Appendix C1

Technical Support Document for the Development of Onroad Mobile Emissions Inventories for 2002, 2007, 2017, and 2025

(Washington, DC-MD-VA PM2.5 Nonattainment Area)

Appendix C1 consists of two separate attachments namely, Attachment A and Attachment B.

Attchment A - Description of inputs developed by MWCOG Department of Transportation Planning

Attachment B – Description of inputs provided by MWCOG Department of Environmental Programs

Appendix C1

Attachment A

(MWCOG/DTP)

Technical Support Document
for the
Development of MOVES2010a Inputs
(Vehicle & Travel)
for 2002, 2007, 2017, and 2025

(Washington, DC-MD-VA PM2.5 Nonattainment Area)

PM2.5 REDESIGNATION REQUEST & MAINTENANCE PLAN

PRECURSOR NO_x, PRIMARY $PM_{2.5}$ & SULFUR DIOXIDE ON ROAD MOBILE EMISSIONS

INVENTORIES DEVELOPMENT

TECHNICAL DOCUMENTATION

Prepared by the:
Metropolitan Washington Council of Governments
Department of Transportation Planning

October 5, 2012

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2. Air Quality Conformity Determination of the 2011 Constrained Long Range Plan for the Washington Metropolitan Region, November 16, 2011, TPB.
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IINTRODUCTION

This technical report documents how the input data that was used in the development of the on road mobile emissions inventories was obtained, processed and incorporated in MOVES model runs. Its focus is to document how the travel-related and vehicle population-related input data were developed and integrated in the analyses as the Department of Transportation Planning (DTP) of the Metropolitan Washington Council of Governments/Transportation Planning Board (MWCOG/TPB) has had the primary responsibility of preparing this input data and executing MOVES model runs. While fuel supply and formulation, Inspection/Maintenance (I/M) and meteorology input data were also integral components of the MOVES model runs, which were executed by the DTP, the input data were supplied by the MWCOG Department of Environmental Programs (DEP) in a MOVES-ready format. As such, documentation pertaining to the origins and development of such input data is not part of this technical report. It will be provided by MWCOG/DEP.

This technical report has the following objectives:

- to provide contextual background on the travel-related and vehicle population-related input data categories
- to tabulate the mobile emissions inventories by state and by analysis year
- to thoroughly document how the input data was obtained, developed and integrated in the MOVES model runs for the purpose of developing on road mobile emissions inventories

The geographical area represented in the analyses encompasses jurisdictions (i.e., counties) in suburban Maryland, Northern Virginia and the District of Columbia (Figure 1). It is also the metropolitan Washington PM2.5 Non Attainment area.

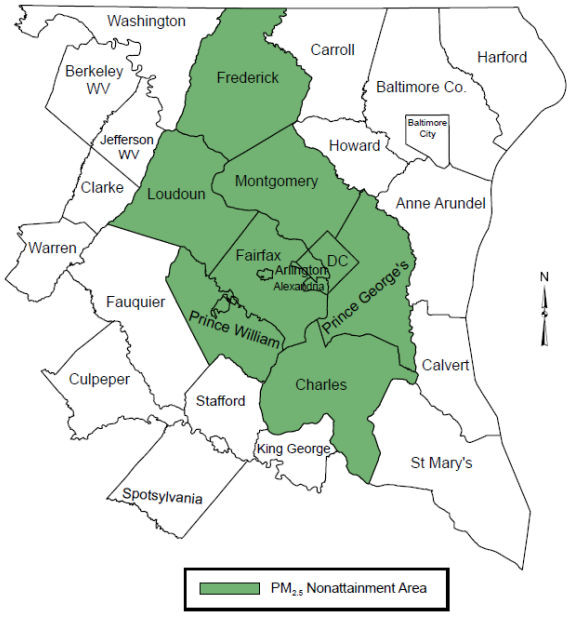

Figure 1 - $PM_{2.5}$ Air Quality Planning Area

TECHNICAL BACKGROUND

On road mobile emissions inventories were developed for the following years:

- Year 2002 (Base Year) – It is a historical year, and it was previously analyzed as part of the 2008 PM2.5 State Implementation Plan (SIP). It is analyzed again – using MOVES as the estimating model -- for consistency with the estimates for the other analysis years (i.e., 2007, 2017, 2025 and 2040).

- Year 2007 (Attainment Year)

- Year 2017 (Interim Year) – It was chosen by the participating air and transportation agencies as a year bridging the chronological gap between 2007 (the Attainment Year) and 2025 (the Final Year of the PM2.5 Maintenance Plan).

- Year 2025 (Final Year of the Maintenance Plan)

- Year 2040 (Final Year of the MWCOG/TPB Transportation Long Range Plan) – It is an additional (optional) year of analysis. Inclusion of year 2040 was not mandatory as part of the PM2.5 Maintenance Plan. Its inclusion, however, was viewed favorably by the participating air and transportation agencies as supplemental mobile emissions data – beyond year 2025 – would enable them to take a longer view of Air Quality Conformity.

Emissions Estimating Model: The mobile emissions inventories were developed using MOVES2010a [(1)].

Long Range Transportation Plan: The mobile emissions inventories were based on the 2011 Constrained Long Range Plan (CLRP) [(2)] of MWCOG/TPB. It was the most recently adopted long range transportation plan when this work was initiated. In accordance with established formal interagency consultation practices the plan went through an extensive review process and a 45-day public comment period as part of the 2011 CLRP Air Quality Conformity Determination. It was approved by MWCOG/TPB concurrently with the 2011 CLRP Air Quality Conformity Determination on November 16, 2011 and subsequently by the U S Department of Transportation (USDOT) on February 17, 2012.

