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# **SO<sub>2</sub> Redesignation Request and Maintenance Plan**

## **Appendix D**

### **MOVES Documentation**

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## **MOVES Documentation**

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The MOVES documentation included in this appendix is repeated from the “Redesignation Request and Maintenance Plan for the Liberty-Clairton, PA and Allegheny County, PA PM<sub>2.5</sub> Nonattainment Areas for the 1997/2006/2012 NAAQS, September 22, 2022.”

The PM<sub>2.5</sub> MOVES onroad mobile source inventories included SO<sub>2</sub> as a precursor to PM<sub>2.5</sub>. Emissions were generated on a countywide basis for Allegheny County for the attainment and projected years. To scale SO<sub>2</sub> emissions to the Allegheny, PA SO<sub>2</sub> nonattainment area, the population percentage of 9.8% of the countywide population was used for the SO<sub>2</sub> onroad mobile emissions for the Allegheny, PA area.

The onroad mobile SO<sub>2</sub> emissions for the Allegheny, PA area are given in the table below for the attainment (2017), interim (2026), and maintenance inventory years (2035).

<b>Allegheny, PA</b>	<b>2017 SO<sub>2</sub> (tons/year)</b>	<b>2026 SO<sub>2</sub> (tons/year)</b>	<b>2035 SO<sub>2</sub> (tons/year)</b>
Onroad Mobile Sources	4.62	2.41	2.17

See other portions of this document and appendices for more information.

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# **APPENDIX D**

## **The Allegheny County, PA Nonattainment Area PM<sub>2.5</sub> Emissions Inventory Using MOVES3**

### **Technical Support Document *Mobile Source Highway Emissions Inventory***

#### **Executive Summary**

##### **Prepared for:**

Mobile Sources Section, Bureau of Air Quality  
Pennsylvania Department of Environmental Protection

##### **Prepared by:**

Michael Baker International

**July 2022**

**Mobile Source Emissions Inventory**  
**Executive Summary**  
July 2022

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# SUMMARY

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This technical appendix supports the PM<sub>2.5</sub> State Implementation Plan (SIP) for the Allegheny County, PA nonattainment area.

To meet emission inventory requirements of section 172(c)(3) of the Clean Air Act, a regional mobile source highway inventory has been prepared for direct and precursor PM<sub>2.5</sub> emissions. Emissions are estimated for annual condition for the 2017, 2026 and 2035 analysis years.

Appendix D has been provided to summarize the methodology and analysis results for the motor vehicle emissions inventory using MOVES3. To complement this executive summary, attachments have been provided with additional detail regarding the analysis methodology, the MOVES input parameters, and the output vehicle miles of travel (VMT) and emission results for the region. These include:

## Exhibit 1: Summary of Appendices

Appendix	Title	Description
D-1	Explanation of Methodology	Provides a detailed summary of the methodology used to calculate the VMT and emissions.
D-2	(PM <sub>2.5</sub> , PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>x</sub> , VOC, and NH <sub>3</sub> ) Emission Results	Provides annual emission exhibits by county, road type, source type and process categories in 2017, 2026 and 2035.
D-3	MOVES Sample Input File	Provides examples of the MOVES input files.

## *Emissions Inventory*

A summary of the motor vehicle emissions for the Allegheny County, PA nonattainment area is provided in **Exhibit 2**. The emission estimates for all pollutants have been developed using the MOVES3 emission model and latest planning assumptions. Emissions have been estimated for the 2017, 2026 and 2035 analysis years.

## Exhibit 2: Motor Vehicle Emissions Using MOVES3 (Short Tons/Year)

Pollutants/ Year	PM <sub>2.5</sub>	PM <sub>10</sub>	SO <sub>2</sub>	NO <sub>x</sub>	VOC	NH <sub>3</sub>
2017	257	584	47	8,046	3,469	271
2026	161	605	25	3,748	1,906	229
2035	128	591	22	2,638	1,556	222

## ***Analysis Methodology***

Guidance documents from EPA were used to develop the base and future year emissions inventories for the region. They include:

- *Policy Guidance on the Use of MOVES3 for State Implementation Plan Development, Transportation Conformity, General Conformity, and Other Purposes*, US EPA Office of Transportation and Air Quality, EPA-420-B-20-044, November 2020.
- *MOVES3 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity*, US EPA Office of Transportation and Air Quality, EPA-420-B-20-052, November 2020.

The highway mobile source emission inventory was developed using available travel data and EPA's MOVES3 emission model. The methodologies used to produce the emission data conform to the recommendations provided in EPA's *Technical Guidance*. A mix of local data and national default (internal to MOVES3) data has been used for this submission. Local data has been used for the primary data items that have a significant impact on emissions. These include:

- Vehicle miles of travel (VMT) by vehicle type
- Average speed distribution
- Vehicle type mixes
- Source type population (for light-duty vehicles)
- Vehicle age distribution
- Hourly distributions
- Meteorology data
- Inspection/Maintenance program

Most local data inputs to the analysis process reflect the latest planning assumptions based on 2020 data obtained from the Pennsylvania Department of Transportation (PennDOT), the Bureau of Motor Vehicles, and other local/national sources. Available more recent data was used for control strategies (e.g. Inspection-Maintenance programs), vehicle age distributions and fuel characteristics.

The analysis methodology is consistent with past statewide inventory efforts including the 2020 National Emissions Inventory (NEI) submission. This includes the use of custom post processing software to calculate hourly speeds and prepare key traffic input files to the MOVES3 emission model. A detailed methodology is provided in **Appendix D-1**. The following sections address the key input data sources and analysis tools used for the emissions inventory.

## DATA SOURCES AND ANALYSIS TOOLS

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This section provides a summary of the key input data and analysis tools used for producing the emissions inventory. The key elements to the modeling protocol are described in the sections below. A more detailed description of the analysis process and tools is provided in the methodology reports in **Appendix D-1** through **D-3**.

### *Analysis Tools*

The mobile vehicle emissions inventory analysis utilizes several key software/programs for producing the county emissions totals. These tools are outlined in **Exhibit 3**.

**Exhibit 3: Summary of Analysis Tools**

Tool	Purpose
MOVES3	Produces emission rates for primary emissions of PM <sub>2.5</sub> and PM <sub>10</sub> and the precursor emissions of SO <sub>2</sub> , NO <sub>x</sub> , VOC and NH <sub>3</sub> .
PPSUITE	Processes the highway data; Calculates hourly congested speeds for each state roadway segment; Prepares MOVES3 input files; Processes MOVES3 output files into a summary report.
CENTRAL	Provides a batch menu driven process to execute PPSUITE, MOVES3 and other SQL steps.

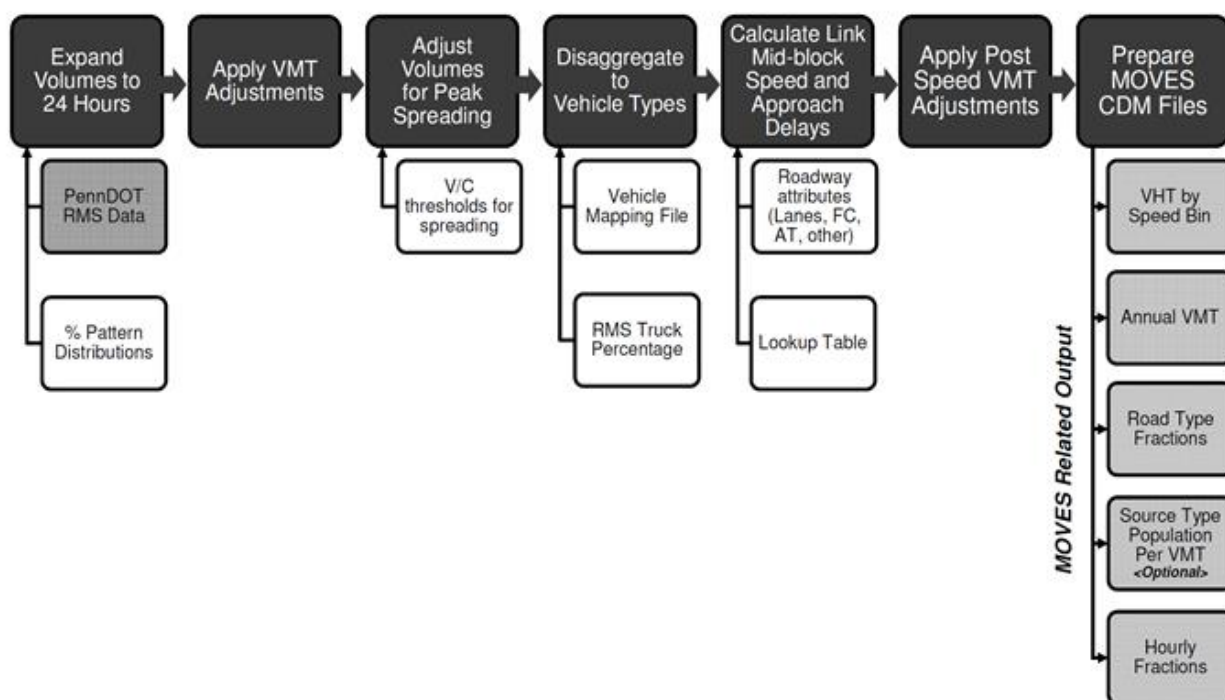
The inventory reflects the highway mobile source emission estimations using EPA's MOVES3 emission model released in November 2020. The MOVES3 model includes updated onroad emission rates for heavy duty greenhouse gas Phase 2 and Safer Affordable Fuel Efficient (SAFE) rules compared to its predecessors MOVES2014/MOVES2014a/MOVES2014b. MOVES3 has been integrated with local traffic, vehicle fleet, environmental, fuel, and control strategy data to estimate emissions.

PPSUITE represents an enhanced version of the Post Processor for Air Quality (PPAQ) software system that has been used for previous inventory and conformity submissions in Pennsylvania. The software has undergone significant revisions to ensure consistency with the MOVES3. PPSUITE was used to calculate hourly congested speeds for each roadway link, apply vehicle type fractions, aggregate VMT, prepare MOVES3 traffic-related input files and process MOVES3 outputs.

The PPSUITE software and process methodologies are consistent with that used for state inventories and transportation conformity analyses throughout Pennsylvania. **Exhibit 4** summarizes the key functions of PPSUITE.

CENTRAL is a menu-driven software platform that executes the PPSUITE and MOVES3 processes in batch mode. The software allows users to execute runs for a variety of input options and integrates custom SQL steps into the process. CENTRAL provides important quality control and assurance steps including file naming and storage automation.

## Exhibit 4: PPSUITE Process



## Traffic Data Source/Fleet Data Inputs

**Traffic Volume Data:** The PennDOT Roadway Management System (RMS) data serves as the primary highway data source for the county and functional class VMT estimates. The data source is used to provide a “snapshot” of the regional roadway system and traffic volumes in 2020 (consistent with past triennial updates of traffic data). The 2020 data is also integrated with traffic signal locations. The data includes the average annual daily traffic (AADT) volumes for all state roadways in Pennsylvania. To account for additional local roadway VMT and to ensure consistency with reported Highway Performance Monitoring System (HPMS) VMT totals, the VMT totals estimated from PennDOT’s RMS are adjusted to match the annual 2020 HPMS VMT totals, as reported to FHWA.

