Technical Memorandum

Low RVP Fuel Removal

Mobile Source Emissions (VOC and NOx)

October 2016

By Ohio Environmental Protection Agency

In Coordination with the OKI, MVRPC and ODOT

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1. Overview

This memorandum is intended to document the U.S. EPA MOVES-based mobile source air quality analyses performed by Ohio EPA for the Cincinnati area (Butler, Clermont, Hamilton and Warren counties) and Dayton area (Clark, Greene, Miami and Montgomery counties). These analyses were conducted in support of the removal of low Reid vapor pressure (RVP) fuel requirements in these areas.

The inventory includes area-based, annual totals of volatile organic compound (VOC) and oxides of nitrogen (NOx) emissions for the year 2017.

Latest Planning Assumptions

The mobile source emission estimates meet the latest planning assumption requirement by using the latest approved version of MOVES at the time emissions modeling began, which is MOVES2014a with default databases dated October 28, 2015. In addition, the input data for the MOVES runs is based on the latest available planning emission inputs. The input data and model run specification were developed in accordance with the latest MOVES technical guidance, which is "MOVES2014 and MOVES2014a Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity", EPA-420-B-15-093, November 2015.

As discussed in Section 2 of this report, travel demand forecast modeling (TDFM) data from the Cincinnati area metropolitan planning organization (MPO), which is the Ohio Kentucky Indiana Regional Council of Governments (OKI) and the Dayton area MPOs, which are the Miami Valley Regional Planning Commission (MVRPC) and the Clark County Springfield Transportation Coordinating Committee (CCSTCC), was used to develop MOVES input files. The TDFM is calibrated using the latest population and land-use data available and is validated with actual traffic count data. Currently, the data are validated to 2005 and 2010.

On Road Mobile Source Emissions Inventory Summary

Tables 1 and 2 present a summary of emissions for the Cincinnati and Dayton areas, respectively, for VOC and NOx emissions for calendar year 2017. The remainder of this document focuses on the assumptions behind the analyses.

Table 1 – Cincinnati Area Emissions

Fuel Scenario	NOx (TPY)	VOC (TPY)
RVP 8.8*	12,773.96	10,733.49
RVP 9.7	12,790.29	10,749.32
Total Emissions Benefit of Low RVP (RVP 9.7 - RVP 8.8)	16.33	15.83

* includes special provision allowing 1 psi exceedance of RVP limit for gasoline containing 10% ethanol per OAC rule 3745-72-07

Table 2 – Dayton Area Emissions

Fuel Scenario	NOx (TPY)	VOC (TPY)
RVP 8.8*	9,260,45	6,773.04
RVP 9.7	9,274.37	6,789.05
Total Emissions Benefit of Low RVP (RVP 9.7 - RVP 8.8)	13.93	16.01

* includes special provision allowing 1 psi exceedance of RVP limit for gasoline containing 10% ethanol per OAC rule 3745-72-07

2. Urban Travel Demand Models

CCSTCC and MVRPC maintain regional travel demand forecasting models for use in the urban transportation planning process. This Cube Voyager model employs the traditional four step modeling process to project existing and future traffic volumes and travel patterns on the regional transportation networks. The four step process consists of trip generation, trip distribution, modal split, and route assignment. Output from the model is link-by-link directional 24-hour traffic volumes for the existing or future regional transportation networks.

The OKI Travel Demand Model Version 8.0 was used to estimate vehicle miles traveled and vehicle hours. The OKI Travel Demand Model utilizes the Citilabs CUBE transportation modeling platform and includes a series of CUBE Voyager programs written by OKI. It is a state of the practice model that uses the standard four phase sequential modeling approach of trip generation, distribution, modal choice and assignment. The model uses demographic and land use data and capacity and free-flow speed characteristics for each roadway segment in the network to produce a “loaded” highway network with forecasted traffic volumes with revised speeds based on specified speed/capacity relationships. A variety of socioeconomic data items are used in the OKI transportation planning process. These data are used primarily to forecast future travel patterns by serving as independent variables in OKI trip generation equations.

Landuse and Socio-economic Data

The areas' socio-economic model variables reflect the current and expected future regional land uses as best known to staff.

Socio-economic variables, such as population and households, were developed for all areas based on 2010 Census data and Ohio Development Services Agency (ODSA) population projections.

3. Emission Estimate Generation

Using MOVES, tons per year emission estimates were generated for 2017. As noted above, the input data and model run specification were developed in accordance with the latest MOVES technical guidance, which is "MOVES2014 and MOVES2014a Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity", EPA-420-B-15-093, November 2015.

Technical Details

Table 3 summarizes the settings used in the MOVES run specification file and the MOVES County-Data Manager. Further information about specific inputs that are not using default values is also discussed below.