Travel Demand Forecasting Model: Travel-related input data such as Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT), were generated using the newest version of the MWCOG/DTP travel demand forecasting model, which is Version 2.3 [(3)]. It is a Cube/Voyager model, developed under the oversight of the MWCOG/TPB Travel Forecasting Subcommittee, and it was first used in an official capacity in the 2011 CLRP Air Quality Conformity Determination.

The highway and transit networks coded in the model and used in the development of the mobile emissions estimates represent project inputs provided by participating state agencies. They reflect the scope and schedule of each project as reported by the sponsoring agencies. Project inputs were approved by MWCOG/TPB prior to the projects being coded in the model networks. The entire package consisting of the Version 2.3 model and the networks project assumptions were formally approved by MWCOG/TPB as part of the 2011 CLRP Air Quality Conformity Determination (November 16, 2011).

Cooperative Land Use Forecasts: The analyses were based on Round 8.0a Cooperative Land Use Forecasts [(4)] [(5)] , and they are reflected in the 2011 CLRP Air Quality Conformity Determination. The Round 8.0a land use forecasts went through an extensive review process and a 45-day public comment period as part of the 2011 CLRP Air Quality Conformity Determination.

Methodologies: The final determination on whether to use local/county input data – as opposed to EPA default values -- in MOVES model runs for Air Quality Conformity Determinations was made by a special task force that was created at MWCOG/TPB to guide and oversee the MPO transition from the Mobile 6.2

platform to MOVES. The MOVES Task Force (MTF) was comprised of technical representatives from state air and transportation agencies, the U S Environmental Protection Agency (USEPA), and Federal Highway Administration (FHWA). During 18 monthly meetings between August 2009 and January 2011, the MTF accomplished the following: (1) approved the use of local input data in the MOVES County Data Manager instead of EPA default values, a decision that was based on a series of sensitivity tests evaluating the appropriateness of using local data; (2) approved the county level as the appropriate level of disaggregation in the MOVES County Data Manager, a decision that was based on a series of sensitivity tests evaluating the appropriateness of the domain (reflecting state level) versus the county (jurisdictional level); and (3) selected the Inventory Approach as opposed to the Emissions Rate approach as the preferred method of developing mobile emissions inventories for Air Quality Conformity Determinations.

Table A1 in the Appendix tabulates the sources of the local/county input data, the methodologies, the approval process for each input data category and methodology, and the dates of key decisions by the MTF. It also provides web links to the technical memoranda, which document the findings of the sensitivity tests supporting the decisions made.

On road mobile emissions inventories were developed for the following criteria pollutants: Precursor NOx, Direct $PM_{2.5}$ and SO_2.

On road mobile emissions inventories for VOC and NH_3 were not inventoried here because these pollutants were considered insignificant for the $PM_{2.5}$.Non Attainment area of the metropolitan Washington region as part of the 2008 $PM_{2.5}$ SIP.

ON ROAD MOBILE EMISSIONS INVENTORIES

On road mobile emissions inventories for Precursor NOx , direct PM2.5 and SO_2 are summarized by state and analysis year in Tables 1, 2 and 3. Jurisdictional level on road mobile emissions inventories are shown in Table A2 of the Appendix.

Table 1. ANNUAL INVENTORIES OF PRECURSOR NOx (t/y)

State	2002	2007	2017	2025	2040
DC	9,962.80	7,511.73	3,395.06	2,005.43	1,890.08
MD	63,391.74	47,279.13	22,097.45	14,225.15	13,381.33
VA	53,598.46	36,847.77	16,216.37	11,169.07	11,546.08
Area Total	126,952.99	91,638.63	41,708.88	27,399.65	26,817.49

Table 2. ANNUAL INVENTORIES OF DIRECT PM2.5 (t/y)

State	2002	2007	2017	2025	2040
DC	302.27	272.39	157.14	123.80	120.25
MD	2,056.87	1,756.91	890.64	637.90	645.89
VA	1,599.75	1,422.32	739.17	560.59	584.24
Area Total	3,958.89	3,451.62	1,786.95	1,322.29	1,350.38

Table 3. ANNUAL INVENTORIES OF SULFUR DIOXIDE, SO2 (t/y)

State	2002	2007	2017	2025	2040
DC	280.67	67.67	65.62	60.02	61.78
MD	1,706.46	319.18	320.97	303.02	331.18
VA	1,621.78	220.18	173.38	167.91	183.69
Area Total	3,608.92	607.03	559.97	530.95	576.65

INPUT DATA DEVELOPMENT

Input data from ten broad categories were used in the MOVES County Manager in order to generate the mobile emissions inventories. The modeling sequence that was followed is graphically illustrated in Figure 2.

