Development of 2023 Default Onroad Activity Data

for the National Emissions Inventory

July 2025

U.S. Environmental Protection Agency

Office of Air and Radiation

Office of Air Quality Planning and Standards

Air Quality Assessment Division

Contacts:

Janice Godfrey, Alison Eyth

TABLE OF CONTENTS

Introduction

The default 2023 National Emissions Inventory (2023NEI) vehicle miles traveled (VMT) activity data are developed primarily from information provided directly by the Federal Highway Administration (FHWA), along with the FHWA's published Highway Statistics 2023 and data from the U.S. Census Bureau. Additionally, some data came from the 2023 Standard and Poors Global (S&P Global) state vehicle registration database. Default VMT in units of annual millions of vehicle miles traveled were developed at the county, road type, vehicle type, and fuel type level of detail, to be used in the 2023NEI in areas for which no state or local agency provided VMT activity data. The vehicle types used were the thirteen MOVES5 source (vehicle) types (see Table 1). The road types included were the four MOVES5 roadway types (see Table 2). The fuel types were the five onroad MOVES5 fuel types (see Table 3) according to the allowable vehicle modeling combinations (see Table 4).

Data used to generate EPA default data

The 2023 VMT data were developed using data supplied directly by FHWA as well as publicly available data from the 2023 version of FHWA's Highway Statistics data series, which can be found at the following Web site: http://www.fhwa.dot.gov/policyinformation/statistics/2023/.

The Highway Statistics data used in the VMT development include:

- Table VM-2, "Functional System Travel - Annual Vehicle-Miles," and
- Table VM-4, "Distribution of Annual Vehicle Distance Traveled."

The publicly available VM-2 table contains state-level summaries of 2023 miles of annual travel in each state by Highway Performance Monitoring System (HPMS) road type. VM-2 road types include interstate, other freeways/expressways, other principal arterial, minor arterial, major/minor collector, and local for both urban and rural areas. The FHWA was able to provide HPMS VM-2 data at the county level directly to the EPA for most road types. However, not all road types were available at the county level from the FHWA. The road types not available at the county level were rural minor collector, rural local, and urban local.

Table VM-4 contains state-level distribution of annual vehicle distance traveled, expressed by the percentage of vehicle miles traveled by HPMS vehicle type for both rural and urban road type groupings. These grouping fractions were applied to all counties in their respective state to produce VMT by HPMS road type and vehicle type.

U.S. Census population estimates were also used in developing default VMT. This included estimates of 2023 population by county. A ratio of county population to state population was developed for each county in the U.S. to distribute state-level VM-2 VMT data to a county level for road types where the FHWA county-level data were not available. U.S. Census data is available from the following Web site: https://www.census.gov/data/tables.html.

S&P Global vehicle population data were used to apportion the VMT from HPMS vehicle type to MOVES source type, and also to fuel type.

For the 2023NEI, vehicle population (VPOP) was derived from county-level 2023 S&P Global data.

