince George's Co., MD	337,653	366,326	375,741
Arlington Co., VA	212,145	225,194	242,136
City of Alexandria, VA	105,568	121,772	127,266
Fairfax Co., VA	681,005	788,281	831,913
Loudoun Co., VA	159,886	211,000	235,476
Prince William Co., VA	170,075	217,510	238,297
Frederick Co., MD	105,437	115,618	121,283
Charles Co., MD	46,459	49,227	52,196
Calvert Co., MD	33,727	39,500	40,900
Total	3,154,682	3,602,069	3,807,553

Source: Round 9.0 Cooperative Forecasts; Includes Census Adjustment

The travel demand model produces a wide array of outputs including zonal origins and destinations by travel volumes and by travel network segments. Modeled VMT is the most critical output of the travel model for the purpose of estimating on-road emissions. The jurisdiction level VMT results estimated by the Version 2.3.66 travel demand model, the 2016 CLRP network and the Round 9.0 Cooperative Forecasts are shown in Table 5. The VMT estimates shown reflect on-network travel only and do not include local road VMT.

Table 5 Average Weekday Vehicle Miles Traveled by Jurisdiction and Year

Jurisdiction	2014	2025	2030
District of Columbia	8,179,181	8,631,346	8,839,109
Montgomery Co., MD	21,650,210	23,530,206	24,728,697
Prince George's Co., MD	23,235,228	25,212,143	26,074,471
Arlington Co., VA	3,880,103	4,159,667	4,250,797
City of Alexandria, VA	2,459,323	2,703,856	2,773,470
Fairfax Co., VA	26,219,999	29,349,765	30,273,391
Loudoun Co., VA	7,434,601	9,231,321	9,662,351
Prince William Co., VA	9,380,430	11,328,126	12,336,037
Frederick Co., MD	8,746,566	9,952,232	10,859,402
Charles Co., MD	3,010,776	3,450,040	3,804,944
Calvert Co., MD	1,741,395	1,980,630	2,109,955
Total	115,937,812	129,529,332	135,712,624

5. MOVES MODEL INPUTS

This section reviews the data inputs that were prepared for the MOVES model. The MOVES model is currently executed on a year-specific basis, for each jurisdiction in the Ozone Maintenance Area. As such, jurisdiction-level databases (or Excel files) are prepared in a format that is consistent with prescribed specifications in the software documentation. Some inputs are prepared as parameters that are indicated in MOVES-related scripting. TPB currently executes the MOVES2014a model in the "inventory" mode.

When EPA released initial versions of the MOVES emissions model, a regional task force was formed to provide guidance on MOVES-related inputs that would be acceptable to regional stakeholders. Staff from both transportation and environmental agencies served on the task force. During 18 monthly meetings, between August 2009 and January 2010, the task force agreed to an approach for developing emissions inventories using MOVES. A summary table of the approach is included as Attachment B.

5.1 Post Processor

A post processor is used to reformat network link-level outputs from the travel model into MOVES compatible format. The post processor is used to create vehicle hours of travel (VHT) and vehicle miles traveled (VMT) distributions by jurisdiction. The jurisdictional distributions are further distinguished by three vehicle types (passenger vehicles, commercial vehicles, and trucks), two facility types (freeways and arterials), and 14 speed groups or "bins."

The post processor aggregates six travel markets from the travel demand model outputs into three vehicle types as follows:

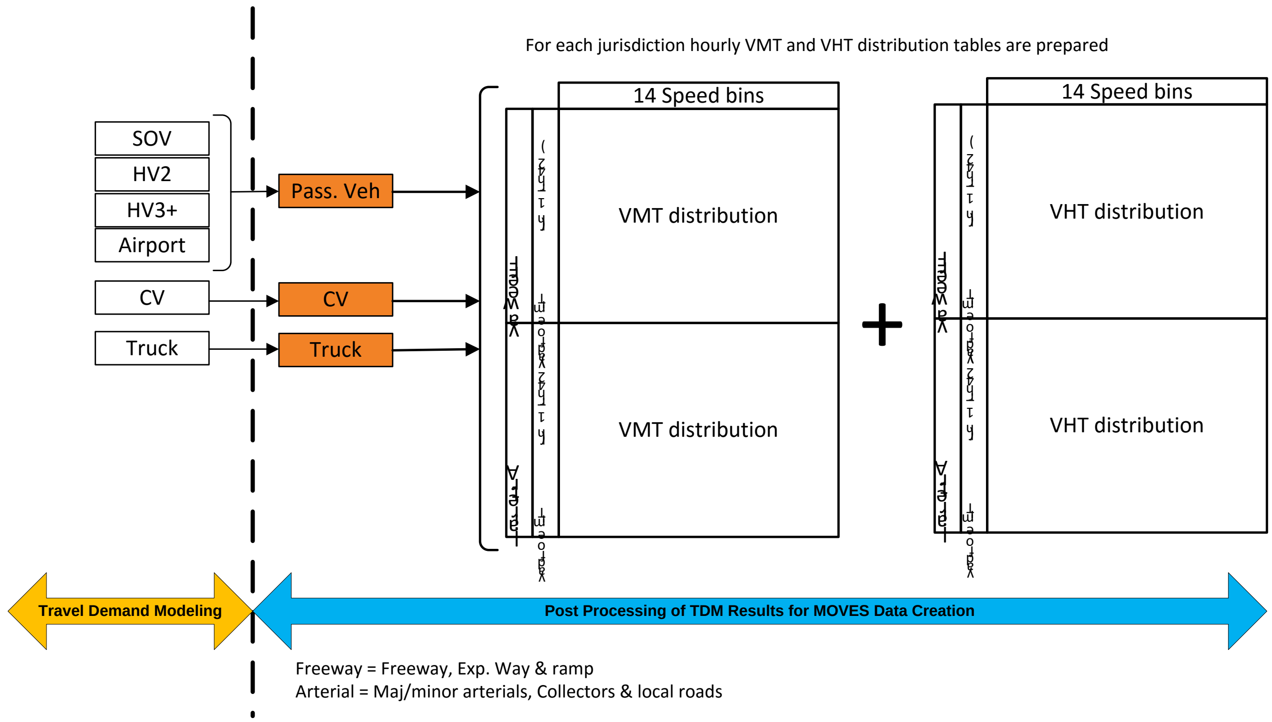
- Passenger Vehicles = SOV + HOV2 + HOV3 (or more) + Airport Passenger Trips;
- Commercial Vehicles = Commercial Vehicles;
- Heavy Duty Vehicles = Trucks;

Six facility types are grouped into two as follows:

- Freeway = freeway + expressway + freeway ramp; and
- Arterials = major arterial + minor arterial + collector.

The post processor is executed four times for each analysis year: one for each of the three vehicle types and another for all vehicle types combined. The post processor yields hourly jurisdictional VMT and VHT distributions by Mobile's 14 speed bins and two facility types. Figure 2 illustrates the post-processing of travel demand outputs. The post processor also includes provisions to add local VMT to the on-network VMT developed by the travel model, so that the full universe of travel is accounted for.