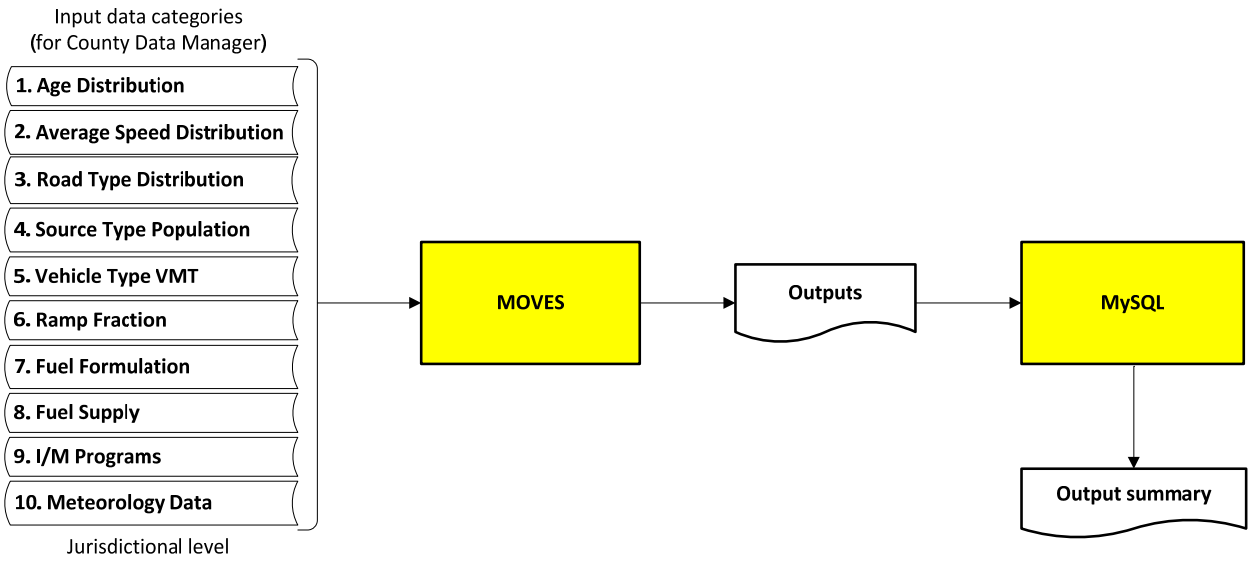

Figure 2. MOVES Modeling Process

Input data were obtained from local/county and regional sources (Table 4). The sources of the data, the methodologies and the processes are documented in the following sections. Fuel supply and formulation, I/M programs and Meteorology data documentation is provided in a companion document.

Table 4. Local Input Data Categories

No	Data Category	Data Table Name	Locality	Methodology
1	Age Distribution	**sourceTypeAgeDistribution**	County	based on VIN
2	Average Speed Distribution	**avgSpeedDistribution**	County	based on travel demand model's post-processor outputs + school bus/refuse truck data from Fairfax Co. + transit bus from WMATA
3	Road Type Distribution	**roadTypeDistribution**	County	based on travel demand model's post-processor outputs
4	Source Type Population	**sourceTypeYear**	County	based on CLRP Vehicle Projection & VIN
5	Vehicle Type VMT	**HPMSVTypeYear**	County	based on TDM's post-processor outputs
		monthVMTFraction	Region	based on Regional Data
		dayVMTFraction	Region	based on Regional Data
		hourVMTFraction	Region	based on Regional Data
6	Ramp Fraction	**roadType**	Region	8% of the urban/rural restricted access roads
7	Fuel	**FuelSupply**	State	from state air agency (state-wide data)
8		**FuelFormulation**	State	from state air agency (state-wide data)
9	I/M Programs	**IMCoverage**	State	from state air agency (state-wide data)
10	Meteorology Data	**zoneMonthHour**	State	from DEP (region-wide data)

Age Distribution

In recent years – 2005, 2008 and 2011 -- the Departments of Motor Vehicles (DMV) of the District of Columbia, Maryland and Virginia have been supplying to MWCOG/TPB vehicle registration data for use in Air Quality Conformity Determinations. The 2005, 2008 and 2011 databases contain a broad range of attributes of the vehicles registered in the jurisdictions of the PM2.5 Non Attainment area (Figure 1). They also reflect vehicles registered as of July 1 of these three years.

Prior to being used as inputs in MOVES model runs, the "raw" vehicle registration data – also known as Vehicle Identification Numbers (VIN) – were decoded using a commercial decoding software program [(6)] . Due to the inability of the decoding software program to classify the decoded VIN entries into a MOVES-compatible format, the vehicle population decoding was achieved in two steps: (1) the "raw" data was decoded to a Mobile 6.2-compatible format (vehicle populations distributions stratified in 16 vehicle classes and in 25 vehicle age categories); (2) the previous vehicle population distributions were subsequently converted to a MOVES-compatible format (vehicle population distributions stratified in 13 vehicle classes and in 31 vehicle age categories) using an EPA-developed converter [(7)] while following the process recommended by EPA.

All three vehicle population databases were reviewed by the MWCOG/TPB technical oversight committees and went through public comments prior to becoming approved for transportation planning applications. The 2011 VIN database was formally approved by MWCOG/TPB concurrently with the 2012 CLRP Air Quality Conformity Determination in July 2012.

In 2002 the state agencies of the District of Columbia, Maryland and Virginia supplied Mobile 6.2-ready vehicle population registration data by jurisdiction, and MWCOG/TPB incorporated them directly into Air

Quality Conformity Determination analyses. Year 2007 mobile emissions estimates were based on the 2008 VIN database while remaining years' mobile emissions estimates for years 2017, 2025 and 2040 were based on the 2011 VIN database.

Average Speed Distribution (Hourly VHT Distribution by Vehicle Type Class)

A custom post processor (i.e., the V2.3 Post Processor) was developed in order to account for Vehicle Hours of Travel (VHT) stratified by three major vehicle type categories: passenger vehicles, commercial vehicles and heavy duty vehicles. The V2.3 Post Processor was necessary because the MWCOG/TPB travel demand model accounts for VHT by six travel markets, which are: light duty vehicles/Single Occupancy Vehicles (SOV), light duty vehicles/High Occupancy Vehicles (HOV2), light duty vehicles/High Occupancy Vehicles (HOV3+), Airport Passenger Trips, Commercial Vehicles and Trucks. The conversion of the VHT totals by the six travel markets to VHT totals by the three major vehicle type categories was done as follows:

- Passenger Vehicles (PVs) = SOV + HOV2 + HOV3+ + Airport Passenger Trips
- Commercial Vehicles (CVs) = Commercial Vehicles
- Heavy Duty Vehicles (HDVs) = Trucks

For each of the three major vehicle type categories, hourly VHT estimates were derived stratified by MOVES-compatible speed bins, jurisdiction (i.e., county level), and road type. MOVES calls for 16 speed bins along a continuous speed spectrum ranging from a low value of 2.5 mph to a high value of 75 mph in increments of 5 mph. MOVES calls for four road types: restricted access facilities (i.e., freeways and expressways) in urban and rural settings and unrestricted access facilities (i.e., major/minor arterials, collectors and local roads) in urban and rural settings.