**Seasonal Adjustments:** Within MOVES, annual VMT is split to monthly sub-totals and then to weekdays and weekends using seasonal factors. The monthly seasonal factors are developed from data contained in the document, *2020 Pennsylvania Traffic Data*, prepared by PennDOT’s Bureau of Planning and Research (BPR). The seasonal and daily factors provided in this document are based on statistical analyses of 2019 traffic counts taken at permanent and in-pavement ATR (automatic traffic recorder) locations throughout the state.

**Congested Speeds:** Based on the average annual daily traffic, a single set of hourly speed distributions are estimated by the PPSUITE post processing system and input to MOVES. To disaggregate the daily RMS volumes to hourly volumes, auto and truck hourly pattern data from PennDOT’s *2020 Pennsylvania Traffic Data* report is used to determine the temporal variations in traffic volumes.

**Vehicle Population:** Vehicle population is a key input that has an important impact on start and evaporative emissions. MOVES3 requires the number of vehicles by 13 source types to determine evaporative emissions. Pennsylvania 2020 vehicle registration data (consistent with past triennial updates of traffic data) was used to estimate vehicle population for light-duty vehicles, school buses and transit buses for each county. The data was split to source types using MOVES default population data. For all other heavy-duty vehicles, PPSUITE calculates vehicle population based on the analysis year VMT for each source type and default MOVES3 ratios of VMT and source type population (e.g. the number of miles per vehicle by source type).

**VMT by Source Type:** The total VMT is disaggregated to the 13 MOVES source types. For this inventory, the vehicle mix was calculated for each county and functional class grouping utilizing a combination of:

- 2020 RMS truck percentages
- 2020 school bus registration data
- 2020 PennDOT transit data

EPA's MOVES default distribution of VMT by source type was used to determine the remaining source type VMT percentages. The development of vehicle type pattern data input to the MOVES3 software is described in more detail in **Appendix D-1**.

**Vehicle Age Distribution:** Vehicle age distributions are required to be input by 13 source types. The distributions reflect the percentage of vehicles in the fleet up to 31 years old. A 2020 registration download from PennDOT's Bureau of Motor Vehicles Registration Database have been used to estimate age distributions for this inventory. Due to insufficient data, only data for light-duty vehicles are used as local inputs; and, heavy-duty vehicles use the MOVES3 national default age distribution. The registration data download is based on MOBILE6.2 vehicle categories. The data was converted to source types using the EPA convertor spreadsheets provided with the MOVES emission model.

## ***Traffic Growth Assumptions***

Traffic growth forecasting plays a pivotal role in estimating future year emissions for the region. There are many uncertainties affecting projections of traffic growth including the current economic conditions, potential fuel prices, the impacts of natural gas industry activities in many counties throughout the state, and the future growth in population and employment. Growth rates for this emissions inventory were based on an assessment of available data sources including PennDOT's BPR growth rate forecasting system based on a PennDOT study originally completed in 2005 and documented in the report, *Statistical Evaluation of Projected Traffic Growth, Traffic Growth Forecasting System: Final Report, March 14, 2005*. As part of that study, a statewide traffic growth forecasting system was developed that incorporates traffic data from PennDOT's Traffic Information System and socioeconomic forecasts. That forecasting system is maintained by the PennDOT BPR and is updated on a periodic basis. This system was updated in July of 2021 to develop new statistical relationships between historic VMT growth (thru 2019) and population. The forecast population was estimated from the Woods and Poole data "2020 State Profile".

## ***Vehicle Population Growth Assumptions***

Vehicle population growth forecasting plays an important key role in determining emissions for future years for the region. For this inventory, vehicle population was forecasted considering the growth from three different sources:

- Household growth
- Population Growth

- VMT Growth

The forecast household and population were estimated from the Woods and Poole data “2020 State Profile”. The final growth rate was calculated assuming the highest growth rate of household and population data but then limiting it to the VMT growth rate. This methodology has been used for past conformity analyses and has been accepted using the interagency consultation process (Pennsylvania Air Quality Workgroup).

## ***I/M and Fuel Parameters***

**I/M Program:** The inspection maintenance (I/M) program inputs to the MOVES model are based on past and current programs within each county (all Pennsylvania I/M programs are based on county boundaries). All analysis years include Pennsylvania’s statewide program. The default I/M program parameters included in MOVES model were examined for each county and necessary changes made to the defaults to match the actual local program. The compliance factors were updated based on data provided PaDEP and 2018 I/M program performance as the latest planning assumptions and consistent with the 2020 NEI submission.

In order to assure that emission controls are working properly, vehicle inspection and maintenance (I/M) programs have been adopted in some nonattainment areas. These programs have the added benefit of improving the fuel efficiency of vehicles. The Pennsylvania inspection and maintenance (I/M) program was upgraded and expanded throughout the state with a phase-in period starting in September 2003 and fully implemented by June 2004.

The program requirements vary by region (five regions) and include on-board diagnostics (OBD) technology that uses the vehicle’s computer for model years 1996 and newer to identify potential engine and exhaust system problems that could affect emissions. The program, named PAOBDII, is implemented by region, as follows:

- *Philadelphia Region* - Bucks, Chester, Delaware, Montgomery and Philadelphia Counties
- *Pittsburgh Region* - Allegheny, Beaver, Washington and Westmoreland Counties
- *South Central and Lehigh Valley Region* - Berks, Cumberland, Dauphin, Lancaster, Lebanon, Lehigh, Northampton and York Counties
- *North Region* - Blair, Cambria, Centre, Erie, Lackawanna, Luzerne, Lycoming, and Mercer Counties

The OBDII program is implemented in Philadelphia and Pittsburgh along with tailpipe (idle in Pittsburgh and idle and ASM in Philadelphia) and gas cap tests. Tests in other regions include:

- Subject vehicles registered in the South Central and Lehigh Valley counties receive the visual, OBD and gas cap tests.
- Subject vehicles registered in the North region receive a gas cap test and visual inspection.
- Subject vehicles registered in the other 42 counties (67 total counties) receive a visual inspection as part of the annual safety inspection.

**Fuel Assumptions:** The MOVES3 default data assumptions have been reviewed and determined adequate to be used as inputs to the MOVES emissions modeling. Key input assumptions included:

- For summer months, using RVP 7.8 for analysis years 2017, and RVP 10 for analysis years 2026 and 2035.
- 100% market share of 10% ethanol throughout the year for analysis years 2017, 2026 and 2035(based on MOVES3 defaults).

## ***Meteorology Data***

Updated weather information has been obtained from AccuWeather, Inc. ([www.accuweather.com](http://www.accuweather.com)). The 10-year (2010-2020) average minimum and maximum monthly temperature and relative humidity values were obtained for each of the 10 airport locations in Pennsylvania.

The MOVES3 model requires temperature and relative humidity data for each hour of the day and for all the 12 months for the annual analysis. EPA's data converters were used to convert minimum and maximum daily temperatures to an hourly temperature profile that could be input to MOVES3. These assumptions are consistent with the 20 NEI inventory submission.

## ***Vehicle Technology Programs***

### Federal Programs

- Current federal vehicle emissions control and fuel programs are incorporated into the MOVES3 software. In addition to the federal programs included in the previous versions of MOVES (including National Program standards covering light duty vehicles through model year 2026, heavy duty greenhouse gas standards for model year 2014-2018 vehicles, and Tier 3 standards), MOVES3 incorporates the following new federal emission standard rules: *Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles – Phase 2 (HD GHG2) Rule*: MOVES3 accounts for the HD GHG2 rule published in 2016. The rule set stricter fuel economy standards for HD vehicles which reduce CO<sub>2</sub> emissions, but also impact other pollutants through changes in glider sales, hoteling activity, vehicle mass and road load coefficients.
- *Safe Affordable Fuel Efficient (SAFE) Vehicles Rule*: MOVES3 also accounts for the March 2020 SAFE standards for light-duty vehicles. These standards were less stringent than the preceding fuel economy standards, and thus increased fuel consumption and CO<sub>2</sub> emissions.

Modifications of default emission rates are required to reflect the early implementation of the National Low Emission Vehicle (NLEV) program in Pennsylvania. To reflect these impacts, EPA has released instructions and input files that can be used to model these impacts. The NLEV input database was created for Pennsylvania per EPA's instructions and was used for this inventory.

### State Programs

The Pennsylvania Clean Vehicles (PCV) Program, adopted in 1998, incorporated the California Low Emission Vehicle Program (CA LEV) by reference, although it allowed automakers to comply with the NLEV program as an alternative to this Pennsylvania program until MY 2006. Beginning with MY 2008, "new" passenger cars and light-duty trucks with a gross vehicle weight rating (GVWR) of 8,500 pounds or less that are sold or leased and titled in Pennsylvania must be certified by the California Air Resources Board (CARB) or be certified for sale in all 50 states. For this program, a "new" vehicle is a qualified vehicle with an odometer reading less than 7,500 miles. PaDEP and PennDOT worked with the automobile manufacturers, dealers and other interested business partners and finalized procedures for complying with these new requirements. DEP focuses its outreach effort with the manufacturers and dealers regarding what vehicles can be offered for sale and how to certify that the vehicles are compliant. PennDOT's role is to ensure licensing and registration records include these certifications of compliance or that the vehicle owner qualifies for an exemption to the requirements. In all cases, DEP will use information obtained during

PennDOT's title and registration process to oversee and audit, as needed, certain vehicle title transactions to determine compliance to the program.

The impacts of this program are modeled for all analysis years beyond 2008 using the same instructions and tools for the early NLEV analysis. A LEV input database was created to reflect a 2008 beginning model year for Pennsylvania.

## RESOURCES

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*2020 Pennsylvania Traffic Data*, PennDOT Bureau of Planning and Research.

Modeling Page within EPA's Office of Mobile Sources Website (<https://www.epa.gov/moves>) contains the latest version of MOVES model 44 download, MOVES users guide and other information.

*Policy Guidance on the Use of MOVES3 for State Implementation Plan Development, Transportation Conformity, General Conformity, and Other Purposes*, US EPA Office of Transportation and Air Quality, EPA-420-B-20-044, November 2020.

*MOVES3 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity*, US EPA Office of Transportation and Air Quality, EPA-420-B-20-052, November 2020.

Metrological Data from AccuWeather, Inc., [www.accuweather.com](http://www.accuweather.com)

## **APPENDIX D-1**

### **Explanation of Methodology**

**Explanation of Methodology**  
July 2022

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# INTRODUCTION

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The purpose of this document is to explain how the Pennsylvania Department of Environmental Protection (Department) estimates emissions from highway vehicles for inclusion in its emission inventories and State Implementation Plans.

## ***Overview of Emissions Inventories***

The Department's inventories generally categorize emissions into four categories:

- Highway vehicles.
- Point sources (major industrial, commercial and utility sources).
- Non-point sources (smaller industrial/commercial sources, consumer products).
- Nonroad mobile sources (including construction and agricultural equipment, lawn and garden equipment).

An evaluation of emissions from point, area, and mobile sources is needed to develop a complete inventory needed for a maintenance demonstration plan. This documentation addresses the mobile source activity and emissions for base and future years used to support such a demonstration.