Figure 2 Post-Processing of Travel Demand Results



5.2 VMT/VHT Fractions

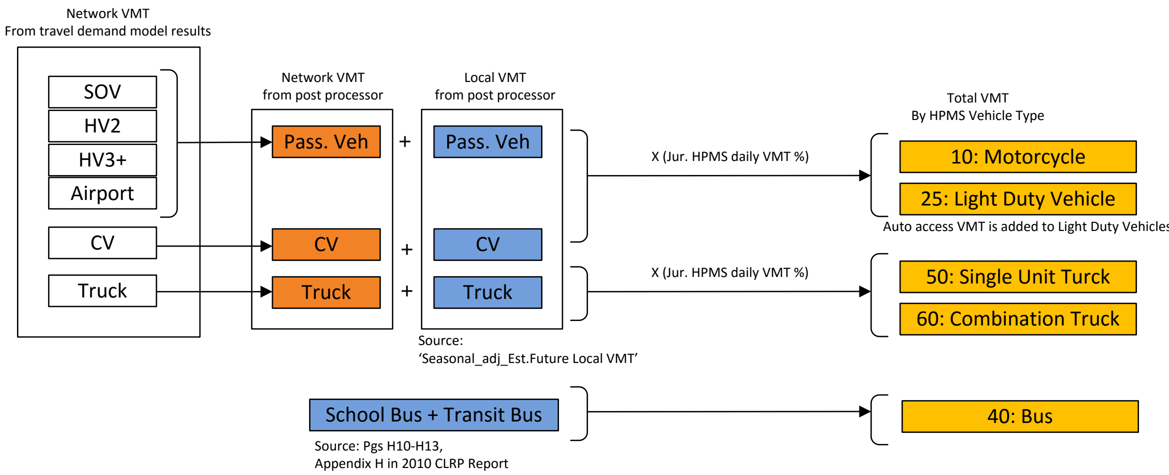
The MOVES2014a model requires annual VMT by five Highway Performance Monitoring System (HPMS) vehicle types:

- Motorcycle (sourceTypeID = 10);
- Light duty vehicle (sourceTypeID = 25);
- Buses (sourceTypeID = 40);
- Single unit trucks (sourceTypeID = 50); and
- Combination trucks (sourceTypeID =60).

Average annual weekday VMT estimates include on-network data from the travel demand model outputs as well as local road VMT estimates, which is added in exogenously. Auto access VMT for transit riders, acquired from a Metrorail Survey, is added to the VMT of Light Duty Vehicles (sourceTypeID = 25). Modeled VMT is divided into three vehicle types: passenger vehicles, commercial vehicles, and heavy duty vehicles. Local road VMT is developed by using a combination of observed and simulated data in the post-processing shown in Figure 4.

The local road VMT shares are added to VMT from the travel model to produce total VMT. The resulting total VMT of the three vehicle types is then classified by five MOVES vehicle types using observed jurisdictional Highway Performance Monitoring System (HPMS) VMT percentages. Figure 4 illustrates the process of developing annual VMT for five HPMS vehicle types.

Figure 3 Annual VMT Calculation Process



The average annual weekday VMT total by five HPMS vehicle types is entered into an EPA converter, AAD VMT Calculator HPMS.XLS, to convert average weekday VMT into average annual weekday travel. The converter includes local monthly adjustment factors and weekend-day adjustment factors. The converter generates three VMT fractions, 'monthVMTfraction,' 'dayVMTfraction' and 'hourlyVMTfraction' as outputs.

5.3 Average Speed

MOVES requires speed distributions by vehicle type and time period. Vehicle Hours of Travel (VHT) distributions are selected as a suitable proxy for average speed distribution. MWCOG/TPB's regional travel demand model outputs are first processed to derive VHT distributions for six vehicle categories:

- Single Occupancy Vehicles (SOV);
- High Occupancy Vehicles 2 (HOV2);
- High Occupancy Vehicles 3+ (HOV3 or more);
- Commercial Vehicles;
- Trucks; and
- Airport Passenger Trips.

Through post-processing, six VHT distributions are developed for three vehicle types, Mobile's 14 speed bins, hour of the day, and two facility types (i.e., freeways and arterials); and later reclassified into MOVES's 16 speed bins, hour of the day, day of the week (i.e., weekdays and weekend days), and four facility types. Six vehicle types from the travel demand model are reclassified into three vehicle types as follows:

- Passenger Vehicles = SOV + HOV2 + HOV3 (or more) + Airport Passenger Trips;
- Commercial Vehicles = Commercial Vehicles; and
- Heavy Duty Vehicles = Trucks.

MOVES requires: (1) 16 speed bins from 2.5 mph to 75 mph in increments of 5 mph; and (2) four road types, which are a combination of two facility types (i.e., restricted and unrestricted) and two environmental settings (i.e., urban and rural settings). The restricted facilities include freeways, expressways and freeway ramps, while the unrestricted facilities include major/minor arterials, collectors, and local roads. The following assumptions are used to develop average speed distributions fulfilling the MOVES requirements stated above:

1. VHT Distribution to Restricted Facilities:

   a. All vehicle types:
      - Weekday VHT Distribution:
        - All Day: Hourly distribution for all vehicles
      - Weekend VHT Distribution:
        - 11:00 am – 7:00 pm: Distribution across the 13 MOVES vehicle type categories reflecting the 3:00 pm hour on a weekday
        - 7:01 pm – 10:59 am: Distribution across the 13 MOVES vehicle type categories reflecting the 12:00 am hour on a weekday

2. VHT Distribution to Unrestricted Facilities:

   a. All vehicle types exclusive of refuse trucks, school buses and transit buses:
      - Weekday VHT Distribution:
        - All Day: Hourly distribution for all vehicles
      - Weekend VHT Distribution:
        - 11:00 am – 7:00 pm: Distribution reflecting the 3:00 pm hour on a weekday
        - 7:01 pm – 10:59 am: Distribution reflecting the 12:00 am hour on a weekday

b. Refuse trucks: Refuse trucks operate on a 3-phase cycle: Phase 1 is the period of driving from the dispatch garage to trash collection sites; Phase 2 is the period of the actual trash/recycle collection; Phase 3 is the period of driving back to transfer stations. Using local data from Fairfax County, VA, the average speed of Phases 1 and 3 is assumed to be in the range of 22.5-27.5 miles per hour (i.e., MOVES Speed Bin 6), and the average speed of Phase 2 is assumed to be in the range of 2.5-7.5 miles per hour (i.e., MOVES Speed Bin 2). Based on the above assumptions the refuse truck vehicle type VHT distributions are as follows:

- Weekday VHT Distribution (see Table 6):
  - 5:00 am–5:00 pm (Trash Collection): VHT hourly distributions according to Phases 1, 2 and 3.
  - 5:01 pm–5:00 am (On Road Phase): VHT hourly distribution consists of Phase 2.
- Weekend VHT Distribution:
  - All Day: VHT distribution made up of Phase 1 and Phase 3 (on road phases)

c. School buses:

- Weekday VHT Distribution:

  -6:00 am – 6:00 pm: VHT distribution (see Table 7)

  -6:00 pm – 6:00 am: VHT distribution of heavy duty vehicles

- Weekend VHT Distribution:
  - 11:00 am–7:00 pm: VHT Distribution of heavy duty vehicles at 3:00 pm on a weekday
  - 7:00 pm – 11:00 am: VHT Distribution of heavy duty vehicles at 12:00 am on a weekday

d. Transit buses:

- Weekday VHT Distributions (see Table 8):

  -6:00 – 9:00 am: Per WMATA's bus speed distribution of the AM peak period

  -9:00 am–3:00 pm: Per WMATA's bus speed distribution of the off-peak period

  -3:00 - 6:00 pm: Per WMATA's bus speed distribution of the PM peak period

  -6:00pm-6:00 am: Per WMATA's bus speed distribution of the off-peak period

- Weekend VHT Distribution (see Table 8):

  -All Day: Per WMATA's bus speed distribution of the off-peak period.

Table 6 Average Weekday VHT Distribution for Refuse Trucks

Source: Fairfax County, VA

Speed Bins	Speed Range	5:00 AM - 5:00 PM	5:01 PM - 4:59 AM
1	speed < 2.5mph	0.00%	0.00%
2	2.5mph <= speed < 7.5mph	62.65%	0.00%
3	7.5mph <= speed < 12.5mph	0.00%	0.00%
4	12.5mph <= speed < 17.5mph	0.00%	0.00%
5	17.5mph <= speed <22.5mph	0.00%	0.00%
6	22.5mph <= speed < 27.5mph	37.35%	100.00%
7	27.5mph <= speed < 32.5mph	0.00%	0.00%
8	32.5mph <= speed < 37.5mph	0.00%	0.00%
9	37.5mph <= speed < 42.5mph	0.00%	0.00%
10	42.5mph <= speed < 47.5mph	0.00%	0.00%
11	47.5mph <= speed < 52.5mph	0.00%	0.00%
12	52.5mph <= speed < 57.5mph	0.00%	0.00%
13	57.5mph <= speed < 62.5mph	0.00%	0.00%
14	62.5mph <= speed < 67.5mph	0.00%	0.00%
15	67.5mph <= speed < 72.5mph	0.00%	0.00%
16	72.5mph <= speed	0.00%	0.00%

Table 7 VHT Distribution of School Buses (6:00 am – 6:00 pm)

Source: Fairfax County, VA

Speed Bins	Speed Range	Bus Trip 1	Bus Trip 2	Bus Trip 3	Bus Trip 4	Bus Trip 5	Bus Trip 6	Bus Trip 7	Bus Trip 8	Bus Trip 9	Bus Trip 10	Bus Trip 11	Weighted Average
1	speed < 2.5mph	35.20%	24.30%	17.58%	14.65%	7.90%	16.11%	6.65%	18.30%	25.76%	16.18%	17.67%	**19.21%**
2	2.5mph <= speed < 7.5mph	10.87%	11.57%	6.45%	11.04%	29.89%	20.20%	44.83%	11.01%	9.68%	6.49%	9.12%	**14.39%**
3	7.5mph <= speed < 12.5mph	10.90%	9.35%	12.89%	6.50%	26.31%	17.69%	3.34%	9.12%	9.52%	6.69%	8.69%	**10.92%**
4	12.5mph <= speed < 17.5mph	8.81%	9.18%	8.59%	9.45%	6.00%	11.13%	23.76%	10.12%	9.98%	8.46%	10.32%	**10.37%**
5	17.5mph <= speed <22.5mph	5.01%	10.15%	5.18%	14.04%	3.04%	5.94%	4.09%	10.36%	7.57%	9.74%	12.02%	**8.30%**
6	22.5mph <= speed < 27.5mph	8.91%	8.55%	11.62%	12.59%	6.18%	5.30%	3.54%	7.29%	7.11%	8.87%	11.73%	**8.13%**
7	27.5mph <= speed < 32.5mph	8.79%	7.97%	14.36%	11.28%	5.86%	13.33%	6.35%	9.43%	5.37%	10.06%	10.20%	**9.41%**
8	32.5mph <= speed < 37.5mph	5.33%	9.10%	5.86%	13.43%	7.62%	3.32%	6.36%	13.79%	8.68%	12.04%	6.81%	**7.81%**
9	37.5mph <= speed < 42.5mph	3.43%	6.89%	8.69%	7.02%	4.80%	3.76%	1.07%	7.94%	9.79%	13.81%	8.16%	**7.22%**
10	42.5mph <= speed < 47.5mph	1.72%	2.44%	8.79%	0.00%	2.40%	2.87%	0.00%	1.31%	5.83%	5.15%	4.75%	**3.42%**
11	47.5mph <= speed < 52.5mph	0.68%	0.00%	0.00%	0.00%	0.00%	0.36%	0.00%	0.67%	0.31%	2.27%	0.36%	**0.59%**
12	52.5mph <= speed < 57.5mph	0.34%	0.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.67%	0.41%	0.24%	0.18%	**0.23%**
13	57.5mph <= speed < 62.5mph	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
14	62.5mph <= speed < 67.5mph	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
15	67.5mph <= speed < 72.5mph	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
16	72.5mph <= speed	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**

Table 8 VHT Distribution of Transit Buses

Source: Washington Metropolitan Area Transit Authority (WMATA)

avgSpeedBinID	avgBinSpeed	avgSpeedBinDesc	6:00AM-9:00AM	3:00PM-6:00PM	9:01AM-2:59PM/6:01PM-5:59AM
1	2.5	speed < 2.5mph	9.94%	9.10%	7.92%
2	5	2.5mph <= speed < 7.5mph	13.79%	18.95%	14.49%
3	10	7.5mph <= speed < 12.5mph	34.07%	37.86%	31.36%
4	15	12.5mph <= speed < 17.5mph	28.52%	23.97%	29.17%
5	20	17.5mph <= speed <22.5mph	10.02%	5.92%	10.77%
6	25	22.5mph <= speed < 27.5mph	1.88%	1.84%	3.91%
7	30	27.5mph <= speed < 32.5mph	0.92%	0.85%	1.04%
8	35	32.5mph <= speed < 37.5mph	0.34%	0.60%	0.72%
9	40	37.5mph <= speed < 42.5mph	0.14%	0.50%	0.35%
10	45	42.5mph <= speed < 47.5mph	0.05%	0.15%	0.15%
11	50	47.5mph <= speed < 52.5mph	0.31%	0.28%	0.06%
12	55	52.5mph <= speed < 57.5mph	0.00%	0.00%	0.06%
13	60	57.5mph <= speed < 62.5mph	0.00%	0.00%	0.00%
14	65	62.5mph <= speed < 67.5mph	0.00%	0.00%	0.00%
15	70	67.5mph <= speed < 72.5mph	0.00%	0.00%	0.00%
16	75	72.5mph <= speed	0.00%	0.00%	0.00%

5.4 Road Type

MWCOG/TPB travel demand model has six facility types; and these facilities are grouped into two as follows for MOVES:

- Restricted facility = freeway + expressway + freeway ramp; and
- Unrestricted facility = major arterial + minor arterial + collector.