Average Speed Distribution by the 16 MOVES-compatible speed bins was achieved as follows:

VHT Distribution to Restricted Facilities (all MOVES-compatible vehicle type categories):

- Weekday VHT Distribution:
  - All Day: Hourly distribution for all vehicles (as derived from the V2.3 Post Processor)
- Weekend VHT Distribution:
  - 11:00 am – 7:00 pm: Distribution across the 13 MOVES-compatible vehicle type categories reflecting the 3:00 pm hour on a weekday (as derived from the V2.3 Post Processor)
  - 7:01 pm – 10:59 am: Distribution across the 13 MOVES-compatible vehicle type categories reflecting the 12:00 am hour on a weekday (as derived from the V2.3 Post Processor)

VHT Distribution to Unrestricted Facilities (all MOVES-compatible vehicle type categories including intercity bus except Refuse Trucks, School Buses and Transit Buses)

- Weekday VHT Distribution:
  - All Day: : Hourly distribution for all vehicles (as derived from the V2.3 Post Processor)
- Weekend VHT Distribution:

- 11:00 am – 7:00 pm: Distribution across the 13 MOVES-compatible vehicle type categories reflecting the 3:00 pm hour on a weekday (as derived from the V2.3 Post Processor)
- 7:01 pm – 10:59 am: Distribution across the 13 MOVES-compatible vehicle type categories reflecting the 12:00 am hour on a weekday (as derived from the V2.3 Post Processor)

VHT Distribution to Unrestricted Facilities (Refuse Trucks, School and Transit Buses):

- Hourly VHT Distribution for refuse trucks (based on hourly distributions provided by Fairfax County)
- Hourly VHT Distribution for school buses (based on hourly distributions provided by Fairfax County)
- Hourly VHT Distribution for transit buses (based on hourly distributions provided by the Washington Metropolitan Area Transit Authority)

Road Type Distribution (VMT Distribution by Vehicle Type Class & Road Type)

The Version 2.3 Post Processor accounts for VMT by three vehicle types: passenger vehicles, commercial vehicles and heavy duty vehicles. In the MOVES environment, 13 vehicle type categories are identified. The challenge was to "expand" the VMT allocations (as percentages of the total) from the three vehicle type categories to the 13 MOVES-compatible vehicle type categories.

The Version 2.3 Post Processor also accounts for VMT by two facility types: restricted access facilities (i.e., freeways and expressways), and unrestricted access facilities (i.e., major/minor arterials, collectors and local roads). The VMT allocated to each of the three vehicle type categories is also stratified by the two facility types.

The VMT distribution by Vehicle Class Type and Facility Type was done as follows:

- The VMT percentages of passenger vehicles by facility type – as derived from the Version 2.3 Post Processor – were applied to motorcycles, passenger cars and passenger trucks
- The VMT percentages of commercial vehicles by facility type – as derived from the Version 2.3 Post Processor – were applied to light commercial trucks
- The VMT percentages of heavy duty vehicles by facility type – as derived from the Version 2.3 Post Processor – were applied to single unit short haul trucks, single unit long haul trucks, combination short haul trucks, combination long haul trucks
- A MOVES default percent value was applied to refuse trucks and motor homes
- Local network VMT percentages – based on local data supplied by bus operators – were applied to school, transit and intercity buses.

Urban versus rural percentage split factors were subsequently applied to differentiate VMT allocations between urban and rural facilities. These factors varied by jurisdiction as they were based on the latest Highway Performance Monitoring System (HPMS) VMT data provided by the three state transportation agencies. Figure 3 graphically illustrates the process that was followed to allocated VMT percentages by vehicle type class and road type in a format that is MOVES-compatible.

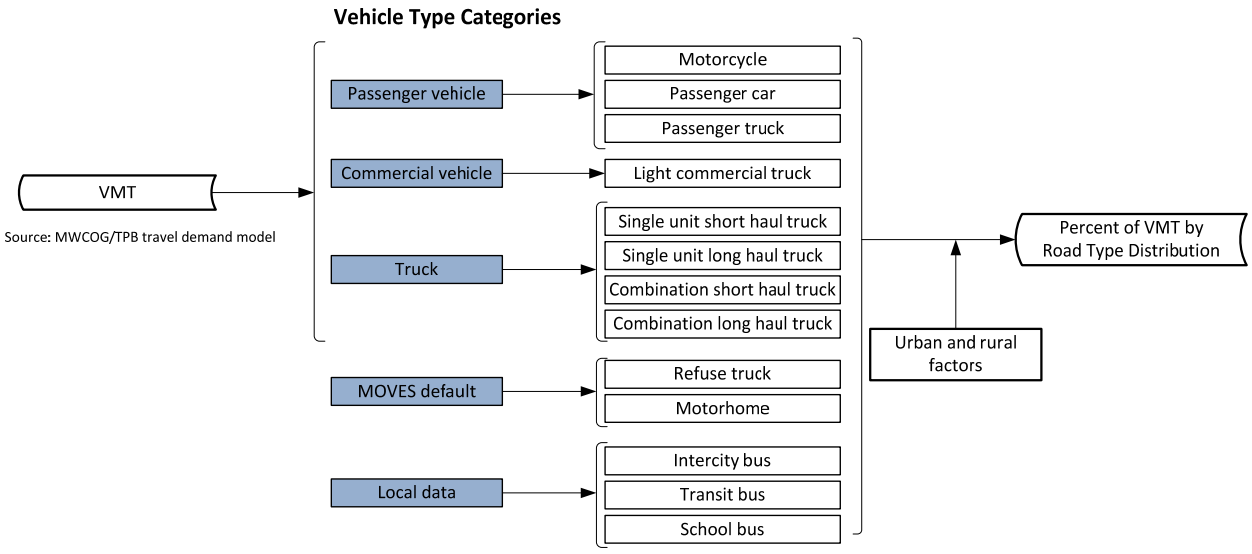

Figure 3. VMT Distribution Development Process

Source Type Population (Regional Vehicle Fleet)

Mobile emissions inventories were developed for the following analyses years: 2002, 2007, 2017, 2025 and 2040. Since these analysis years span a long time period, and the composition and characteristics of the regional vehicle fleet vary over time, different vehicle population profiles were used to develop the mobile emissions inventories for each of the above analysis years.