Of all of the sources of air pollution, only the emissions of some stationary sources are measured directly and continuously through instrumentation. Emissions from all other sources must be modeled based on available local data, including those from highway vehicles. In their very simplest form, estimates of emissions follow the following pattern:

$$\text{Emission rate} \times \text{activity level} = \text{emissions per time period (usually day or year)}$$

Most emission rates have been developed by the U.S. Environmental Protection Agency (EPA), in cooperation with industry and states, and are compiled and documented into key references or emission models. These include Compilation of Air Pollution Emission Factors (AP-42), the Motor Vehicle Emission Simulator (MOVES) model, and the NONROAD model. Adding up the products of the emission rates and activity levels for all sources of a given pollutant constitutes the emission inventory for that pollutant.

## ***Highway Vehicle Emission Inventories***

Highway vehicles contribute significantly to air pollution, particularly to ground-level ozone, which is the most persistent air pollutant in Pennsylvania. Ground-level ozone is not emitted directly to the atmosphere, but is formed by photochemical reactions between volatile organic compounds (VOCs) and oxides of nitrogen (NO<sub>x</sub>) in the presence of sunlight. The long, hot, humid days of summer are particularly conducive to ozone formation, so ozone levels are of concern primarily during the months of May through September. Both VOCs and NO<sub>x</sub> are emitted from highway vehicles. In addition, fine particulates are also emitted directly by motor vehicles as a result of the combustion process (tailpipe emissions), re-entrained and transportation construction dust; and formed through reactions in the atmosphere among the precursors VOC, CO, NO<sub>x</sub>, NH<sub>3</sub> and SO<sub>x</sub>. Pennsylvania's PM-related emission inventory efforts focus on these pollutants.

Obviously, direct measurement of emission levels from all vehicles in use is impossible. In comparison to highway vehicles, estimating residential heating emissions is a fairly simple calculation because there

is a constant emission rate and a fairly simple measure of activity. However, for highway vehicles estimating the emission rate and activity levels of all vehicles on the road during a typical summer day is a complicated endeavor.

If every vehicle emitted the same amount of pollution all the time, one could simply multiply those emission standards (emission rate in grams of pollution per mile) times the vehicle miles traveled (VMT) to estimate total emissions. But emission rates from all vehicles vary over the entire range of conditions under which they operate. These variables include air temperature, speed, traffic conditions, operating mode and fuel characteristics. The inventory must also account for non-exhaust or evaporative emissions. In addition, the fleet is composed of several generations and types of vehicles with different emission control technologies. This requires the estimation algorithm include the composition of the fleet (vehicle ages and types).

In order to estimate both the rate at which emissions are being generated and to calculate vehicle miles traveled (activity level), Pennsylvania examines its road network and fleet to estimate vehicle activity. For ozone-related inventories, this is done for a typical summer weekday. For carbon monoxide (CO) and particulate matter (PM) emission inventories, this may be done for a typical winter weekday, summer weekday and/or annual conditions. Not only must this be done for a baseline year, but it must also be projected into the future. This process involves a large quantity of data and is extremely complex.

Computer models have been developed to perform these calculations by simulating the travel of vehicles on the Commonwealth's roadway system. The models also generate emissions rates (also called emission factors) for different vehicle types for area-specific conditions, and then combine them in summary form. The area-specific conditions include vehicle and highway data, plus control measure characteristics and future year projections of all variables. The key models used to generate this mobile source emissions inventory are:

**MOVES:** EPA's MOVES3 model, released in November 2020, was used for this mobile source inventory as approved by EPA. MOVES calculates average in-use fleet emissions for each of thirteen categories of vehicles under various conditions affecting in-use emission levels (e.g., ambient temperatures, average traffic speeds, gasoline volatility) as specified by the model user.

MOVES can be used to estimate national, state, and county level inventories of criteria air pollutants, precursors, greenhouse gas emissions, and some mobile source air toxics from highway vehicles. Additionally, MOVES can make projections for energy consumption (total, petroleum-based, and fossil-based).

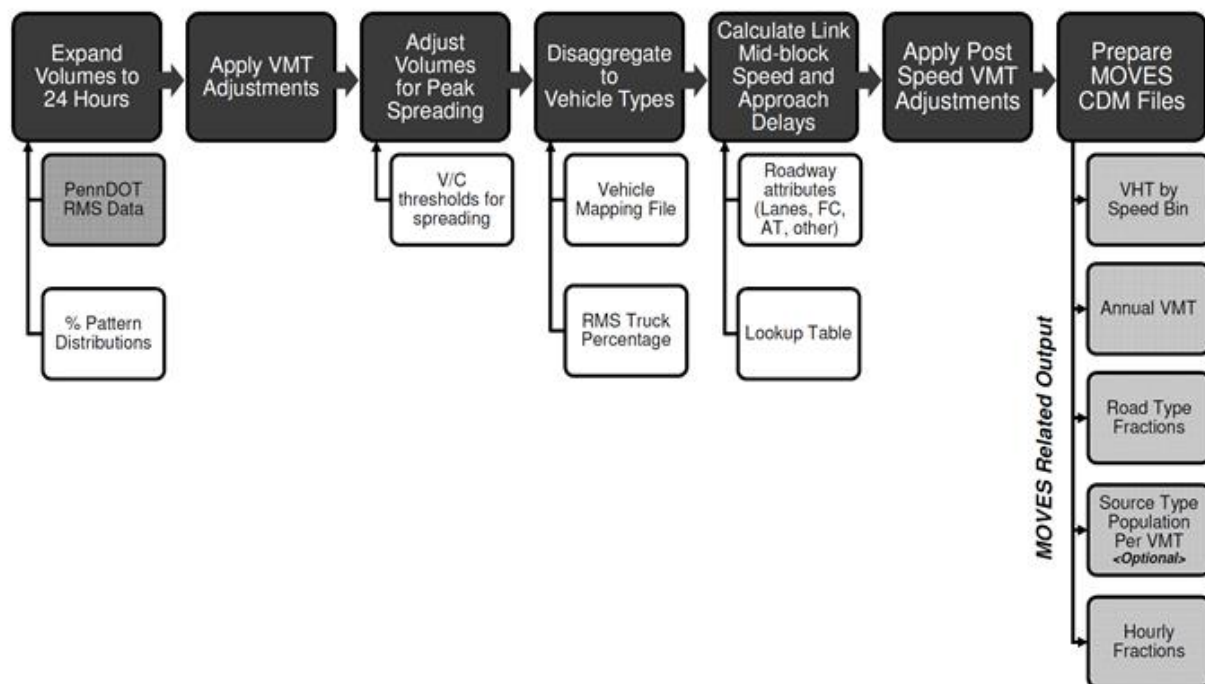
**PPSUITE:** For the Department's highway emissions inventory, a post processor named PPSUITE (formerly named PPAQ - Post Processor for Air Quality) is used, which consists of a set of programs that perform the following functions:

- Analyzes highway operating conditions.
- Calculates highway speeds.
- Compiles vehicle miles of travel (VMT) and vehicle type mix data.
- Prepares MOVES runs and processes MOVES outputs.

PPSUITE is a widely used and accepted tool for estimating speeds and processing emissions rates. The software is based upon accepted transportation engineering methodologies. For example, PPSUITE uses speed and delay estimation procedures based on planning methods provided in the *Highway Capacity Manual*, a report prepared by the Transportation Research Board (TRB) summarizing current knowledge and analysis techniques for capacity and level-of-service analyses of the transportation system.

The PPSUITE process is integral to producing key input files to the MOVES emission model. Exhibit 1 summarizes the key functions of PPSUITE and the traffic-related input files prepared for the MOVES County Data Manager (CDM).

**Exhibit 1: Summary of PPSUITE Process**



The following sections summarize the key data and methodologies used to produce the mobile source emissions inventory. This includes a summary of local data sources and a step-by-step review of the speed calculation process. The emission data and process has been developed according to recommendations provided by EPA in key policy and technical guidance as provided below:

- *Policy Guidance on the Use of MOVES3 for State Implementation Plan Development, Transportation Conformity, General Conformity, and Other Purposes*, US EPA Office of Transportation and Air Quality, EPA-420-B-20-044, November 2020.
- *MOVES3 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity*, US EPA Office of Transportation and Air Quality, EPA-420-B-20-052, November 2020.

The process has focused on developing an emissions inventory using the available tools and data to its fullest extent. This includes the use of available local data for items that have a significant impact on emissions and applying a robust calculation process to estimate hourly traffic speeds.

### *Summary of MOVES Inputs*

A mix of local and default data is used for this inventory. Local data sources are used for all inputs that have a significant impact on calculated emission rates. Exhibit 2 summarizes Pennsylvania-specific inputs assembled and used for this inventory. These data items are discussed in the following sections.

Traffic Data	Vehicle Descriptions	Fuel Parameters	Inspection Maintenance	Environmental Variables
Vehicle Type VMT	Vehicle Type Mix	RVP	Start Year Model Years	Hourly Temperatures
Vehicle Population	Vehicle Age Distribution	Sulfur Level	Test Standards, Source Types, Frequency	Humidity
VMT Fractions (PPSUITE)	Average Speeds (PPSUITE)	Ethanol Volume	Stringency, Waiver Rate, Compliance	
Road Type Distribution (PPSUITE)	Hourly Distributions	Refueling Controls		
Emission Rates				

## ***Vehicle Miles of Travel (VMT)***

The VMT input to emissions calculations for Pennsylvania is based on information from the Roadway Management System (RMS) maintained by the Pennsylvania Department of Transportation's (PennDOT's) Bureau of Planning and Research (BPR). PennDOT obtains this information from periodic visual and electronic traffic counts. RMS data is dynamic, since it is continually reviewed and updated from new traffic counts and field visits conducted by PennDOT. Information on roadways included in the National Highway System is reviewed at least annually, while information on other roadways is reviewed at least biennially.

On a triennial basis, a current "snapshot" of the RMS database is taken and downloaded to provide an up-to-date record of the Commonwealth's highway system for estimating emissions. This emissions inventory is based on the most current snapshot of the RMS data.

The RMS database contains all state highways, including the Pennsylvania Turnpike, divided into segments approximately 0.5 miles in length. These segments are usually divided at important intersections or locations where there is a change in the physical characteristics of the roadway (e.g. the number of lanes changes). There are approximately 120,000 state highway segments for the 67 Pennsylvania counties contained in the RMS. Each of these segments contains an abundance of descriptive data, but only the following information is extracted for emission calculations:

- Lanes.
- Distances.
- Volumes representing Average Annual Daily Traffic (AADT).
- Truck percentages.
- PennDOT urban/rural classifications.
- PennDOT functional class codes.
- Number of signals.

RMS volumes and distances are used in calculating highway VMT totals for each county. As discussed in the next section, adjustments are needed to convert the volumes to an average summer weekday, winter weekday, and monthly day. In addition, the traffic volumes must be forecast to support future year emission inventories. Lane values and traffic signals are an important input for determining the congestion and speeds for individual highway segments. Truck percentages are used in the speed determination process and are used to split volumes to individual vehicle types used by the MOVES software.