Restricted and Unrestricted facilities are further divided into urban or rural facilities. Thus five facility types were created as urban restricted, urban unrestricted, rural restricted, rural unrestricted, and off network.

5.5 Age Distribution

Every three years since 2005, the Departments of Motor Vehicles of the District of Columbia, Maryland, and Virginia have been supplying MWCOG/TPB with vehicle registration data for use in Air Quality Conformity (AQC) Determinations and State Implementation Plan (SIP) updates. The most recent 2014 Vehicle Identification Number (VIN) data are a snapshot of vehicle registrations by year, collected by Departments of Motor Vehicles in the three states. The VIN data contain a broad range of attributes of the vehicles registered in the jurisdictions of the Metropolitan Washington DC area. The latest data are used in the development of future year vehicle population profiles (i.e., vehicle age and vehicle type distribution) for all the analysis years in the Ozone Maintenance Plan.

Prior to using the VIN data as input to MOVES, the 'raw' vehicle registration data were decoded using a commercial decoding software program[9]. Following EPA's guidelines, the data were decoded in two steps: (1) the 'raw' data were decoded to a Mobile 6.2 format; and (2) the Mobile 6.2 format vehicle population distributions were converted to a MOVES format using an EPA converter[10]. Thus, 16 Mobile vehicle types and 25 vehicle age categories were mapped into MOVES' 13 vehicle and 31 vehicle age categories. The vehicle population of the 2014 VIN data was reviewed by the MWCOG/TPB technical oversight committees prior to becoming approved for transportation planning applications.

5.6 Fuel Formulation

The state air agencies of the District of Columbia, the state of Maryland, and the Commonwealth of Virginia provided fuel characteristics data for the analysis years in a MOVES2014a ready format. For year 2014, the gasoline sulfur content was 30 ppm or lower. For analysis years 2025 and 2030, the gasoline sulfur content used was 10 ppm, which is an assumption that is consistent with the 2014 Tier 3 rule of EPA.

5.7 Meteorology Data

The temperature and humidity data used for the 2008 Ozone Maintenance Plan were developed using July 2014 meteorology data from Dulles airport.

5.8 Ramp Fraction

Local data were used to estimate the local ramp fraction using a method approved by the MOVES Task Force. The locally-derived percentage is equal to 8 percent of VHT, which, coincidentally, is the same as the MOVES default value.

5.9 Road Type Distribution

Vehicle Miles Traveled (VMT) was distributed into MOVES 13 vehicle types and four road (facility) types. The method of developing VMT distribution was as follows:

1. Through post-processing of travel demand results, jurisdictional VMT distributions of six vehicle types were reclassified to VMT distributions by three vehicle types as follows:

   - Passenger Vehicles = SOV + HOV2 + HOV3 (or more) + Airport Passenger Trips;
   - Commercial Vehicles = Commercial Vehicles; and
   - Heavy Duty Vehicles = Trucks.

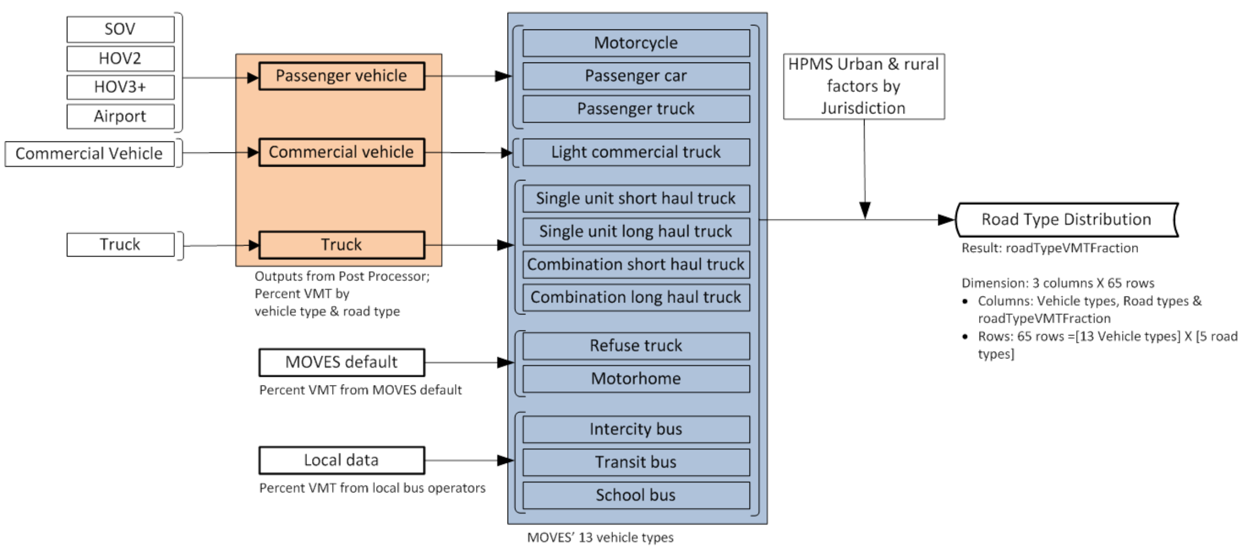
[9] VinPower, Copyright; ESP Data Solutions Inc., Product version 4.0.0.16

[10] RegistrationDistributionConverter_Veh16

2. VMT percentages by three vehicle types were allocated to MOVES vehicle types as follows:

- Passenger Vehicles: VMT percentages by facility type were applied to motorcycles, passenger cars and passenger trucks;
- Commercial Vehicles: VMT percentages by facility type were applied to commercial trucks;
- Heavy Duty Vehicles: VMT percentages by facility type were applied to single unit short and long haul trucks, and combination short and long haul trucks;
- Refuse Trucks and Motor Homes: MOVES default percentage values;
- School, Transit and Intercity Buses (Tables 7 and 8): Local network percentages from local data sources (i.e., local bus operators); and
- Urban and rural percentage split factors were used to further allocate facility type VMT between urban and rural facilities. These factors vary by jurisdiction, and were based on the latest HPMS VMT data provided by the three state transportation agencies. Figure 5 illustrates the process of allocating VMT by vehicle type, facility type, and urban/rural split.