Each vehicle population profile that was used reflected the actual (and unique) composition of the regional vehicle fleet of the corresponding year in terms of its vehicle type and age distributions. While only modest changes in the vehicle type distributions were observed over time, substantial changes in the vehicle age distributions were observed over time. It is noteworthy that in the most recent vehicle population profile the regional fleet was found to be substantially older than before. For informational purposes, the area vehicle fleet is documented in Table 5.

Table 5. Vehicle Population in Metropolitan Washington Region (PM2.5 Air Quality Planning Area)

State	2002 Area Total	2007 Area Total	2017 Area Total	2025 Area Total	2040 Area Total
DC	247,230	260,385	285,814	295,720	314,294
MD	1,522,566	1,666,524	1,928,529	2,208,174	2,732,508
VA	1,549,440	1,631,964	1,968,282	2,234,885	2,734,766
Area Total	3,319,236	3,558,873	4,182,625	4,738,779	5,781,568

Note:
- 2002 area total was provided by state air agencies
- 2007 area total was based on 2005 Vehicel Registration Data and linear growth factors (by jurisdiction)
- 2017, 2025 and 2040 area totals were based on the 2011 Vehicle Registration Data and linear growth factors (by jurisdiction)

In order to capture the prevailing vehicle population characteristics (i.e., vehicle type and age distributions) over time, the most representative vehicle population profile for each analysis year was used. For the development of year 2002 mobile emissions, the 2002 vehicle population profile (i.e., vehicle type and age distributions) was used. Similarly, for the 2007 emissions, the year 2005 vehicle population profile was used. Finally, for the emissions inventories of years 2017, 2025 and 2040 – future year projections -- the 2011 VIN database profile was used as the best proxy of future vehicle populations.

Year 2002 vehicle population data were supplied by the state agencies of the District of Columbia, Maryland and Virginia. Years 2005, 2008 and 2011 vehicle population data were provided by the state agencies in a "raw" format, which were required decoding to a Mobile 6.2 format using a commercially available Vehicle Identification Number (VIN) decoding software program. The vehicle population data used throughout this analysis was considered as 100-percent representative samples of the vehicles registered in jurisdictions in the air quality planning area (Figure 1). As such, they did not require any extrapolation or any other type of "expansion" in order to capture the entire vehicle population in the jurisdictions of the air quality planning area.

The 2011 vehicle population profile – by jurisdiction -- was projected to years 2017, 2025 and 2040 using linear growth factors, which were unique for each jurisdiction since they were derived from historical local data. Similarly, the 2005 VIN vehicle population profile was projected to analysis year 2007 using the same jurisdiction-level annual growth factors. Finally, the resulting vehicle populations for all analysis years were converted to a MOVES-compatible format (i.e., 13 MOVES vehicle types) using the population mapping table provided by the EPA Technical Guidance (Appendix: Table A3 Population Mapping from MOBILE 6.2 Vehicle Types to MOVES Source Types). Figure 4 graphically illustrates the process.

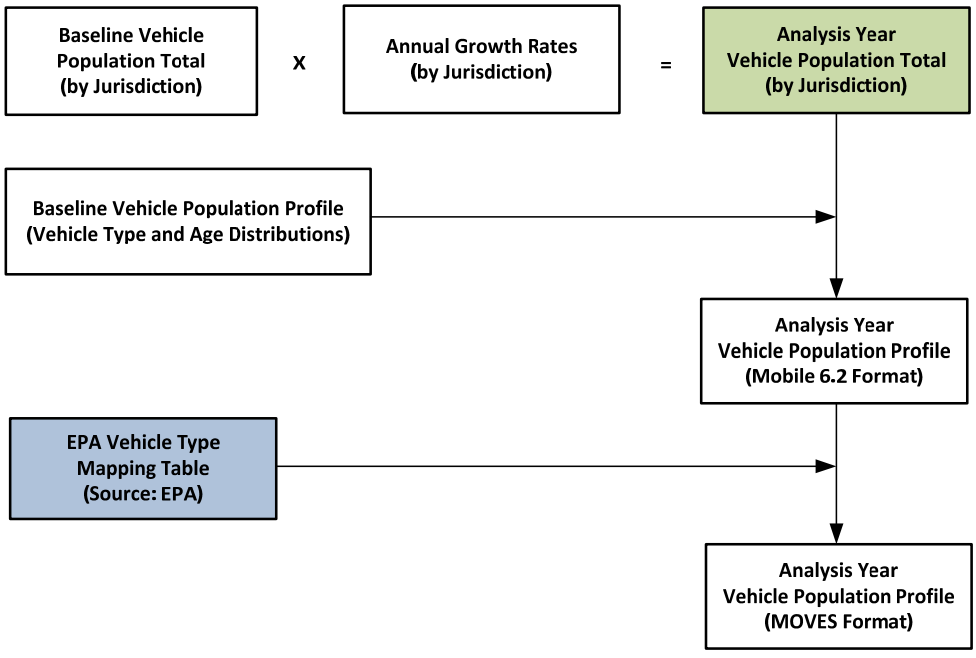

Figure 4. Source Type Population Development Process

Vehicle Type VMT

Unlike other transportation inputs mentioned in the previous sections in this report, MOVES requires annual VMT by six Highway Performance Monitoring System (HPMS) vehicle types instead of the 13 MOVES vehicle types. The Version 2.3 Post Processor produces average annual weekday VMT estimates by three vehicle types: passenger vehicles, commercial vehicles and heavy duty vehicles. Based on the VMT percent by 13 HPMS vehicle types and the vehicle registration data, average annual weekday VMT in three vehicle types from the Version 2.3 post processor and the local bus, VMT estimates are split into six HPMS vehicle types (Table 6).