Road segments are classified by function, as well as whether it is located in an urban, small urban or rural area, as indicated below in Exhibit 3. The PennDOT urban/rural (UR) and functional classes (FC) are important indicators of the type and function of each roadway segment. The variables provide insights into other characteristics not contained in the RMS data that are used for speed and emission calculations.

### Exhibit 3: PennDOT Urban/Rural and Functional Class Codes

Urban/Rural Code	1=Rural 2=Small Urban 3=Urban	
Functional Class	Rural Functional Classes Used For Rural Areas	Urban Functional Classes Used For Small Urban and Urban Areas
	-----	-----
	1=Rural Freeway	11=Urban Freeway
	2=Rural Other Principal Arterial	12=Urban Expressway
	6=Rural Minor Arterial	14=Urban Principal Arterial
	7=Rural Major Collector	16=Urban Minor Arterial
	8=Rural Minor Collector	17=Urban Collector
	9=Rural Local	19=Urban Local

**Additional Network Information:** The PPSUITE software system allows for many additional variables other than those available in the RMS database. Using these variables improves the ability of the Department to incorporate real roadway conditions into its estimates. The variables include information regarding free-flow speeds and capacities, signal characteristics and other physical roadway features that can affect a roadway's calculated congested speed. This data can be determined from lookup tables based on a roadway segment's urban/rural code and functional class. Much of the lookup table data was developed from information contained in the *Highway Capacity Manual*, PennDOT information on speeds and signal densities, and other engineering judgment.

**MOVES Traffic Inputs:** The PPSUITE software uses RMS traffic data to prepare key inputs to the MOVES emission model including:

- VMT.
- Travel speeds.
- Road type distributions.

VMT is the primary traffic input that affects emission results. The roadway segment distances and traffic volumes are used to prepare estimates of VMT. PPSUITE performs these calculations and outputs the MOVES annual VMT input file to the CDM.

In MOVES, typical drive cycles and associated operating conditions vary by the type of roadway. MOVES defines five different road types as follows:

- 1 Off-Network.
- 2 Rural Restricted Access.
- 3 Rural Unrestricted Access.
- 4 Urban Restricted Access.
- 5 Urban Unrestricted Access.

The off-network road type includes emissions from vehicle starts, extended idle activity, and evaporative emissions. Off-network activity in MOVES is primarily determined by the Source Type Population input, as discussed in a following section. The remaining distribution among road types is determined by equating the PennDOT functional class with each MOVES road type as follows:

- MOVES Road Type (2) = PennDOT Functional Class (1).
- MOVES Road Type (3) = PennDOT Functional Class (2,6,7,8,9).
- MOVES Road Type (4) = PennDOT Functional Class (11,12).
- MOVES Road Type (5) = PennDOT Functional Class (14,16,17,19).

For this inventory, the MOVES road type distribution file is automatically generated by PPSUITE using the defined equivalencies.

## ***Adjustments to Roadway Data***

Before the RMS data can be used by PPSUITE for speed and emission calculations, several adjustments and additions must be made to the roadway data. These adjustments are summarized below.

**HPMS Adjustments:** According to EPA guidance, baseline inventory VMT computed from the RMS highway segment volumes must be adjusted to be consistent with Highway Performance Monitoring System (HPMS) VMT totals. The HPMS VMT reported for Pennsylvania is a subsystem of the RMS established to meet the data reporting requirements of the Federal Highway Administration (FHWA) and to serve as PennDOT's official source of highway information. Although it has some limitations, the HPMS system is currently in use in all 50 states and is being improved under FHWA direction.

Although the HPMS VMT and the roadway data used for an inventory emissions analysis are both based on data from the RMS system, differences do exist between them and include the following. First, the HPMS and inventory roadway data are "snapshots" of the RMS data taken at different times. Since the RMS is dynamic, changing constantly due to new data, differences will result between the data used for calculating HPMS VMT totals and the inventory data used for an emissions analysis. Second, since the RMS does not contain many of the local roadways, local road estimates of HPMS VMT are obtained through alternative procedures developed by PennDOT. To account for such differences, adjustment factors are calculated and used to adjust the inventory roadway data to the reported HPMS VMT totals submitted to FHWA. The VMT contained in the HPMS reports are considered to represent average annual daily traffic (AADT).

Adjustment factors are calculated which adjust the base year RMS download VMT to the reported HPMS totals for that year. These factors are developed for each county and functional class combination and are also applied to all future year runs. Adjustments for the "higher" functional classes (e.g. Freeway, Arterials - major routes) are close to 1.000 since HPMS VMT is derived from RMS information, and the only difference in the data is that the "snapshot" for the emission calculations is taken at a different time than for the HPMS. "Lower" classes (e.g. local roads) require greater adjustment since a large part of the local system is not under state jurisdiction and is not in the RMS database. There is, of course, a significant amount of local road mileage in the state. It is assumed that those local streets that are in RMS are representative of all local streets in their area with respect to volume and speed, so that roadway mileage adjustment is appropriate.

**Seasonal Adjustments to Volumes:** The RMS contains AADT volumes that are an average of all days in the year, including weekends and holidays. An ozone emission analysis, however, is based on a typical July or summer weekday. PM and CO analyses require volumes representing a typical summer weekday, winter weekday and/or annual average daily conditions (needed for producing annual totals). Therefore, the RMS volumes must be seasonally adjusted. Seasonal factors were developed for each functional class and urban/rural code based on yearly count information prepared by PennDOT's BPR. These factors are applied to the existing RMS AADT volumes to produce the July volumes. The same factors are also used to develop the MOVES daily and monthly VMT fraction files.

**Hourly Adjustments:** Speeds and emissions vary considerably depending on the time of day. Therefore, it is important to estimate the pattern by which roadway volume varies by hour of the day. The 24-hour pattern data provides PPSUITE with information used to split the daily roadway segment volumes to each of the 24 hours in a day. Pattern data is in the form of a percentage of the daily volumes for each hour. Distributions are provided for each county and functional class grouping. This data is developed from 24-hour count data compiled by PennDOT's BPR, according to the process in the agencies annual traffic data reports. The same factors are also used to develop the MOVES hourly fraction file.

**Traffic Volume Forecasts:** Traffic growth forecasting plays a pivotal role in estimating future year emissions for the region. There are many uncertainties affecting projections of traffic growth, including the current economic conditions, potential fuel prices, the impacts of Marcellus Shale activities in many counties throughout the state, and the future growth in population and employment. Growth rates for the Department's emissions inventories are based on an assessment of available data sources which include:

- PennDOT BPR growth rate forecasting system.
- Regional travel model, if available.

All SIP mobile source highway inventories include the review and assessment of county-specific growth rates from a PennDOT study originally completed in 2005 and documented in the report, *Statistical Evaluation of Projected Traffic Growth, Traffic Growth Forecasting System: Final Report, March 14, 2005*. As part of that study, a statewide traffic growth forecasting system was developed that incorporates traffic data from PennDOT's Traffic Information System and socioeconomic forecasts. That forecasting system is maintained by the PennDOT BPR and is updated on a periodic basis to develop new statistical relationships between historic VMT growth and population and updated demographic forecasts from Woods and Poole, Inc. The growth rates from the PennDOT BPR forecasting system are evaluated against other available data including travel model growth and other insights.

## ***Vehicle Type Processing***

Emission rates within MOVES vary significantly by the type of vehicle. The MOVES model produces emissions and rates by thirteen MOVES vehicle source types. However, VMT is input to MOVES by five HPMS vehicle groups. Exhibit 4 summarizes the distinction between each classification scheme.

The process used for this inventory includes a method to disaggregate the RMS traffic volumes to the thirteen source types and then to recombine the estimates to the five HPMS vehicle classes. Vehicle type pattern data is used by PPSUITE to divide the hourly roadway segment volumes to the thirteen MOVES source types. Similar to the 24-hour pattern data, this data contains percentage splits to each source type for every hour of the day. The vehicle type pattern data for this inventory is developed from several sources of information:

- PennDOT truck percentages from the RMS database.
- Hourly distributions for trucks and total traffic compiled by PennDOT's BPR.
- Transit data from PennDOT.
- School bus registration data from PennDOT's Bureau of Motor Vehicles Registration Database.

The vehicle type pattern data is developed for each county and functional class combination. First, RMS truck percentages are averaged for all roadways within a county and functional class grouping. Using this percentage data, the total roadway volume for any segment is divided to auto and truck vehicle type categories. The transit data and school bus data is used to further disaggregate trucks, resulting in four vehicle groups (light-duty, school, transit, and other heavy-duty).

#### Exhibit 4: MOVES Source Types and HPMS Vehicle Groups

<u>SOURCE TYPES</u>		<u>HPMS Class Groups</u>	
11	Motorcycle	10	Motorcycle
21	Passenger Car	25	Light Duty Vehicles
31	Passenger Truck	40	Buses
32	Light Commercial Truck	50	Single Unit Trucks
41	Intercity Bus	60	Combination Trucks
42	Transit Bus		
43	School bus		
51	Refuse Truck		
52	Single Unit Short-haul Truck		
53	Single Unit Long-haul Truck		
54	Motor Home		
61	Combination Short-haul Truck		
62	Combination Long-haul Truck		

From these groups, MOVES default Pennsylvania county VMT distributions by source type are used to divide the four groups into each of the MOVES source types. PennDOT hourly distributions for trucks and total traffic are used to create source type percentage breakdowns for each hour of the day.

**Vehicle Type Capacity Analysis Factors:** Vehicle type percentages are provided to the capacity analysis section of PPSUITE to adjust the speeds in response to trucks. That is, a given number of larger trucks take up more roadway space than a given number of cars, and this is accounted for in the speed estimation process by adjusting capacity using information from the *Highway Capacity Manual*.

#### ***Vehicle Fleet and Population Data***

The information on the vehicle fleet including the number and age of vehicles has a significant impact on forecasted start and evaporative emissions within MOVES. The MOVES Model requires the population of vehicles by the thirteen source type categories. Pennsylvania county vehicle registration data is used to estimate vehicle population for light-duty vehicles, school buses and transit buses. The data is split to source types using MOVES3 default Pennsylvania county population data. Other heavy-duty vehicle population values are based on VMT for each source type using the vehicle mix and pattern data discussed previously. The PPSUITE software automatically applies default MOVES3 ratios of VMT and source type population (e.g. the number of miles per vehicle by source type) to the local VMT estimates to produce vehicle population for heavy duty trucks.

Vehicle population is forecast based on projected household and population growth from Woods and Poole Inc. for each Pennsylvania county. The growth rate methodology includes:

- Choosing the highest growth rate between population and households.
- Limiting growth as to not exceed the VMT growth assumptions.

**Vehicle Age:** Vehicle age distributions are input to MOVES for each county by the thirteen source types. The distributions reflect the percentage of vehicles in the fleet up to 31 years old. The most recent available registration download from PennDOT's Bureau of Motor Vehicles Registration Database has been used for the inventory. Due to insufficient data, only information for light-duty vehicles are used as

local inputs; and, heavy-duty vehicles use the MOVES3 national default age distribution. The registration data download is based on MOBILE6.2 vehicle categories. As a result, the data was converted to source types using the EPA convertor spreadsheets provided with the MOVES model.