Figure 4 Road Type Distribution Development Process



5.10 Source Type (Vehicle) Population

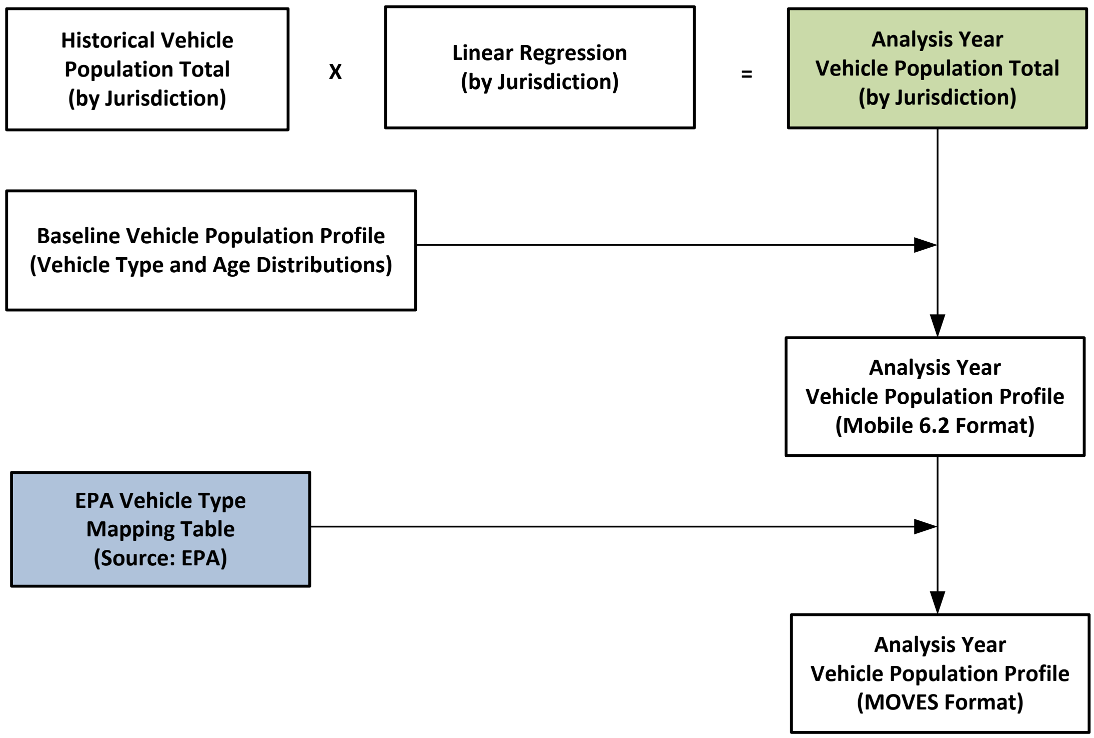
Source type population, or vehicle population, was acquired from the vehicle registration (VIN) data. The VIN decoding software output vehicle population totals by Mobile 6.2 vehicle types. The vehicle population from the VIN data was then used to estimate vehicle population for each analysis year. Methods of estimating vehicle population vary by analysis year and availability of VIN data. For the 2014 analysis year, the 2014 vehicle population data were used. For 2025 and 2030, regression analysis was used to project future vehicle population totals based on available VIN data (collected from 1975 to 2014), which draws the 'best fitting' line among scattered VIN data points.

Table 9 shows vehicle population forecasts for each of the analysis years. Vehicle profiles of the 2014 VIN data are used to develop future year vehicle profiles by jurisdiction. Vehicle profiles were prepared in a Mobile format in this data processing first, and were converted to a MOVES vehicle type using a vehicle mapping table provided by EPA. Figure 6 shows the process of calculating source type population.

Table 9 Vehicle Population by Analysis Year

		MOVES Input Vehicle Populations (in vehicles/year)		
State	**Jurisdiction**	**2014**	**2025**	**2030**
DC	**District of Columbia**	291,662	328,864	346,756
	DC Total	**291,662**	**328,864**	**346,756**
MD	**Calvert County**	81,770	107,839	116,781
	Charles County	128,705	159,547	171,202
	Frederick County	206,817	262,998	281,962
	Montgomery County	724,567	848,000	891,986
	Prince George's County	623,283	676,513	702,298
	MD Total	**1,765,142**	**2,054,897**	**2,164,229**
VA	**Alexandria city**	110,679	147,093	154,232
	Arlington County	142,002	160,608	166,170
	Fairfax County	906,630	1,098,015	1,167,554
	Loudoun County	282,436	341,626	375,857
	Prince William County	388,283	479,318	521,800
	VA Total	**1,830,031**	**2,226,662**	**2,385,613**
Region Total		**3,886,834**	**4,610,423**	**4,896,599**

Figure 5 Source Type Population Development Process of Future Analysis Year



5.11 Inspection/Maintenance (I/M) Programs & Hoteling

The air agencies of the District of Columbia, Maryland, and Virginia provided details of Inspection/Maintenance (I/M) programs for all analysis years in a MOVES2014 ready format. Hoteling data are not provided by local air agencies, so the MOVES default hoteling data were used.

5.12 Federal and State Specific Control Programs

In addition to the environmental inputs there are state-specific programs that were taken into account in the analyses:

- Early NLEV: The District of Columbia, Maryland, and Virginia adopted an Early NLEV program, which was reflected in all analysis years. Early NLEV input database file – MOVES2014_early_NLEV

- Stage II: Varies by jurisdiction as follows:

  - District of Columbia: 1999 onwards - Refueling vapor program adjustment- 0.9, Refueling spill program adjustment- 0.5 (MOVES2014a defaults)

  - Maryland: 1999 onwards - Refueling vapor program adjustment- 0.7, Refueling spill program adjustment- 0.7, MOVES2014a Stage II database file - md_stageii_yy (provided by MDE on 6.04.2014)

  - Virginia: Refueling vapor program adjustment- .77 for years 1999-2010, .56 for years 2011-2013, and 0 for all other years; Refueling spill program adjustment- .77 for years 1999-2010, .56 for years 2011-2013, and 0 for all other years, MOVES2014a Stage II database file - va_stage2_input_20161104 (provided by VDEQ on 11.04.2016)

- CAL-LEV /ZEV Programs: Maryland's CAL-LEV program, adopted in 2011, is reflected in all analysis years. The following auxiliary files, provided by the Maryland Department of the Environment (MDE), were used to model these programs in the Maryland jurisdictions: MOVES2014a Cal-Lev Database File (MOVES2014a_caleviii2011); and MOVES2014a ZEV Program Information is included in all MD MS-Excel input files as a tab (ZEV_AVFT_MD_moves2014a).

6.0 RESULTS

On-road mobile inventories for the entire Ozone Maintenance Area are shown on Tables 10 and 11. Table 10 provides the total inventories for the Ozone Maintenance Area, and Table 11 summarizes the inventories by jurisdiction. The inventories were produced using MOVES2014a, which reflects federal fuel and vehicle technology (Tier 3) programs.