Table 6. Annual VMT in Metropolitan Washington Region (PM2.5 Air Quality Planning Area)

State	2002 Area VMT Total	2007 Area VMT Total	2017 Area VMT Total	2025 Area VMT Total	2040 Area VMT Total
DC	3,739,392,134	3,958,909,906	4,155,214,419	4,326,158,542	4,614,913,658
MD	20,090,976,143	20,926,701,687	23,071,489,084	24,705,756,640	27,700,884,113
VA	16,730,587,862	18,024,722,031	20,472,567,625	22,339,692,536	24,968,189,974
Area Total	40,560,956,140	42,910,333,623	47,699,271,128	51,371,607,718	57,283,987,745

The average annual weekday VMT by six HPMS vehicle types is then fed into the EPA-provided annual VMT converter (AAD VMT Calculator HPMS.XLS) [8] with local monthly adjustment factors and weekend-day adjustment factors. The converter develops annual VMT in six HPMS vehicle types required as an input to MOVES with two additional outputs (i.e., 'monthVMTfraction' and 'dayVMTfraction'). The local "hourlyVMTfraction" is also provided as part of the annual VMT input.

Ramp Fraction

Local data was used to estimate the appropriate percentage of ramps representing the metropolitan Washington region. The methodology and estimates were reviewed and audited by the MOVES Task Force (MTF), which resulted in a regional percent estimate equal to 8 percent. It is the same as the national default value.

APPENDIX

TABLE A1 - Methodologies, Sources, Approval Process and Dates of Key Decisions of the MOVES Task Force

MOVES TASK FORCE

Local Input Data Development Matrix for the County Data Manager (Emissions Inventory Approach)*

as of January 11, 2011

	LOCAL INPUT DATA CATEGORIES	DATA DESCRIPTION	DATA FORMAT		DATA DEVELOPMENT			LOCAL INPUT DATA APPROVAL DATE
			MOBILE6.2	MOVES	METHODOLOGY	METHODOLOGY DOCUMENTATION **	SENSITIVITY TESTING DOCUMENTATION **	
1	Age Distribution	Registered vehicles stratified by age and vehicle type	25 Age Groups (covering 1-25+ years of vehicle age) 28 Vehicle Types	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	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)	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)	N/A	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	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)	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	DC/MD/VA - EPA Methodology/data in MOBILE6.2 format	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)	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)	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 MOBILE6.2 format Start Time: 6:00 am End Time: 5:00 am (next day)	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	Memoranda 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) & "Development of Meteorology Inputs for existing Conformity Analyses (Ozone & PM2.5 – 1997 Standards, CO – 1971 Standard)",)," S. Kumar Drafted/presented 7/20/2010	Memorandum titled "Results of MOVES2010 Model Sensitivity Tests:...Maryland Clean Car Program-ZEV," E. Lucas, Drafted/presented 5/18/2010 (Item 4a)	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	N/A	8% of VHT (EPA National Default)	DTP tested local input data and found consistent with the EPA National Default value	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)	7/20/2010
8	Road Type Distribution	Percentages of VMT allocated to each road type by vehicle type	N/A	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	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)	4/20/2010
9	Source Type Population	Population of registered vehicles by county and vehicle type	N/A	13 Vehicle Types	DTP used vehicle registration and source type fractions			
10	Vehicle Type VMT	Annual VMT by HPMS vehicle type	Annual VMT at link level	Annual VMT allocated by HPMS vehicle type	DTP used daily VMT and an EPA converter	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)	4/20/2010

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

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

TABLE A1 - (Continues)

Web Links for the Sensitivity Testing Documentation:

- MOVES Task Force, September 15, 2009 Meeting Agenda Item 3: MOVES Model Testing: Work Plan and Schedule http://www.mwcog.org/uploads/committee-documents/aV5bV1xa20090914163330.pdf

- "Development of Local Transportation Data Inputs for MOVES2010 Model", May 14, 2010 Technical memorandum from D. Sivasailam to MTF Item 3b; "Results of MOVES2010 Model Sensitivity...," Technical memorandum E. Lucas, Item 4a, May 18, 2010
  http://www.mwcog.org/uploads/committee-documents/Zl5ZV1ta20100514180205.pdf
  http://www.mwcog.org/uploads/committee-documents/ZF5ZV1la20100517155131.pdf

- "Development of Annual VMT for MOVES2010 Model," May 14, 2010, Technical memorandum from D. Sivasailam to MTF, Item 3b
  http://www.mwcog.org/uploads/committee-documents/Z15ZV1tb20100514180126.pdf

- "Local Vehicle Hours of Travel (VHT) Distributions ", July 20, 2010, Technical memorandum from D. Sivasailam to MTF, Item 3b
  http://www.mwcog.org/uploads/committee-documents/ZV5YXFhY20100719160715.pdf

- "School Bus Average Speed Distribution", September 21, 2010, Technical memorandum from E. Morrow to MTF, Item 3a
  http://www.mwcog.org/uploads/committee-documents/Y15YV1tY20100920171335.pdf

- "Vehicle Hours of Travel (VHT) for Refuse Truck", September 21, 2010, Technical memorandum from D. Sivasailam and E. Morrow to MTF, Item 3a
  http://www.mwcog.org/uploads/committee-documents/YV5YV1tW20100921084613.pdf

- "MOVES Vehicle Hours of Travel (VHT) Distribution for Transit Buses", October 19, 2010, Technical memorandum from Y. Gao to MTF, Item 3
  http://www.mwcog.org/uploads/committee-documents/al5XX1pZ20101015155653.pdf