### ***Environmental, Fuel and Technology Assumptions***

Information on environmental, fuel, vehicle technology and other control strategy assumptions were determined based on a review of MOVES3 default information by the PaDEP.

**Fuel Parameters:** The same vehicle will produce different emissions using a different type of gasoline. Fuel control strategies can be powerful emission reduction mechanisms. The MOVES3 default fuel formulation and fuel supply data were reviewed and determined adequate to be used as inputs to the MOVES emissions modeling.

**Refueling Emissions:** MOVES also allows users to calculate refueling emissions, the emissions created when vehicles are refueled at service stations. Pennsylvania includes refueling emissions in its area source inventory and not in its highway vehicle inventory. Refueling emissions are not included in the highway emissions inventory.

**Vehicle Emission Inspection/Maintenance (I/M) Parameters:** MOVES allows users to vary inputs depending on the I/M program in place for the area. The inputs include:

- Program start year and first and last model years subject to the program
- Waiver and compliance rates and stringency level
- Program type (test-only, test-and-repair, etc.) and effectiveness
- Frequency of inspection (annual, biennial) and vehicle type coverage
- Test type (idle, loaded, etc.)

The MOVES default Pennsylvania assumptions were reviewed and modifications were made per actual program parameters.

**Environmental Variables:** Ambient temperature and humidity are known to have a significant impact on most pollutant processes for on-road vehicles. In MOVES, temperature and humidity affect emissions through three mechanisms: 1) direct effect via a temperature adjustment on emission rates; 2) direct effect via a humidity correction factor for NO<sub>x</sub>; 3) indirect effect via an air conditioning adjustment for which temperature and relative humidity are used to populate a heat index which in turn is used to calculate the fraction of vehicle fleet with air conditioning turned on. Hourly temperatures have been compiled for each county based on information from AccuWeather, Inc. to specify temperatures from nine airports within the state. Ozone analysis temperature and humidity values were determined using the procedures documented in EPA's technical guidance. Minimum and maximum temperatures for each month were converted to hourly temperatures using EPA convertors supplied with the MOVES model.

A summary of the MOVES related inputs used for the inventory and future year estimates are attached with the submission.

## **SPEED/EMISSION ESTIMATION PROCEDURE**

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The previous sections have summarized the input data used for computing speeds and emissions for Pennsylvania. This section explains how PPSUITE and MOVES uses that input data to produce emission estimates. Exhibit 5 summarizes PPSUITE's analysis procedure used for each of the RMS highway segments in the state.

Producing an emissions inventory with PPSUITE requires a process of disaggregation and aggregation. Data is available and used on a very small scale -- individual ½ mile roadway segments 24 hours of the day. This data needs to be processed individually to determine the distribution of vehicle hours of travel (VHT) by speed and then aggregated by vehicle class to determine input VMT to the MOVES emission model.

### ***Volume/VMT Development***

Before speeds can be calculated and MOVES run, volumes acquired from RMS must be adjusted and disaggregated. Such adjustments include factoring to future years, seasonal adjustments, and disaggregating daily volumes to each hour of the day and to each of the thirteen MOVES source types.

**Determine Future Year Volumes:** The RMS database contains up-to-date current year volumes. However, to conduct a future year analysis, these volumes must be factored to the year being analyzed. Growth factors have been prepared for each county and functional class grouping. These growth factors are applied to the base year RMS volumes to obtain future year estimates that can be utilized by PPSUITE. For this base year inventory, forecasting was not required.

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#### **Example:**

A typical freeway link in the RMS database is I-80 segment 2500 in Luzerne County, Pennsylvania. This link has an urban/rural code=1 which indicates the link is in a rural area, and a functional class=1 indicating a rural freeway.

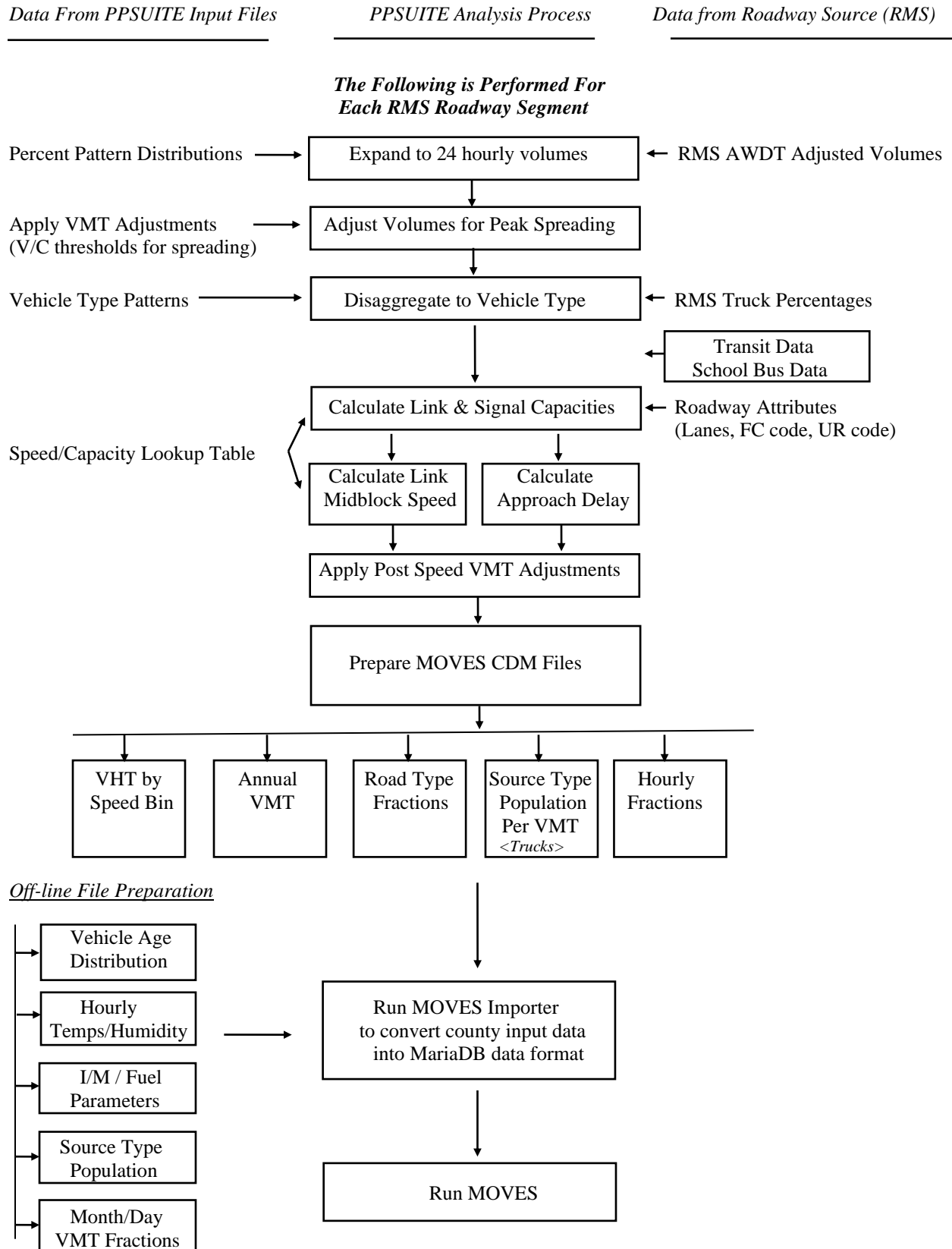
The average annual daily traffic (AADT) from the RMS database for this link in 2008 is 12,077 vehicles/day.

Growth factors have been developed to factor the 2008 volume to future years. For example, to factor the 2008 volume to the year 2014, a growth factor of 1.282 would yield:

2014 volume = 12,077 vehicles/day x 1.282 = 15,483 vehicles/day

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## Exhibit 5: PPSUITE Speed / Emission Estimation Procedure



**Seasonal Adjustments:** PPSUITE takes the input daily volumes from RMS (which represents annual average daily traffic (AADT)) and seasonally adjusts the volumes to an average weekday in July. This adjustment utilizes factors developed for each functional class and urban/rural code. VMT can then be calculated for each link using the adjusted weekday volumes.

---

**Example:**

Again, assume the rural freeway link: I-80 segment 2500 in Luzerne County, Pennsylvania. The AADT for this link in 2008 is 12,077 vehicles/day.

Seasonal factors have been developed for urban/rural code and functional class combinations. For an urban/rural code=1 and a functional class=1, the factor to convert from AADT to an average weekday in July is = 1.15.

Average Weekday July Volume =  $12,077 \times 1.15 = 13,889$  vehicles/day.

Total VMT (daily) for this link is calculated as volume x distance. The distance of this link as obtained from RMS is 0.296 miles.

2008 VMT =  $13,889 \text{ vehicles/day} \times 0.296 \text{ miles} = 4,111 \text{ vehicle-miles / day}$ .

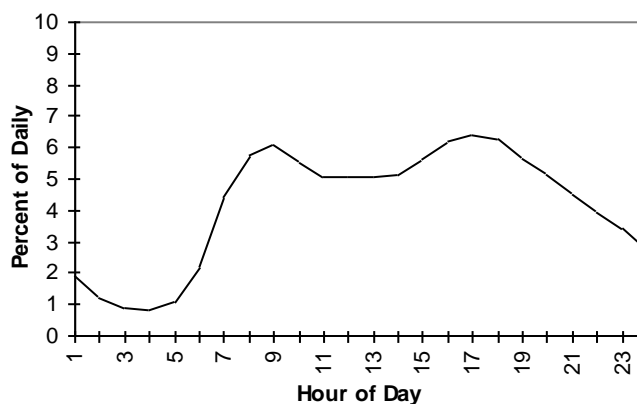
---

**Disaggregation to 24 Hours:** After seasonally adjusting the link volume, the volume is split to each hour of the day. This allows for more accurate speed calculations (effects of congested hours) and allows PPSUITE to prepare the hourly VMT and speeds for input to the MOVES model.

---

**Example:**

To support speed calculations and emission estimates by time of day, the July weekday volume is disaggregated to 24 hourly volumes. Temporal patterns were previously developed from PennDOT count data and input to PPSUITE. For the I-80 rural freeway link with morning peak volumes similar to evening peak hours (neutral), the following temporal pattern is applied:



Using the I-80 segment, typical hourly volumes which result include:

8-9 a.m.	$6.0\% \times (4,111 \text{ vehicle miles} / 0.296\text{mi.}) = 833 \text{ vehicles/hour (vph)}$
12-1 p.m.	$5.0\% \times (4,111 \text{ vehicle .miles} / 0.296\text{mi.}) = 694 \text{ vph}$
5-6 p.m.	$6.3\% \times (4,111 \text{ vehicle miles} / 0.296\text{mi.}) = 875 \text{ vph}$

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After dividing the daily volumes to each hour of the day, PPSUITE identifies hours that are unreasonably congested. For those hours, PPSUITE then spreads a portion of the volume to other hours within the same peak period, thereby approximating the “peak spreading” that normally occurs in such over-capacity conditions.