Table 10 Ozone Maintenance Plan On-Road Emissions Inventories (short tons/day)

Pollutant	2014	2025	2030
Carbon Monoxide (CO)	744.1	457.1	323.7
Nitrogen Oxides (NOx)	136.8	40.7	27.4
Volatile Organic Compounds (VOC)	61.2	33.2	24.1

Table 11 Ozone Maintenance Plan On-Road Emissions Inventories by Jurisdiction

		VOC (in short tons/day)			NOX (in short tons/day)			CO (in short tons/day)		
State	Jurisdiction	2014	2025	2030	2014	2025	2030	2014	2025	2030
DC	District of Columbia	4.9	2.6	2.0	9.3	2.5	1.6	59.4	37.9	26.9
	DC Total	**4.9**	**2.6**	**2.0**	**9.3**	**2.5**	**1.6**	**59.4**	**37.9**	**26.9**
MD	Calvert County	1.4	1.0	0.6	2.3	0.9	0.5	14.6	8.2	5.3
	Charles County	2.3	1.3	0.9	4.7	1.4	0.9	21.9	12.3	9.0
	Frederick County	4.6	2.6	1.8	13.4	4.7	3.2	61.0	35.6	25.4
	Montgomery County	10.7	5.6	4.1	22.1	6.3	4.3	128.4	76.6	54.8
	Prince George's County	12.2	5.8	4.0	28.3	7.9	5.1	154.6	89.4	62.9
	MD Total	**31.2**	**16.3**	**11.4**	**70.9**	**21.2**	**14.0**	**380.6**	**222.2**	**157.4**
VA	Alexandria city	1.4	0.8	0.6	2.6	0.8	0.5	15.7	10.3	7.3
	Arlington County	1.9	1.0	0.7	3.2	0.9	0.6	23.9	14.8	10.3
	Fairfax County	12.2	6.9	5.1	27.8	8.0	5.5	151.3	98.3	69.7
	Loudoun County	4.0	2.3	1.7	10.1	3.2	2.2	47.4	30.9	21.5
	Prince William County	5.7	3.4	2.5	13.0	4.1	2.9	65.8	42.7	30.7
	VA Total	**25.2**	**14.3**	**10.7**	**56.7**	**17.0**	**11.7**	**304.0**	**196.9**	**139.5**
Region Total		**61.2**	**33.2**	**24.1**	**136.8**	**40.7**	**27.4**	**744.1**	**457.1**	**323.7**

A detailed listing of MOVES inputs, outputs, and configuration files is provided in Attachment C.

ATTACHMENT A

Non-travel Related MOVES Inputs:

Daniel Son

Subject: FW: MOVES2014a Inputs (2008 Ozone NAAQS RR/MP Analysis)

Importance: High

From: Sunil Kumar
Sent: Monday, December 12, 2016 12:05 PM
To: Jinchul Park <jpark@mwcog.org>
Cc: Ronald Milone <rmilone@mwcog.org>; Dusan Vuksan <dvuksan@mwcog.org>; Jane Posey <jposey@mwcog.org>; Stephen Walz <swalz@mwcog.org>; Jennifer Desimone <jdesimone@mwcog.org>
Subject: MOVES2014a Inputs (2008 Ozone NAAQS RR/MP Analysis)
Importance: High

Please find the MS-Excel files containing MOVES2014a inputs for fuel supply, fuel usage fraction, fuel formulation, meteorology, and I/M programs for the milestone years 2014, 2025, and 2030 for the 2008 ozone NAAQS RR/MP analysis. These input files have been placed in the folder – H:\2008 Ozone SIP\2014_25_30

Please use the three control programs listed below for all milestone years mentioned above. Databases provided by states for modeling Early NLEV, Stage II, and Cal-Lev/ZEV programs are mentioned below.

Early NELV Program
Use early NLEV database titled "MOVES2014_early_NLEV" for DC, MD, and VA in all MOVES2014a runs for all milestone years.

Stage II
DC: MOVES2014a defaults
MD: MOVES2014a database (md_stageii_yy)
VA: MOVES2014a database (va_stage2_input_20161104)
Note: MDE provided Stage II inputs (valid for 1999 and beyond) on 06.04.2014.
VDEQ provided updated Stage II inputs (valid for 2014, 2025, and 2030) on 11.04.2016.

Cal-Lev Program (MD Only)
MOVES2014a Cal-Lev database (MOVES2014_caleviii2011)
MOVES2014a ZEV Program info- included in all MD excel input files as a tab (ZEV_AVFT_MD_moves2014a)
Note: Maryland's Cal-Lev program is valid for the year 2011 and beyond.

Meteorology
Meteorology inputs were developed for the ozone season analysis by using Dulles airport data for July 2014 in the MOVES2010a format by the COG/DEP staff.

Please use the "July/Weekday" combination to represent the average ozone season day for the MOVES2014a runs.

Thanks,

Sunil

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ATTACHMENT B

MOVES TASK FORCE

Summary of Local Data Development for the County Data Manager (Emissions Inventory Approach)*

as of January 11, 2011

	LOCAL INPUT DATA CATEGORIES	DATA DESCRIPTION	DATA FORMAT MOVES	DATA DEVELOPMENT METHODOLOGY	LOCAL INPUT DATA APPROVAL DATE
1	**Age Distribution**	Registered vehicles stratified by age and vehicle type	31 Age Groups (covering 0-30+ years of vehicle age) 13 Vehicle Types	DTP used an EPA Converter to convert local registration data from MOBILE6.2 format to MOVES format	4/20/2010
2	**Average Speed Distribution**	Average vehicle speeds stratified by vehicle type, road type, time of day/type of day (i.e., weekday vs weekend)	Distributions of hourly average vehicle speeds by vehicle type, road type, and type of day (weekday/weekend)	DTP used MOBILE6.2 post-processor speed distribution augmented by local input data for school and transit buses and refuse trucks	Local VHT 7/20/2010 School Buses 9/21/2010 Refuse Trucks 9/21/2010 Transit Buses 10/19/2010
3	**Fuel Supply**	Market share of available fuels by county, month, year, state	MD/VA - EPA Methodology/local data in MOVES format DC - EPA Default Values	None Required (Direct Data Input from DC, MD, and VA air agencies)	Not Required
4	**Fuel Formulation**	Fuel formulation data stratified by state			
5	**I/M Programs**	Available Inspection/Maintenance Programs stratified by state			
6	**Meteorology Data**	Hourly temperature and relative humidity readings	Hourly Records of temperature and relative humidity in MOVES format Start Time: 12:00 am End Time: 11:00 pm	For Conformity Determinations - DEP converted meteorology data from existing SIPs to MOVES format using an EPA converter For Upcoming SIP Development - DEP compiled meteorology datasets from two weather stations based on a 3-yr period (2007-09) pending EPA approval	06/22/2010 (SIP for 2008 or Later Ozone Standard) 07/20/2010 (Conformity for Ozone & PM2.5 – 1997 Standards, CO – 1971 Standard)
7	**Ramp Fraction**	Percentage of driving time on ramps stratified by road type	8% of VHT (EPA National Default)	DTP tested local input data and found consistent with the EPA National Default value	7/20/2010
8	**Road Type Distribution**	Percentages of VMT allocated to each road type by vehicle type	VMT percentages by road type and vehicle type	DTP combined VMT from the travel demand model; and VMT distributions from the travel demand model, NEI data, and MOVES default data	4/20/2010
9	**Source Type Population**	Population of registered vehicles by county and vehicle type	13 Vehicle Types	DTP used vehicle registration and source type fractions	
10	**Vehicle Type VMT**	Annual VMT by HPMS vehicle type	Annual VMT allocated by HPMS vehicle type	DTP used daily VMT and an EPA converter	4/20/2010