- "Results of MOVES Model Ramp Analysis", July 20, 2010, Technical memorandum from E. Lucas to MTF, Item 4a
  http://www.mwcog.org/uploads/committee-documents/aV5YXFhc20100719150333.pdf

- "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)", June 22, 2010 Technical memorandum from S. Kumar to MTF, Item 4a
  http://www.mwcog.org/uploads/committee-documents/b15YXlxc20100628132825.pdf

- "Development of Meteorology Inputs for existing Conformity Analyses (Ozone & PM2.5 – 1997 Standards, CO –1971 Standard)" July 20, 2010 Technical memorandum from S. Kumar to MTF, Item 3a http://www.mwcog.org/uploads/committee-documents/aF5YXFhb20100719153740.pdf

TABLE A2 – Mobile Emissions Inventories (Jurisdictional Level)

ANNUAL INVENTORIES OF PRECUSOR NOX BY JURISDICTION (t/y)

State	Jurisdiction	2002	2007	2017	2025	2040
DC	DC	9,962.80	7,511.73	3,395.06	2,005.43	1,890.08
MD	Charles County	3,813.95	2,993.74	1,631.57	1,034.64	947.98
	Frederick County	11,264.93	8,970.68	4,672.49	3,029.73	2,739.08
	Montgomery County	21,692.31	15,896.74	7,023.95	4,697.68	4,573.33
	Prince George's County	26,620.54	19,417.96	8,769.43	5,463.10	5,120.94
	MD Total	63,391.74	47,279.13	22,097.45	14,225.15	13,381.33
VA	City of Alexandria	2,457.24	1,445.54	650.04	428.90	424.40
	Arlington County	4,210.91	2,683.65	1,025.22	680.94	652.59
	Fairfax County	28,390.46	19,203.65	8,104.39	5,535.10	5,624.50
	Loudoun County	7,275.93	5,412.87	2,596.69	1,909.13	2,072.88
	Prince William County	11,263.92	8,102.06	3,840.03	2,615.01	2,771.71
	VA Total	53,598.46	36,847.77	16,216.37	11,169.07	11,546.08
Area Total		126,952.99	91,638.63	41,708.88	27,399.65	26,817.49

ANNUAL INVENTORIES OF DIRECT PM2.5 BY JURISDICTION (t/y)

State	Jurisdiction	2002	2007	2017	2025	2040
DC	DC	302.27	272.39	157.14	123.80	120.25
MD	Charles County	130.67	112.96	60.54	42.00	43.41
	Frederick County	374.66	340.90	180.63	119.75	117.25
	Montgomery County	685.23	596.94	309.28	233.31	239.36
	Prince George's County	866.31	706.12	340.19	242.84	245.87
	MD Total	2,056.87	1,756.91	890.64	637.90	645.89
VA	City of Alexandria	68.60	53.61	31.65	24.35	24.27
	Arlington County	113.66	97.92	51.37	40.72	39.88
	Fairfax County	828.29	733.16	372.46	282.23	285.05
	Loudoun County	244.94	228.70	120.10	94.21	104.84
	Prince William County	344.27	308.92	163.58	119.07	130.20
	VA Total	1,599.75	1,422.32	739.17	560.59	584.24
Area Total		3,958.89	3,451.62	1,786.95	1,322.29	1,350.38

TABLE A2 – Mobile Emissions Inventories (Jurisdictional Level) (Continues)

ANNUAL INVENTORIES OF SULFUR DIOXIDE, SO2, BY JURISDICTION (t/y)

State	Jurisdiction	2002	2007	2017	2025	2040
DC	DC	280.67	67.67	65.62	60.02	61.78
MD	Charles County	98.53	18.05	18.91	18.52	21.50
	Frederick County	301.94	51.70	54.14	52.13	59.41
	Montgomery County	601.98	122.08	119.27	112.68	123.20
	Prince George's County	704.01	127.35	128.65	119.69	127.07
	MD Total	1,706.46	319.18	320.97	303.02	331.18
VA	City of Alexandria	76.17	9.87	8.01	7.50	7.78
	Arlington County	141.63	18.28	14.30	12.95	13.17
	Fairfax County	875.03	116.93	90.61	86.04	91.56
	Loudoun County	216.19	31.05	25.01	26.43	31.22
	Prince William County	312.78	44.05	35.45	35.00	39.96
	VA Total	1,621.78	220.18	173.38	167.91	183.69
Area Total		3,608.92	607.03	559.97	530.95	576.65

TABLE A3 - Population Mapping from MOBILE6.2 Vehicle Types to MOVES Source Types

MOBILE6.2 Vehicle		MOVES Source Type		
ID	Name	ID	Name	Fraction
1	LDGV	21	Passenger Car	1.00
2	LDGT1	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
3	LDGT2	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
4	LDGT3	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
5	LDGT4	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
6	HDGV2B	31	Passenger Truck	0.63
		32	Light Commercial Truck	0.37
7	HDGV3	31	Passenger Truck	0.63
		32	Light Commercial Truck	0.37
8	HDGV4	31	Passenger Truck	0.06
		32	Light Commercial Truck	0.94
9	HDGV5	31	Passenger Truck	0.06
		32	Light Commercial Truck	0.94
10	HDGV6	43	School Bus	0.04
		52	Single Unit Short-haul Truck	0.69
		53	Single Unit Long-haul Truck	0.03
		54	Motor Home	0.23
		61	Combination Short-haul Truck	0.01
11	HDGV7	43	School Bus	0.04
		52	Single Unit Short-haul Truck	0.69
		53	Single Unit Long-haul Truck	0.03
		54	Motor Home	0.23
		61	Combination Short-haul Truck	0.01
12	HDGV8A	52	Single Unit Short-haul Truck	0.90
		53	Single Unit Long-haul Truck	0.08
		61	Combination Short-haul Truck	0.02
13	HDGV8B	52	Single Unit Short-haul Truck	0.90
		53	Single Unit Long-haul Truck	0.08
		61	Combination Short-haul Truck	0.02
14	LDDV	21	Passenger Car	1.00