**Disaggregation to Vehicle Type:** EPA requires VMT estimates to be prepared by source type, reflecting specific local characteristics. As a result, for Pennsylvania’s emission inventory runs, the hourly volumes are disaggregated to the thirteen MOVES source types based on count data assembled by PennDOT in combination with MOVES defaults.

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**Example:**

Disaggregation of the total I-80 VMT to the various source types would include the following:

Total Volume 8-9 am = 833 vph

Source Type Volume 8-9 am:

Motorcycle	11	0.5%	4 vph
Passenger Car	21	54.7%	456 vph
Passenger Truck	31	27.9%	232 vph
Light Commercial Truck	32	9.3%	78 vph
Intercity Bus	41	0.1%	1 vph
Transit Bus	42	0.1%	1 vph
School bus	43	0.1%	1 vph
Refuse Truck	51	0.0%	0 vph
Single Unit Short-haul Truck	52	2.2%	19 vph
Single Unit Long-haul Truck	53	0.3%	2 vph
Motor Home	54	0.1%	1 vph
Combination Short-haul Truck	61	1.9%	16 vph
Combination Long-haul Truck	62	2.6%	22 vph

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## ***Speed/Delay Determination***

EPA recognizes that the estimation of vehicle speeds is a difficult and complex process. Because emissions are so sensitive to speeds, it recommends special attention be given to developing reasonable and consistent speed estimates; it also recommends that VMT be disaggregated into subsets that have roughly equal speed, with separate emission factors for each subset. At a minimum, speeds should be estimated separately by road type.

The computational framework used for this analysis meets and exceeds that recommendation. Speeds are individually calculated for each roadway segment and hour and include the delays encountered at signals. Rather than accumulating the roadway segments into a particular road type and calculating an average speed, each individual link hourly speed is represented in the MOVES vehicle hours of travel (VHT) by speed bin file. This MOVES input file allows the specification of a distribution of hourly speeds.

For example, if 5% of a county’s arterial VHT operates at 5 mph during the AM peak hour and the remaining 95% operates at 65 mph, this can be represented in the MOVES speed input file. For the model runs, distributions of speeds are input to MOVES by road type and source type by each hour of the day; VMT and VHT is accumulated by the same groupings for the application of the emission factors to produce resulting emission totals.

To calculate speeds, PPSUITE first obtains initial capacities (how much volume the roadway can serve before heavy congestion) and free-flow speeds (speeds assuming no congestion) from the speed/capacity lookup data. As described in previous sections, this data contains default roadway information indexed by the urban/rural code and functional class. For areas with known characteristics, values can be directly coded to the RMS database and the speed/capacity data can be overridden. However, for most areas where known information is not available, the speed/capacity lookups provide valuable default information regarding speeds, capacities, signal characteristics, and other capacity adjustment information used for calculating congested delays and speeds. An effort has been made to enhance the RMS data with traffic signal locations using other GIS signal data available from PennDOT's Bureau of Highway Safety and Traffic Engineering.

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**Example:**

The speed/capacity lookup table is used to obtain important data used for link speed calculations. For the I-80 link with an urban/rural code = 1 (rural) and a functional class = 1 (freeway), the lookup table provides information including the following:

freelfow speed = 65 mph  
capacity = 1800 vph per lane  
number of signals = 0 (per RMS linkage to GIS traffic signal locations)

This information is used along with the physical characteristics of the roadway to calculate the delay (including congestion) to travel this link during each hour of the day:

For example: The I-80 link is calculated to have a travel time, including delay of 17.76 seconds for the 8-9am hour.

Total travel time, in vehicle hours, for the 8-9am hour is calculated as:

$$\text{VHT (8-9am)} = 17.76 \text{ seconds} \times 833\text{vph} / 3600 \text{ sec/hr} = 4.12 \text{ vehicle hours.}$$

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The result of this process is an estimated average travel time for each hour of the day for each highway segment. The average time can be multiplied by the volume to produce vehicle hours of travel (VHT).

## ***HPMS and VMT Adjustments***

Volumes must also be adjusted to account for differences with the HPMS VMT totals, as described previously. VMT adjustment factors are provided as input to PPSUITE, and are applied to each of the roadway segment volumes. These factors were developed from the latest HPMS download (conducted triennially); however, they are also applied to any future year runs. The VMT added or subtracted to the RMS database assumes the speeds calculated using the original volumes for each roadway segment for each hour of the day.

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**Example:**

Using the Luzerne County I-80 rural freeway link example, the daily assigned volume is adjusted to account for reconciliation with the HPMS VMT. RMS VMT (in AADT) for Luzerne County rural freeways totals 962,559 vehicle miles in 2008. HPMS VMT (in AADT) as supplied by PennDOT and reported to FHWA totals to 990,088 vehicle miles for the rural freeways. A factor is developed by dividing the HPMS VMT by the RMS VMT:

HPMS adjustment factor for Luzerne County rural freeways =  $990,088 / 962,559 = 1.029$ .

This factor is held constant in all future years. As an example, this adjustment is made to the I-80 freeway link VMT for the 8-9am hour after speed calculations are made, and produces the final July weekday VMT for this hour used for Ozone runs.

I-80 Link VMT (8-9am) =  $833\text{vph} \times 0.296 \text{ miles} \times 1.029 = 254 \text{ vehicle miles/hour}$ .

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## ***MOVES Emissions Run***

After computing speeds and aggregating VMT and VHT, PPSUITE prepares traffic-related inputs needed to run EPA's MOVES software, which is used to estimate emission factors in grams of pollutant per vehicle mile and to produce total emissions based on input VMT to the model. The process uses MOVES3, the latest officially released emissions model that was obtained directly from EPA.

The MOVES inputs prepared by PPSUITE include the following:

- Vehicle Type VMT.
- Vehicle Population.
- VMT fractions.
- Average speed distributions.
- Road Type Distribution.

These files are text formatted files with a \*.csv extension. The files are provided as inputs within the MOVES county data importer. In addition the remaining MOVES input data including temperatures, I/M programs, fuel and vehicle ages are prepared manually outside of the PPSUITE process.

The MOVES county importer is run in batch mode. This program converts all data files into the MariaDB formats used by the MOVES model. At that point a MOVES run specification file (\*.mrs) is created which specifies options and key data locations for the run. MOVES is then executed in batch mode.

MOVES can be executed using either the *inventory* or *rate-based* approaches. For this highway emissions inventory, MOVES is applied using the *inventory-based* approach. Under this method, actual VMT and population are provided as inputs to the model; MOVES is responsible for producing the total emissions for the region. Under the rate-based approach, MOVES would produce emission factors, after which PPSUITE would apply the emission factors to the link data and calculate total regional emissions.

## RESOURCES

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### **MOVES model**

Modeling Page within EPA's Office of Mobile Sources Website (<https://www.epa.gov/moves>) contains the latest version of MOVES model to download, MOVES users guide and other information.

*Policy Guidance on the Use of MOVES3 for State Implementation Plan Development, Transportation Conformity, General Conformity, and Other Purposes*, US EPA Office of Transportation and Air Quality, EPA-420-B-20-044, November 2022.

*MOVES3 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity*, US EPA Office of Transportation and Air Quality, EPA-420-B-20-052, November 2020.

### **Traffic Engineering**

*Highway Capacity Manual*, Transportation Research Board, presents current knowledge and techniques for analyzing the transportation system.

*2020 Pennsylvania Traffic Data*, PennDOT Bureau of Planning and Research.

## Highway Vehicle Inventory Glossary

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*AADT:* Average Annual Daily Traffic, average of ALL days.

*AWDT:* Average Weekday Daily Traffic.

*Basic emission rates:* MOBILE emission rates based on the applicable Federal emission standards and the emission control technologies characterizing the fleet in various model years.

*Emission rate or factor:* Expresses the amount of pollution emitted per unit of activity. For highway vehicles, usually in grams of pollutant emitted per mile driven.

*FC:* Functional code, applied in data management to road segments to identify their type (freeway, local, etc.).

*Fuel volatility:* The ability of fuel components to evaporate, thus entering the atmosphere as pollution. Fuel volatility is usually measured as Reid Vapor Pressure (RVP) in pounds per square inch. The lower the RVP, the less volatile the fuel.

*Growth factor:* Factor used to convert volumes to future years.

*HPMS:* Highway Performance Monitoring System, PENNDOT's official source of highway information and a subset of RMS.

*I/M:* Vehicle emissions inspection/maintenance programs ensure that vehicle emission controls are in good working order throughout the life of the vehicle. The programs require vehicles to be tested for emissions. Most vehicles that do not pass must be repaired.

*MOBILE:* The model EPA has developed and which Pennsylvania uses to estimate emissions from highway vehicles.

*MOVES:* The latest model EPA has developed with which Pennsylvania uses to estimate emissions from highway vehicles.

*Pattern data:* Extrapolations of traffic patterns (such as how traffic volume on road segment types varies by time of day, or what kinds of vehicles tend to use a road segment type) from segments with observed data to similar segments.

*PPSUITE:* Post-Processor for Air Quality, a set of programs that estimate speeds and processes MOBILE emission rates.

*RMS:* Roadway Management System, a database maintained by PENNDOT from traffic counts and field visits.

*Segment (also referred to as link):* Division of roadway in the PENNDOT Roadway Management System. Usually represents 0.5 mile segments of roadway.

*UR:* Urban/rural code, applied in data management to identify whether a road segment is urban, small urban or rural.

*VHT:* Vehicle hours traveled.

*VMT:* Vehicle miles traveled. In modeling terms, it is the simulated traffic volumes times link length.

*Vehicle Type:* One of eight types, distinguished primarily by fuel type and/or weight, used in MOBILE modeling.

*Source Type:* One of thirteen types, distinguished primarily by weight, used in MOVES modeling.

*Road Type:* Functional code, applied in data management to road segments to identify their type (rural/urban highways, rural/urban arterials, etc.)

*County Data Manager:* User interface developed to simplify importing specific local data for a single county or a user-defined custom domain without requiring direct interaction with the underlying MariaDB database.