*** The Task Force adopted the Emissions Inventory Approach (October 19, 2010)**

**** Documents can be found on the MOVES Task Forc** http://www.mwcog.org/committee/committee/documents.asp?COMMITTEE_ID=253

MOVES TASK FORCE

Summary of MOVES Data Development Documentation

as of January 11, 2011

	LOCAL INPUT DATA CATEGORIES	DATA DESCRIPTION	DATA DOCUMENTATION: METHODOLOGY	DATA DOCUMENTATION: SENSITIVITY TESTING
1	**Age Distribution**	Registered vehicles stratified by age and vehicle type	Memorandum titled "Development of Local Transportation Data Inputs for MOVES2010 Model" D. Sivasailam Memorandum Drafted: 4/13/2010 Memorandum Presented: 4/20/2010 (Item 3) Memorandum Revised: 5/14/2010 (Item 3b)	Memorandum titled "Results of MOVES 2010 Model Sensitivity...", E. Lucas, Drafted/presented 4/20/2010 (Item 4) Memorandum titled "Results of MOVES2010 Model Sensitivity...," E. Lucas, Drafted/presented 5/18/2010 (Item 4a)
2	**Average Speed Distribution**	Average vehicle speeds stratified by vehicle type, road type, time of day/type of day (i.e., weekday vs weekend)	Memorandum titled "Local Vehicle Hours of Travel (VHT) Distributions," D. Sivasailam Drafted/presented 7/20/10 (Item 3b) Tables titled "School Bus Average Speed Distribution," Drafted/presented 9/21/2010 (Item 3a) Memorandum titled "Vehicle Hours of Travel (VHT) for Refuse Trucks," D. Sivasailam and E. Morrow, Drafted/presented on 9/21/2010 (Item 3a) Memorandum titled "MOVES Vehicle Hours of Travel (VHT) Distribution for Transit Buses," Y. Gao" Drafted/presented on 10/19/2010 (Item 3)	Memorandum titled "Results of MOVES2010 Model Sensitivity Tests: Final Scenario for Average Speed Testing," E. Lucas Memorandum Drafted: 10/16/2010 Memorandum Presented: 10/19/2010 (Item 4) Memorandum titled "Proposed Sensitivity Tests with Different Average Speed Distributions/SIP Temperatures" Drafted/presented 9/21/2010 (Item 3a)
3	**Fuel Supply**	Market share of available fuels by county, month, year, state	Memorandum titled "Development of Methodologies for Meteorology, I/M Program, and Fuel Inputs for Upcoming Ozone SIP (2008 or 2010 Standard) and Existing Conformity Analyses (Ozone & PM2.5 - 1997 Standards, CO - 1971 Standard)," S. Kumar Drafted/presented 6/22/2010 (Item 4a)	Memorandum titled "Results of MOVES2010 Model Sensitivity Tests:...Maryland Clean Car Program-ZEV," E. Lucas, Drafted/presented 5/18/2010 (Item 4a)
4	**Fuel Formulation**	Fuel formulation data stratified by state		
5	**I/M Programs**	Available Inspection/Maintenance Programs stratified by state		
6	**Meteorology Data**	Hourly temperature and relative humidity readings	Memorandum titled "Development of Methodologies for Meteorology, I/M Program, and Fuel Inputs for Upcoming Ozone SIP (2008 or 2010 Standard) and Existing Conformity Analyses (Ozone & PM2.5 - 1997 Standards, CO - 1971 Standard)," S. Kumar Drafted/presented 6/22/2010 (Item 4a) Memorandum titled "Development of Meteorology Inputs for existing Conformity Analyses (Ozone & PM2.5 – 1997 Standards, CO – 1971 Standard)",)," S. Kumar Drafted/presented 7/20/2010 (Item3a)"	Memorandum titled "Results of MOVES2010 Model Sensitivity Tests:...Maryland Clean Car Program-ZEV," E. Lucas, Drafted/presented 5/18/2010 (Item 4a)
7	**Ramp Fraction**	Percentage of driving time on ramps stratified by road type	Memorandum titled "Results of MOVES 2010 Model Ramp Analysis," E. Lucas, Drafted/presented 7/20/2010 (Item 4a)	Memorandum titled "Results of MOVES 2010 Model Ramp Analysis," E. Lucas, Drafted/presented 7/20/2010 (Item 4a)
8	**Road Type Distribution**	Percentages of VMT allocated to each road type by vehicle type	Memorandum titled "Development of Local Transportation Data Inputs for MOVES2010 Model," D. Sivasailam Memorandum Drafted: 4/13/2010 Memorandum Presented: 4/20/2010 (Item 3) Memorandum Revised: 5/14/2010 (Item 3b)	Memorandum titled "Results of MOVES 2010 Model Sensitivity...", E. Lucas, Drafted/presented 4/20/2010 (Item 4) Memorandum titled "Results of MOVES2010 Model Sensitivity...," E. Lucas, Drafted/presented 5/18/2010 (Item 4a)
9	**Source Type Population**	Population of registered vehicles by county and vehicle type		
10	**Vehicle Type VMT**	Annual VMT by HPMS vehicle type	Memorandum titled "Development of Annual VMT for MOVES2010,"D. Sivasailam Memorandum Drafted: 4/16/2010 Memorandum Presented: 4/20/2010 (Item 3) Memorandum Revised: 5/14/2010 (Item 3b)	Memorandum titled "Results of MOVES 2010 Model Sensitivity...", E. Lucas, Drafted/presented 4/20/2010 (Item 4) Memorandum titled "Results of MOVES2010 Model Sensitivity...," E. Lucas, Drafted/presented 5/18/2010 (Item 4a)