TABLE A3 - Population Mapping from MOBILE6.2 Vehicle Types to MOVES Source Types (Continues)

MOBILE6.2 Vehicle Type		MOVES Source Type		
ID	Name	ID	Name	Fraction
15	LDDT12	31	Passenger Truck	0.42
		32	Light Commercial Truck	0.58
16	HDDV2B	31	Passenger Truck	0.43
		32	Light Commercial Truck	0.57
17	HDDV3	31	Passenger Truck	0.43
		32	Light Commercial Truck	0.57
18	HDDV4	31	Passenger Truck	0.10
		32	Light Commercial Truck	0.90
19	HDDV5	31	Passenger Truck	0.10
		32	Light Commercial Truck	0.90
20	HDDV6	51	Refuse Truck	0.01
		52	Single Unit Short-haul Truck	0.72
		53	Single Unit Long-haul Truck	0.06
		54	Motor Home	0.07
		61	Combination Short-haul Truck	0.11
		62	Combination Long-haul Truck	0.03
21	HDDV7	51	Refuse Truck	0.01
		52	Single Unit Short-haul Truck	0.72
		53	Single Unit Long-haul Truck	0.06
		54	Motor Home	0.07
		61	Combination Short-haul Truck	0.11
		62	Combination Long-haul Truck	0.03
22	HDDV8A	51	Refuse Truck	0.02
		52	Single Unit Short-haul Truck	0.30
		53	Single Unit Long-haul Truck	0.02
		61	Combination Short-haul Truck	0.35
		62	Combination Long-haul Truck	0.31
23	HDDV8B	51	Refuse Truck	0.02
		52	Single Unit Short-haul Truck	0.30
		53	Single Unit Long-haul Truck	0.02
		61	Combination Short-haul Truck	0.35
		62	Combination Long-haul Truck	0.31
24	MC	11	Motorcycle	1.00
25	HDGB	43	School Bus	1.00
26	HDDBT	41	Intercity Bus	0.62
		42	Transit Bus	0.38
27	HDDBS	43	School Bus	1.00
28	LDDT34	31	Passenger Truck	0.42
		32	Light Commercial Truck	0.58

Appendix C1

Attachment B

(MWCOG/DEP)

Technical Support Document for the Development of MOVES2010a Inputs (Fuel Characteristics, I/M Programs, Meteorology) for 2002, 2007, 2017, and 2025

(Washington, DC-MD-VA PM2.5 Nonattainment Area)

Table of Contents

1.0 INTRODUCTION

This portion of the onroad mobile technical support document (TSD) describes in detail data and their sources and the methodologies used to develop a few inputs namely, fuel formulation, fuel supply, meteorology, and Inspection & Maintenance (I/M) Programs for the MOVES2010a model. This model was used to develop emissions inventories for the onroad mobile sources for 2002, 2007, 2017, and 2025 for PM2.5-Pri, NOx, and SO2 for the Washington, DC-MD-VA PM2.5 nonattainment area counties.

Onroad mobile emissions inventories were developed by the MWCOG Department of Transportation Planning (MWCOG/DTP) in association with the MWCOG Department of Environmental Planning (MWCOG/DEP). MWCOG/DEP provided to MWCOG/DTP four specific inputs for the MOVES2010a model. These inputs along with the other inputs developed by MWCOG/DTP (See Appendix C1-Attachment A for details of DTP input development) were used to develop emissions inventories for the four milestone years mentioned above.

1.1 DESCRIPTION OF MOVES2010a MODEL INPUTS USED FOR INVENTORY DEVELOPMENT

The emissions inventories were developed at the county level. Therefore input files for the four inputs namely, fuel formulation, fuel supply, meteorology, and Inspection & Maintenance (I/M) Programs were also developed in MOVES2010a format at the county level. The methodologies, data, and their sources are being described for each input below.

1.1.1 FUEL FORMULATION

Inputs for fuel formulation were provided by the state air agencies of the District of Columbia, Maryland, and Virginia. Four sets of input files were provided at the state level for the four milestone years, which were then applied to individual counties within the three states.

1.1.2 FUEL SUPPLY

Inputs for fuel supply were provided by the state air agencies of the District of Columbia, Maryland, and Virginia. Each state developed a single set of inputs applicable to a particular milestone year and applied that to each county within their jurisdictions. Thus each state provided four such sets for the four analysis years.

1.1.3 INSPECTION & MAINTENANCE PROGRAMS

Inputs for I/M programs were provided by the state air agencies of the District of Columbia, Maryland, and Virginia. Each state developed a single set of inputs applicable to a particular milestone year and applied that to each county within their jurisdictions. Thus each state provided four such sets for the four analysis years.

1.1.4 METEOROLOGY

Inputs for meteorology (temperature & relative humidity) were developed by MWCOG/DEP in the MOVES201 format for all Washington, DC-MD-VA PM2.5 nonattainment area counties. These inputs were the same as used in the NMIM model for developing nonroad model emissions inventories for the three milestone years (2007, 2017, 2025) of the PM2.5 maintenance plan. NMIM used county-specific default hourly average temperature and relative humidity for each of the twelve months. Meteorology data used for the 2007 analysis were also used for the 2017 and 2025 NMIM analyses. For the sake of consistency, NMIM county-specific default meteorology data for the year 2002 were also used for the 2002 MOVES2010a analysis.

Detailed information regarding the default meteorology data in the NMIM model is provided in the EPA document titled "EPA's National Inventory Model (NMIM), A Consolidated Emissions Modeling System for MOBILE6 and NONROAD, EPA420-R-05-024, page 16".