## **APPENDIX D-2**

### **Allegheny County, PA Nonattainment Area Emission Summary Tables**

#### **Appendix D-2-1**

##### **2017 Annual Emissions**

*Emission Summary*  
*Emission Summary by Road Type*  
*Emission Summary by Source Type*  
*Emission Summary by Process*

#### **Appendix D-2-2**

##### **2026 Annual Emissions**

*Emission Summary*  
*Emission Summary by Road Type*  
*Emission Summary by Source Type*  
*Emission Summary by Process*

#### **Appendix D-2-3**

##### **2035 Annual Emissions**

*Emission Summary*  
*Emission Summary by Road Type*  
*Emission Summary by Source Type*  
*Emission Summary by Process*

**Appendix D-2-1**  
**2017 Allegheny County, PA Nonattainment Area Emission Summary**  
**Annual (Tons/Year)**

County	VMT	Speed (mph)	PM2.5	PM10	SO2	NOx	VOC	NH3
Allegheny	8,266,734,599	30.0	257.4	583.9	47.2	8,045.8	3,468.5	270.5

**Appendix D-2-1**  
**2017 Allegheny County, PA Nonattainment Area Emission Summary by Road Type**  
**Annual (Tons/Year)**

County	Road Type	VTM	Speed (mph)	PM2.5	PM10	SO2	NOx	VOC	NH3
Allegheny	Off-Network	-	N/A	42.80	47.72	4.92	1,222.44	2,209.66	21.86
	Rural Restricted Access	0	N/A	0.00	0.00	0.00	0.00	0.00	0.00
	Rural Unrestricted Access	432,707,400	50.4	9.74	20.16	2.08	348.41	53.85	13.20
	Urban Restricted Access	2,814,732,091	57.6	67.74	117.60	13.16	2,620.59	329.53	87.91
	Urban Unrestricted Access	5,019,295,107	31.9	137.10	398.37	27.04	3,854.38	875.50	147.58
	<b>Total</b>	<b>8,266,734,599</b>		<b>257.4</b>	<b>583.9</b>	<b>47.2</b>	<b>8,045.8</b>	<b>3,468.5</b>	<b>270.5</b>

**Appendix D-2-1**  
**2017 Allegheny County, PA Nonattainment Area Emission Summary by Source Type**  
**Annual (Tons/Year)**

County	Sourcetype	VMT		PM2.5		PM10		SO2		NOx		VOC		NH3	
		Miles	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Allegheny	Motorcycle	53,393,338	0.6%	1.29	0.5%	2.32	0.4%	0.27	0.6%	42.29	0.5%	129.53	3.7%	2.47	0.9%
	Passenger Car	4,203,224,775	50.8%	36.85	14.3%	168.46	28.9%	20.39	43.2%	712.83	8.9%	962.92	27.8%	108.70	40.2%
	Passenger Truck	2,735,406,602	33.1%	57.52	22.3%	154.51	26.5%	17.97	38.1%	2,598.27	32.3%	1,585.64	45.7%	109.78	40.6%
	Light Commercial Truck	699,321,971	8.5%	22.90	8.9%	49.51	8.5%	4.71	10.0%	908.79	11.3%	481.82	13.9%	28.04	10.4%
	Intercity Bus	582,886	0.0%	0.12	0.0%	0.20	0.0%	0.00	0.0%	3.49	0.0%	0.28	0.0%	0.03	0.0%
	Transit Bus	38,045,501	0.5%	9.23	3.6%	12.85	2.2%	0.30	0.6%	363.15	4.5%	32.65	0.9%	1.63	0.6%
	School Bus	16,478,209	0.2%	4.86	1.9%	6.64	1.1%	0.08	0.2%	99.50	1.2%	14.32	0.4%	0.53	0.2%
	Refuse Truck	7,945,411	0.1%	2.28	0.9%	3.36	0.6%	0.06	0.1%	59.45	0.7%	4.15	0.1%	0.33	0.1%
	Single Unit Short-haul Truck	174,624,229	2.1%	22.72	8.8%	36.45	6.2%	1.08	2.3%	536.58	6.7%	102.34	3.0%	7.17	2.7%
	Single Unit Long-haul Truck	10,387,540	0.1%	1.10	0.4%	1.91	0.3%	0.06	0.1%	26.18	0.3%	3.75	0.1%	0.41	0.2%
	Motor Home	16,423,558	0.2%	3.04	1.2%	4.73	0.8%	0.17	0.4%	81.88	1.0%	26.22	0.8%	0.84	0.3%
	Combination Short-haul Truck	75,330,701	0.9%	19.12	7.4%	29.60	5.1%	0.50	1.1%	561.66	7.0%	27.38	0.8%	2.72	1.0%
	Combination Long-haul Truck	235,569,878	2.8%	76.37	29.7%	113.32	19.4%	1.60	3.4%	2,051.74	25.5%	97.56	2.8%	7.90	2.9%
	<b>Total</b>	<b>8,266,734,599</b>	<b>100.0%</b>	<b>257.4</b>	<b>100.0%</b>	<b>583.9</b>	<b>100.0%</b>	<b>47.2</b>	<b>100.0%</b>	<b>8,045.8</b>	<b>100.0%</b>	<b>3,468.5</b>	<b>100.0%</b>	<b>270.5</b>	<b>100.0%</b>

**Appendix D-2-1**  
**2017 Allegheny County, PA Nonattainment Area Emission Summary by Process**  
**Annual (Tons/Year)**

County	Process	PM2.5		PM10		SO2		NOx		VOC		NH3	
		Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Allegheny	Running Exhaust	158.09	61.4%	173.18	29.7%	45.18	95.8%	7,114.98	88.4%	1,026.82	29.6%	270.07	99.8%
	Start Exhaust	26.74	10.4%	30.20	5.2%	1.98	4.2%	843.23	10.5%	1,091.79	31.5%	0.00	0.0%
	Brakewear	32.22	12.5%	257.73	44.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Tirewear	14.14	5.5%	94.24	16.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Permeation	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	250.18	7.2%	0.00	0.0%
	Evap Fuel Vapor Venting	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	500.52	14.4%	0.00	0.0%
	Evap Fuel Leaks	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	548.43	15.8%	0.00	0.0%
	Crankcase Running Exhaust	24.03	9.3%	26.13	4.5%	0.00	0.0%	16.47	0.2%	27.00	0.8%	0.00	0.0%
	Crankcase Start Exhaust	0.26	0.1%	0.29	0.0%	0.00	0.0%	0.05	0.0%	14.46	0.4%	0.00	0.0%
	Crankcase Extended Idle Exhaust	0.46	0.2%	0.50	0.1%	0.00	0.0%	0.32	0.0%	0.67	0.0%	0.00	0.0%
	Extended Idle Exhaust	1.42	0.6%	1.55	0.3%	0.02	0.0%	70.18	0.9%	8.63	0.2%	0.48	0.2%
	Auxiliary Power Exhaust	0.03	0.0%	0.03	0.0%	0.00	0.0%	0.58	0.0%	0.05	0.0%	0.00	0.0%
	<b>Total</b>	<b>257.4</b>	<b>100.0%</b>	<b>583.9</b>	<b>100.0%</b>	<b>47.2</b>	<b>100.0%</b>	<b>8,045.8</b>	<b>100.0%</b>	<b>3,468.5</b>	<b>100.0%</b>	<b>270.5</b>	<b>100.0%</b>

**Appendix D-2-2**  
**2026 Allegheny County, PA Nonattainment Area Emission Summary**  
**Annual (Tons/Year)**

County	VMT	Speed (mph)	PM2.5	PM10	SO2	NOx	VOC	NH3
Allegheny	8,659,512,983	26.5	161	605	25	3,748	1,906	229

**Appendix D-2-2**  
**2026 Allegheny County, PA Nonattainment Area Emission Summary by Road Type**  
**Annual (Tons/Year)**

County	Road Type	VTM	Speed (mph)	PM2.5	PM10	SO2	NOx	VOC	NH3
Allegheny	Off-Network	N/A	N/A	33.99	38.22	2.54	757.22	1,357.90	20.64
	Rural Restricted Access	0	N/A	0.00	0.00	0.00	0.00	0.00	0.00
	Rural Unrestricted Access	37,547,302	43.1	0.44	1.72	0.09	12.13	1.96	0.89
	Urban Restricted Access	3,279,271,795	48.7	37.75	129.21	7.92	1,245.83	159.36	82.06
	Urban Unrestricted Access	5,342,693,886	28.3	88.44	436.10	14.01	1,733.20	386.65	125.12
	<b>Total</b>	<b>8,659,512,983</b>		<b>160.6</b>	<b>605.2</b>	<b>24.6</b>	<b>3,748.4</b>	<b>1,905.9</b>	<b>228.7</b>

**Appendix D-2-2**  
**2026 Allegheny County, PA Nonattainment Area Emission Summary by Source Type**  
**Annual (Tons/Year)**

County	Sourcetype	VMT		PM2.5		PM10		SO2		NOx		VOC		NH3	
		Miles	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Allegheny	Motorcycle	55,479,338	0.6%	1.36	0.8%	2.73	0.5%	0.14	0.6%	38.15	1.0%	123.44	6.5%	2.70	1.2%
	Passenger Car	3,570,600,237	41.2%	36.17	22.5%	181.49	30.0%	7.59	30.9%	202.63	5.4%	487.33	25.6%	80.95	35.4%
	Passenger Truck	3,890,857,448	44.9%	62.19	38.7%	237.88	39.3%	11.60	47.3%	958.10	25.6%	1,018.38	53.4%	107.18	46.9%
	Light Commercial Truck	457,680,378	5.3%	9.61	6.0%	31.06	5.1%	1.45	5.9%	174.03	4.6%	137.17	7.2%	13.30	5.8%
	Intercity Bus	12,407,497	0.1%	0.85	0.5%	2.85	0.5%	0.08	0.3%	44.76	1.2%	2.89	0.2%	0.52	0.2%
	Transit Bus	57,240,116	0.7%	2.58	1.6%	8.39	1.4%	0.38	1.5%	184.79	4.9%	14.95	0.8%	2.41	1.1%
	School Bus	26,271,509	0.3%	2.07	1.3%	4.90	0.8%	0.12	0.5%	67.77	1.8%	6.17	0.3%	0.84	0.4%
	Refuse Truck	1,930,912	0.0%	0.20	0.1%	0.51	0.1%	0.01	0.1%	8.25	0.2%	0.68	0.0%	0.09	0.0%
	Single Unit Short-haul Truck	198,877,484	2.3%	8.11	5.0%	26.90	4.4%	0.87	3.5%	312.24	8.3%	54.02	2.8%	7.42	3.2%
	Single Unit Long-haul Truck	13,206,940	0.2%	0.57	0.4%	1.85	0.3%	0.06	0.2%	19.08	0.5%	1.77	0.1%	0.49	0.2%
	Motor Home	7,060,834	0.1%	0.89	0.6%	1.82	0.3%	0.05	0.2%	21.66	0.6%	6.12	0.3%	0.30	0.1%
	Combination Short-haul Truck	69,497,973	0.8%	5.96	3.7%	17.88	3.0%	0.42	1.7%	296.31	7.9%	11.25	0.6%	2.53	1.1%
	Combination Long-haul Truck	298,402,317	3.4%	30.05	18.7%	86.98	14.4%	1.79	7.3%	1,420.61	37.9%	41.71	2.2%	9.99	4.4%
	<b>Total</b>	<b>8,659,512,983</b>	<b>100.0%</b>	<b>160.6</b>	<b>100.0%</b>	<b>605.2</b>	<b>100.0%</b>	<b>24.6</b>	<b>100.0%</b>	<b>3,748.4</b>	<b>100.0%</b>	<b>1,905.9</b>	<b>100.0%</b>	<b>228.7</b>	<b>100.0%</b>

**Appendix D-2-2**  
**2026 Allegheny County, PA Nonattainment Area Emission Summary by Process**  
**Annual (Tons/Year)**