ATTACHMENT C

Input, Output, and "Runspec" MOVES2014a Files for 2014, 2025, and 2030

Year 2014

Input	Output	Runspec
Ozone_DC_2014_NAAQ_In	Ozone_DC_2014_NAAQ_Out	Ozone_DC_2014_NAAQ.MRS
Ozone_NoAVFT_CAL_2014_NAAQ_In	Ozone_NoAVFT_CAL_2014_NAAQ_Out	Ozone_NoAVFT_CAL_2014_NAAQ.MRS
Ozone_AVFT_CAL_2014_NAAQ_In	Ozone_AVFT_CAL_2014_NAAQ_Out	Ozone_AVFT_CAL_2014_NAAQ.MRS
Ozone_NoAVFT_CHL_2014_NAAQ_In	Ozone_NoAVFT_CHL_2014_NAAQ_Out	Ozone_NoAVFT_CHL_2014_NAAQ.MRS
Ozone_AVFT_CHL_2014_NAAQ_In	Ozone_AVFT_CHL_2014_NAAQ_Out	Ozone_AVFT_CHL_2014_NAAQ.MRS
Ozone_NoAVFT_FRD_2014_NAAQ_In	Ozone_NoAVFT_FRD_2014_NAAQ_Out	Ozone_NoAVFT_FRD_2014_NAAQ.MRS
Ozone_AVFT_FRD_2014_NAAQ_In	Ozone_AVFT_FRD_2014_NAAQ_Out	Ozone_AVFT_FRD_2014_NAAQ.MRS
Ozone_NoAVFT_MTG_2014_NAAQ_In	Ozone_NoAVFT_MTG_2014_NAAQ_Out	Ozone_NoAVFT_MTG_2014_NAAQ.MRS
Ozone_AVFT_MTG_2014_NAAQ_In	Ozone_AVFT_MTG_2014_NAAQ_Out	Ozone_AVFT_MTG_2014_NAAQ.MRS
Ozone_NoAVFT_PG_2014_NAAQ_In	Ozone_NoAVFT_PG_2014_NAAQ_Out	Ozone_NoAVFT_PG_2014_NAAQ.MRS
Ozone_AVFT_PG_2014_NAAQ_In	Ozone_AVFT_PG_2014_NAAQ_Out	Ozone_AVFT_PG_2014_NAAQ.MRS
Ozone_FFX_2014_NAAQ_In	Ozone_FFX_2014_NAAQ_Out	Ozone_FFX_2014_NAAQ.MRS
Ozone_LDN_2014_NAAQ_In	Ozone_LDN_2014_NAAQ_Out	Ozone_LDN_2014_NAAQ.MRS
Ozone_PW_2014_NAAQ_In	Ozone_PW_2014_NAAQ_Out	Ozone_PW_2014_NAAQ.MRS

Year 2025

Input	Output	Runspec
Ozone_DC_2025_NAAQ_In	Ozone_DC_2025_NAAQ_Out	Ozone_DC_2025_NAAQ.MRS
Ozone_NoAVFT_CAL_2025_NAAQ_In	Ozone_NoAVFT_CAL_2025_NAAQ_Out	Ozone_NoAVFT_CAL_2025_NAAQ.MRS
Ozone_AVFT_CAL_2025_NAAQ_In	Ozone_AVFT_CAL_2025_NAAQ_Out	Ozone_AVFT_CAL_2025_NAAQ.MRS
Ozone_NoAVFT_CHL_2025_NAAQ_In	Ozone_NoAVFT_CHL_2025_NAAQ_Out	Ozone_NoAVFT_CHL_2025_NAAQ.MRS
Ozone_AVFT_CHL_2025_NAAQ_In	Ozone_AVFT_CHL_2025_NAAQ_Out	Ozone_AVFT_CHL_2025_NAAQ.MRS
Ozone_NoAVFT_FRD_2025_NAAQ_In	Ozone_NoAVFT_FRD_2025_NAAQ_Out	Ozone_NoAVFT_FRD_2025_NAAQ.MRS
Ozone_AVFT_FRD_2025_NAAQ_In	Ozone_AVFT_FRD_2025_NAAQ_Out	Ozone_AVFT_FRD_2025_NAAQ.MRS
Ozone_NoAVFT_MTG_2025_NAAQ_In	Ozone_NoAVFT_MTG_2025_NAAQ_Out	Ozone_NoAVFT_MTG_2025_NAAQ.MRS
Ozone_AVFT_MTG_2025_NAAQ_In	Ozone_AVFT_MTG_2025_NAAQ_Out	Ozone_AVFT_MTG_2025_NAAQ.MRS
Ozone_NoAVFT_PG_2025_NAAQ_In	Ozone_NoAVFT_PG_2025_NAAQ_Out	Ozone_NoAVFT_PG_2025_NAAQ.MRS
Ozone_AVFT_PG_2025_NAAQ_In	Ozone_AVFT_PG_2025_NAAQ_Out	Ozone_AVFT_PG_2025_NAAQ.MRS
Ozone_FFX_2025_NAAQ_In	Ozone_FFX_2025_NAAQ_Out	Ozone_FFX_2025_NAAQ.MRS
Ozone_LDN_2025_NAAQ_In	Ozone_LDN_2025_NAAQ_Out	Ozone_LDN_2025_NAAQ.MRS
Ozone_PW_2025_NAAQ_In	Ozone_PW_2025_NAAQ_Out	Ozone_PW_2025_NAAQ.MRS

Year 2030

Input	Output	Runspec
Ozone_DC_2030_NAAQ_In	Ozone_DC_2030_NAAQ_Out	Ozone_DC_2030_NAAQ.MRS
Ozone_NoAVFT_CAL_2030_NAAQ_In	Ozone_NoAVFT_CAL_2030_NAAQ_Out	Ozone_NoAVFT_CAL_2030_NAAQ.MRS
Ozone_AVFT_CAL_2030_NAAQ_In	Ozone_AVFT_CAL_2030_NAAQ_Out	Ozone_AVFT_CAL_2030_NAAQ.MRS
Ozone_NoAVFT_CHL_2030_NAAQ_In	Ozone_NoAVFT_CHL_2030_NAAQ_Out	Ozone_NoAVFT_CHL_2030_NAAQ.MRS
Ozone_AVFT_CHL_2030_NAAQ_In	Ozone_AVFT_CHL_2030_NAAQ_Out	Ozone_AVFT_CHL_2030_NAAQ.MRS
Ozone_NoAVFT_FRD_2030_NAAQ_In	Ozone_NoAVFT_FRD_2030_NAAQ_Out	Ozone_NoAVFT_FRD_2030_NAAQ.MRS
Ozone_AVFT_FRD_2030_NAAQ_In	Ozone_AVFT_FRD_2030_NAAQ_Out	Ozone_AVFT_FRD_2030_NAAQ.MRS
Ozone_NoAVFT_MTG_2030_NAAQ_In	Ozone_NoAVFT_MTG_2030_NAAQ_Out	Ozone_NoAVFT_MTG_2030_NAAQ.MRS
Ozone_AVFT_MTG_2030_NAAQ_In	Ozone_AVFT_MTG_2030_NAAQ_Out	Ozone_AVFT_MTG_2030_NAAQ.MRS
Ozone_NoAVFT_PG_2030_NAAQ_In	Ozone_NoAVFT_PG_2030_NAAQ_Out	Ozone_NoAVFT_PG_2030_NAAQ.MRS
Ozone_AVFT_PG_2030_NAAQ_In	Ozone_AVFT_PG_2030_NAAQ_Out	Ozone_AVFT_PG_2030_NAAQ.MRS
Ozone_FFX_2030_NAAQ_In	Ozone_FFX_2030_NAAQ_Out	Ozone_FFX_2030_NAAQ.MRS
Ozone_LDN_2030_NAAQ_In	Ozone_LDN_2030_NAAQ_Out	Ozone_LDN_2030_NAAQ.MRS
Ozone_PW_2030_NAAQ_In	Ozone_PW_2030_NAAQ_Out	Ozone_PW_2030_NAAQ.MRS