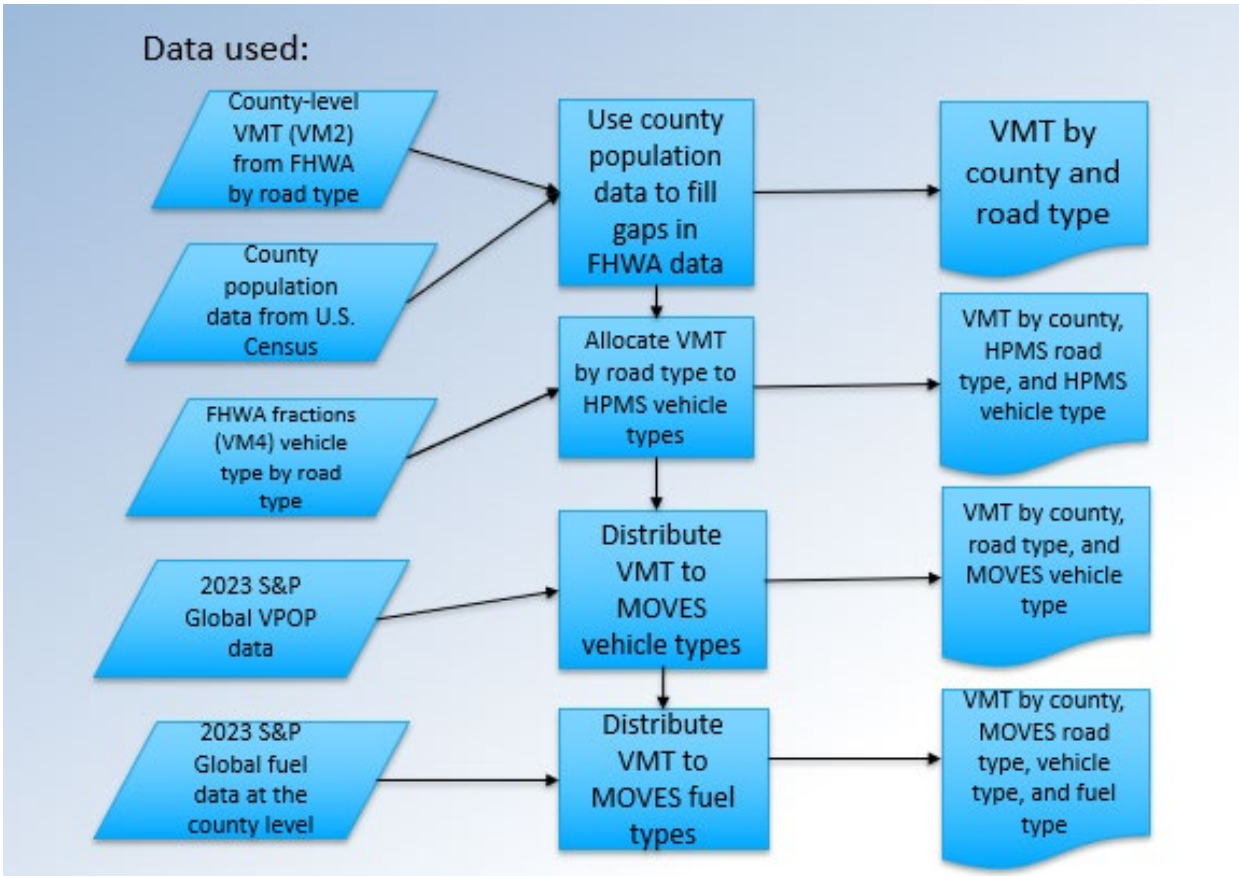
Development procedures for VMT and VPOP datasets

The procedures used in the development of the 2023 NEI default VMT are broken down into five parts (see Figure 1):

1. FHWA *Highway Statistics* VM-2 county-level VMT, along with VM-2 state-level VMT and county-level human population data from U.S. Census used to fill in gaps in FHWA VM-2 county-level data;
2. To allocate county-level VMT by HPMS road type to HPMS vehicle type the *Highway Statistics* Table VM-4 was used to develop VMT by county, HPMS road type, and HPMS vehicle type;
3. To distribute VMT to MOVES source types the S&P Global year 2023 vehicle population data were used to develop VMT by county, HPMS road type, and MOVES source (vehicle) type;
4. HPMS road types were combined to the four MOVES3 road types to develop VMT by county, MOVES source type, and MOVES road type; and
5. VMT was distributed to the MOVES fuel types using fractions derived from the S&P Global vehicle population data to develop the final VMT by county, MOVES source type, MOVES road type, and MOVES fuel type.

Each of these steps in the development of the 2023 VMT is discussed separately below.

Figure 1. Overview of 2023 NEI default VMT development



2023 County-level VMT by HPMS Road Type

Highway Performance Maintenance System (HPMS) VM-2 county-level data from the FHWA contains the majority of the road types of interest. However, rural minor collectors and rural and urban locals (HPMS types RminCOLL, RLOC, and ULOC) were not available. For these missing road types, the HPMS VM-2 (state-level), Functional System Travel - Annual Vehicle-Miles (http://www.fhwa.dot.gov/policyinformation/statistics/2023/) and 2023 county-level U.S. Census data https://www.census.gov/data/tables.html were used to fill in VMT for missing road types as follows:

$$2023\ state\ VMT * (county\ population)/(state\ population) = county\ VMT$$

2023 County-level VMT by HPMS Road Type and Vehicle Type

To allocate the county-level VMT by Highway Performance Maintenance System (HPMS) road type to HPMS vehicle type, the Table VM-4, Distribution of Annual Vehicle Distance Traveled (http://www.fhwa.dot.gov/policyinformation/statistics/2023/) was used to apportion 2023 county-level VMT by HPMS road type to HPMS vehicle type as follows:

*HPMS vehicle type fraction * county VMT by road type =county VMT by HPMS road type and vehicle type*

2023 County-level VMT by HPMS Road Type and MOVES5 Source Type

For this step, HPMS vehicle types were mapped to MOVES5 source types. The table below illustrates the mapping of the HPMS vehicle types to the MOVES5 source types:

Table 1. MOVES5 onroad source types

MOVES sourceType ID	MOVES Source Type Name	HPMSVTypeID	Description
11	Motorcycles	10	Motorcycles
21	Passenger Cars	25	Light-Duty Vehicles
31	Passenger Trucks	25	Light-Duty Vehicles
32	Light Commercial Trucks	25	Light-Duty Vehicles
41	Other Buses (non-school non-transit)	40	Buses
42	Transit Buses	40	Buses
43	School Buses	40	Buses
51	Refuse Trucks	50	Single Unit Trucks
52	Single Unit Short-Haul Trucks	50	Single Unit Trucks
53	Single Unit Long-Haul Trucks	50	Single Unit Trucks
54	Motor Homes	50	Single Unit Trucks
61	Combination Short-Haul Trucks	60	Combination Trucks
62	Combination Long-Haul Trucks	60	Combination Trucks

In order to further refine HPMSVType, the EPA used data compiled from 2023 state vehicle registration data from S&P Global to develop county-level fractions to break down:

*2023 HPMSVTypeID VMT * county-level S&P Global fraction = county VMT by HPMS road type and MOVES source type*

Thus, the source types are allocated in the same proportion as they were found in the county-level 2023 S&P Global data.

2023 County-level VMT by MOVES3 Road Type, Source Type, and Fuel Type

To assign VMT from the FHWA functional types to the MOVES5 road types, VMT was combined by the following table:

Table 2. MOVES5 road types

roadTypeID	Description	FHWA Functional Types
1	Off Network	Off Network
2	Rural Interstate	Rural Interstate & Rural Freeway/Expressway
3	Rural Unrestricted Access	Rural Principal Arterial, Minor Arterial, Major Collector, Minor Collector & Local
4	Urban Restricted Access	Urban Interstate & Urban Freeway/Expressway
5	Urban Unrestricted Access	Urban Principal Arterial, Minor Arterial, Major Collector, Minor Collector & Local

The four MOVES road types (2-5) are thus aggregations of FHWA functional types.

2023 County-level VMT by HPMS Road Type, MOVES5 Source Type and Fuel Type

To assign VMT to fuel type, the EPA used fuel fraction data from year 2023 S&P Global vehicle population databases for each MOVES source type. Fuel fractions were calculated at the county level for light-duty vehicles as follows:

$$\textit{county VMT by MOVES road type and MOVES source type} * \textit{county-level fuel fraction} = \textit{county VMT by MOVES road type, source type, and fuel type}$$

For heavy-duty vehicles, we found that some source types were not reported at the county level in some counties, even though it is likely that those source types travel those areas. Therefore, it was determined to apply fuel fractions averaged at the state level to the heavy-duty vehicle types as follows:

$$\textit{county VMT by MOVES road type and MOVES source type} * \textit{state-level fuel fraction} = \textit{county VMT by MOVES road type, source type, and fuel type}$$

MOVES5 fuel types and the matrix of allowable source type-fuel type combinations are shown in tables 3 and 4.

Table 3. MOVES5 fuel types

fuelTypeID	Description
1	Gasoline
2	Diesel Fuel
3	Compressed Natural Gas (CNG)
5	Ethanol (E-85) Capable
9	Electricity (Electric and Fuel Cell)

Table 4. Matrix of allowable source type-fuel type combinations in MOVES5

	Motorcycles (11)	Passenger cars (21)	Passenger trucks (31)	Light comm. Trucks (32)	Other buses (41)	Transit buses (42)	School buses (43)	Refuse trucks (51)	Short-haul SUTs (52)	Long-haul SUTs (53)	Motor homes (54)	Comb. short-haul trucks (61)	Comb. long-haul trucks (62)
fuelTypeID													
Gasoline (1)	X	X	X	X	X	X	X	X	X	X	X	X	
Diesel (2)		X	X	X	X	X	X	X	X	X	X	X	X
CNG (3)					X	X	X	X	X	X	X	X	X
E85-Capable (5)		X	X	X									
Electricity (9)		X	X	X	X	X	X	X	X	X	X	X	X

References

Highway Statistics Table VM-2 “Functional System Travel – 2023; Annual Vehicle-Miles”, http://www.fhwa.dot.gov/policyinformation/statistics/2023/.

Highway Statistics Table VM-4 “Distribution of Annual Vehicle Distance Traveled”, http://www.fhwa.dot.gov/policyinformation/statistics/2023/.

United States Census Bureau, “County Population Totals and Components of Change: 2020-2024,” https://www.census.gov/data/tables.html.