County	Process	PM2.5		PM10		SO2		NOx		VOC		NH3	
		Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Allegheny	Running Exhaust	59.12	36.8%	65.18	10.8%	23.56	96.0%	3,191.01	85.1%	316.82	16.6%	228.17	99.8%
	Start Exhaust	28.47	17.7%	32.16	5.3%	0.97	3.9%	476.28	12.7%	557.64	29.3%	0.00	0.0%
	Brakewear	48.77	30.4%	390.16	64.5%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Tirewear	16.37	10.2%	109.15	18.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Permeation	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	108.69	5.7%	0.00	0.0%
	Evap Fuel Vapor Venting	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	247.06	13.0%	0.00	0.0%
	Evap Fuel Leaks	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	649.22	34.1%	0.00	0.0%
	Crankcase Running Exhaust	6.93	4.3%	7.54	1.2%	0.00	0.0%	28.43	0.8%	15.68	0.8%	0.00	0.0%
	Crankcase Start Exhaust	0.24	0.1%	0.27	0.0%	0.00	0.0%	0.02	0.0%	7.01	0.4%	0.00	0.0%
	Crankcase Extended Idle Exhaust	0.27	0.2%	0.29	0.0%	0.00	0.0%	0.46	0.0%	0.55	0.0%	0.00	0.0%
	Extended Idle Exhaust	0.39	0.2%	0.43	0.1%	0.02	0.1%	47.92	1.3%	2.94	0.2%	0.54	0.2%
	Auxiliary Power Exhaust	0.07	0.0%	0.08	0.0%	0.00	0.0%	4.25	0.1%	0.26	0.0%	0.00	0.0%
	<b>Total</b>	<b>160.6</b>	<b>100.0%</b>	<b>605.2</b>	<b>100.0%</b>	<b>24.6</b>	<b>100.0%</b>	<b>3,748.4</b>	<b>100.0%</b>	<b>1,905.9</b>	<b>100.0%</b>	<b>228.7</b>	<b>100.0%</b>

**Appendix D-2-2**  
**2035 Allegheny County, PA Nonattainment Area Emission Summary**  
**Annual (Tons/Year)**

County	VMT	Speed (mph)	PM2.5	PM10	SO2	NOx	VOC	NH3
Allegheny	9,018,014,459	26.4	128	591	22	2,638	1,556	222

**Appendix D-2-2**  
**2035 Allegheny County, PA Nonattainment Area Emission Summary by Road Type**  
**Annual (Tons/Year)**

County	Road Type	VMT	Speed (mph)	PM2.5	PM10	SO2	NOx	VOC	NH3
Allegheny	Off-Network	N/A	N/A	30.21	34.08	2.46	640.32	1,177.36	19.98
	Rural Restricted Access	0	N/A	0.00	0.00	0.00	0.00	0.00	0.00
	Rural Unrestricted Access	39,096,855	43.3	0.32	1.63	0.08	7.71	1.33	0.87
	Urban Restricted Access	3,693,320,833	48.3	28.52	133.21	7.66	875.13	117.68	86.03
	Urban Unrestricted Access	5,285,596,771	27.8	68.76	421.75	11.96	1,114.90	259.28	115.41
	<b>Total</b>	<b>9,018,014,459</b>		<b>127.8</b>	<b>590.7</b>	<b>22.2</b>	<b>2,638.1</b>	<b>1,555.7</b>	<b>222.3</b>

**Appendix D-2-2**  
**2035 Allegheny County, PA Nonattainment Area Emission Summary by Source Type**  
**Annual (Tons/Year)**

County	Sourcetype	VMT		PM2.5		PM10		SO2		NOx		VOC		NH3	
		Miles	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Allegheny	Motorcycle	57,634,112	0.6%	1.42	1.1%	2.84	0.5%	0.15	0.7%	39.07	1.5%	125.07	8.0%	2.91	1.3%
	Passenger Car	3,709,283,549	41.1%	34.45	27.0%	185.33	31.4%	6.81	30.7%	127.22	4.8%	420.46	27.0%	82.10	36.9%
	Passenger Truck	4,041,975,855	44.8%	51.26	40.1%	232.77	39.4%	10.34	46.6%	337.97	12.8%	806.33	51.8%	99.03	44.6%
	Light Commercial Truck	475,449,799	5.3%	6.70	5.2%	28.56	4.8%	1.30	5.9%	58.85	2.2%	100.18	6.4%	12.36	5.6%
	Intercity Bus	12,528,357	0.1%	0.48	0.4%	2.47	0.4%	0.07	0.3%	36.53	1.4%	2.26	0.1%	0.52	0.2%
	Transit Bus	61,254,086	0.7%	1.78	1.4%	7.95	1.3%	0.37	1.7%	165.49	6.3%	12.83	0.8%	2.54	1.1%
	School Bus	28,700,964	0.3%	0.94	0.7%	3.91	0.7%	0.12	0.5%	53.25	2.0%	3.28	0.2%	0.93	0.4%
	Refuse Truck	2,065,296	0.0%	0.07	0.1%	0.38	0.1%	0.01	0.1%	6.62	0.3%	0.60	0.0%	0.09	0.0%
	Single Unit Short-haul Truck	213,401,950	2.4%	5.20	4.1%	25.12	4.3%	0.84	3.8%	265.58	10.1%	42.24	2.7%	7.86	3.5%
	Single Unit Long-haul Truck	14,181,023	0.2%	0.35	0.3%	1.70	0.3%	0.05	0.2%	15.49	0.6%	1.14	0.1%	0.52	0.2%
	Motor Home	7,272,156	0.1%	0.54	0.4%	1.51	0.3%	0.05	0.2%	13.14	0.5%	3.06	0.2%	0.28	0.1%
	Combination Short-haul Truck	74,517,489	0.8%	4.53	3.5%	17.23	2.9%	0.39	1.8%	276.19	10.5%	9.52	0.6%	2.69	1.2%
	Combination Long-haul Truck	319,749,822	3.5%	20.09	15.7%	80.89	13.7%	1.66	7.5%	1,242.66	47.1%	28.68	1.8%	10.45	4.7%
	<b>Total</b>	<b>9,018,014,458</b>	<b>99.9%</b>	<b>127.8</b>	<b>100.0%</b>	<b>590.7</b>	<b>100.0%</b>	<b>22.2</b>	<b>100.0%</b>	<b>2,638.1</b>	<b>100.0%</b>	<b>1,555.7</b>	<b>100.0%</b>	<b>222.3</b>	<b>100.0%</b>

**Appendix D-2-2**  
**2035 Allegheny County, PA Nonattainment Area Emission Summary by Process**  
**Annual (Tons/Year)**

County	Process	PM2.5		PM10		SO2		NOx		VOC		NH3	
		Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Allegheny	Running Exhaust	27.97	21.9%	30.95	5.2%	21.08	95.1%	2,177.06	82.5%	158.83	10.2%	221.86	99.8%
	Start Exhaust	27.95	21.9%	31.57	5.3%	1.07	4.8%	389.74	14.8%	462.80	29.7%	0.00	0.0%
	Brakewear	51.29	40.1%	410.34	69.5%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Tirewear	17.10	13.4%	113.98	19.3%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Permeation	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	48.65	3.1%	0.00	0.0%
	Evap Fuel Vapor Venting	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	187.06	12.0%	0.00	0.0%
	Evap Fuel Leaks	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	678.56	43.6%	0.00	0.0%
	Crankcase Running Exhaust	2.94	2.3%	3.20	0.5%	0.00	0.0%	29.35	1.1%	12.01	0.8%	0.00	0.0%
	Crankcase Start Exhaust	0.22	0.2%	0.25	0.0%	0.00	0.0%	0.01	0.0%	5.61	0.4%	0.00	0.0%
	Crankcase Extended Idle Exhaust	0.16	0.1%	0.18	0.0%	0.00	0.0%	0.37	0.0%	0.39	0.0%	0.00	0.0%
	Extended Idle Exhaust	0.15	0.1%	0.16	0.0%	0.02	0.1%	33.79	1.3%	1.39	0.1%	0.43	0.2%
	Auxiliary Power Exhaust	0.03	0.0%	0.03	0.0%	0.01	0.0%	7.73	0.3%	0.35	0.0%	0.00	0.0%
	<b>Total</b>	<b>127.8</b>	<b>100.0%</b>	<b>590.7</b>	<b>100.0%</b>	<b>22.2</b>	<b>100.0%</b>	<b>2,638.1</b>	<b>100.0%</b>	<b>1,555.7</b>	<b>100.0%</b>	<b>222.3</b>	<b>100.0%</b>

## **APPENDIX D-3**

### **Allegheny County, PA MOVES Sample Input Files**

# Annual MOVES Run Specification File Settings

## Sample xml file format

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<moves>
  <importer mode="county" >
    <filters>
      <geographicselections>
        <geographicselection type="COUNTY" key="42003" description="PENNSYLVANIA - Allegheny County"/>
      </geographicselections>
    </importer>
    <timespan>
      <year key="2017"/>
      <month id="00"/>
      <day id="2"/>
      <day id="5"/>
      <beginhour id="1"/>
      <endhour id="24"/>
      <aggregateBy key="Hour"/>
    </timespan>
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      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="62" sourcetyponame="Combination Long-haul Truck"/>
      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="61" sourcetyponame="Combination Short-haul Truck"/>
      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="41" sourcetyponame="Intercity Bus"/>
      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="32" sourcetyponame="Light Commercial Truck"/>
      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="54" sourcetyponame="Motor Home"/>
      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="11" sourcetyponame="Motorcycle"/>
      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="21" sourcetyponame="Passenger Car"/>
      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="31" sourcetyponame="Passenger Truck"/>
      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="51" sourcetyponame="Refuse Truck"/>
      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="43" sourcetyponame="School Bus"/>
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      <onroadvehiclessselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="42" sourcetyponame="Transit Bus"/>
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      <onroadvehiclessselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="61" sourcetyponame="Combination Short-haul Truck"/>
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  </moves>
```

```

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        <onroadvehicselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="54" sourcetyname="Motor Home"/>
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        <onroadvehicselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="43" sourcetyname="School Bus"/>
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    </offroadvehiclesccs>
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        <roadtype roadtypeid="2" roadtyname="Rural Restricted Access"/>
        <roadtype roadtypeid="3" roadtyname="Rural Unrestricted Access"/>
        <roadtype roadtypeid="4" roadtyname="Urban Restricted Access"/>
        <roadtype roadtypeid="5" roadtyname="Urban Unrestricted Access"/>
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    </imcoverage>
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            </FuelSupply>
            <FuelFormulation>
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            </FuelUsageFraction>
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  <parts>
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</sourcetypepopulation>

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    </hpmsVTypeYear>
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```

```

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  <parts>
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  </parts>
</generic>
</importer>
</moves>

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---

## Sample mrs file format

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  </models>
<modelscale value="Inv"/>
<modeldomain value="SINGLE"/>
<geographicselections>
  <geographicselection type="COUNTY" key="42003" description="Allegheny County, PA (42003)"/>
</geographicselections>
<timespan>
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<month id="2"/>
<month id="3"/>
<month id="4"/>
<month id="5"/>
<month id="6"/>
<month id="7"/>
<month id="8"/>
<month id="9"/>

```

```

<month id="10"/>
<month id="11"/>
<month id="12"/>
<day id="5"/>
    <beginhour id="1"/>
    <endhour id="24"/>
<aggregateBy key="Hour"/>
    </timespan>
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<onroadvehiclesselction fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="21" sourcetyponame="Passenger Car"/>`
<onroadvehiclesselction fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="31" sourcetyponame="Passenger Truck"/>
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```



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