Table 3 – MOVES Inputs

RunSpec Parameter Settings	
MOVES Version	MOVES2014a default database 20151028
Scale	County
MOVES Modeling Technique	Inventory
Time Span	Time Aggregation: Hour All months All hours of day selected Weekdays and weekends
Geographic Bounds	Custom Domains for Cincinnati and Dayton areas
Vehicles/Equipment	All source types, gasoline, diesel, CNG and electricity
Road Type	All road types including off-network
Pollutants and Processes	VOC and NOx including prerequisite pollutants
General Output	Units = pounds, joules and miles
Output Emissions	Time = Year, Location = zone
Advance Performance	None

County Data Manager Sources	
Source Type Population	Local data from motor vehicle registration. Default data used for source types 41, 51, 54, 61 and 62. Future year growth rate based on TDFM's household growth rates.
Vehicle Type VMT	Combination of local and default data HPMSVTypeYear VMT = daily VMT from travel demand model monthVMTFraction = default dayVMTFraction = default hourVMTFraction = local from travel demand model
I/M Program	No I/M program
Fuel Formulation	Default for existing RVP 8.8 emissions. Default used in all other areas of the state for RVP 9.7 emissions.
Fuel Supply	Default for existing RVP 8.8 emissions. Default used in all other areas of the state for RVP 9.7 emissions.
Meteorology Data	Local data obtained from National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center for Cincinnati/Northern Kentucky International Airport for Cincinnati area and Dayton International Airport for Dayton area.
Ramp Fraction	Travel Demand Forecast Model
Road Type Distribution	Travel Demand Forecast Model
Age Distribution	Local data from motor vehicle registration. Default data used for source types 41, 51, 54, 61 and 62.
Average Speed Distribution	ODOT data for urban roads and default data for rural roads.

Fuel Formulation and Fuel Supply

For existing fuels used in the Cincinnati and Dayton areas, which include low RVP fuel used during the ozone season, MOVES default fuel formulation and fuel supply data was used for the Cincinnati and Dayton areas. This data is included in Tables 4 and 5. For the proposed removal of low RVP fuel, default fuel formulation and fuel supply data from all other areas of the state was applied to the Cincinnati and Dayton areas. Tables 6 and 7 contain this proposed fuel supply and fuel formulation data.

As can be seen in Table 5, the low RVP fuels are Fuel Formulation IDs 3479 for RVP 8.8 (includes special provision allowing 1 psi exceedance of RVP limit for gasoline containing 10% ethanol per OAC rule 3745-72-07) and 3481 for RVP 7.8. These fuels are used during the months of May to September (Month Group IDs 5 to 9), as included in Table 4. For the RVP 8.8 fuel scenario in the emission summary Tables 1 and 2, the fuel data in Tables 4 and 5 were used in MOVES.

For the proposed removal of low RVP fuel, as can be seen in Table 7, the "regular summer" fuels are Fuel Formulation IDs 3470 for RVP 9.7 and 3472 for RVP 8.7. These fuels are used during the months of May to September (Month Group IDs 5 to 9), as included in Table 6. For the RVP

9.7 fuel scenario in the emission summary Tables 1 and 2, the fuel data in Tables 6 and 7 were used in MOVES. These fuels are used in all other regions of Ohio.

Table 4 – Existing Fuel Supply Data (includes Low RVP)

fuelRegionID	fuelYearID	monthGroupID	fuelFormulationID	marketShare
100000000	2017	1	90	1
100000000	2017	1	3471	0.965115
100000000	2017	1	3473	0.034885
100000000	2017	1	25005	1
100000000	2017	1	27001	1
100000000	2017	1	28001	1
100000000	2017	2	90	1
100000000	2017	2	3471	0.965115
100000000	2017	2	3473	0.034885
100000000	2017	2	25005	1
100000000	2017	2	27001	1
100000000	2017	2	28001	1
100000000	2017	3	90	1
100000000	2017	3	3471	0.965115
100000000	2017	3	3473	0.034885
100000000	2017	3	25005	1
100000000	2017	3	27001	1
100000000	2017	3	28001	1
100000000	2017	4	90	1
100000000	2017	4	3483	0.965115
100000000	2017	4	3484	0.034885
100000000	2017	4	25005	1
100000000	2017	4	27002	1
100000000	2017	4	28001	1
100000000	2017	5	90	1
100000000	2017	5	3479	0.965115
100000000	2017	5	3481	0.034885
100000000	2017	5	25005	1
100000000	2017	5	27002	1
100000000	2017	5	28001	1
100000000	2017	6	90	1
100000000	2017	6	3479	0.965115
100000000	2017	6	3481	0.034885
100000000	2017	6	25005	1
100000000	2017	6	27002	1
100000000	2017	6	28001	1
100000000	2017	7	90	1
100000000	2017	7	3479	0.965115
100000000	2017	7	3481	0.034885
100000000	2017	7	25005	1
100000000	2017	7	27002	1

fuelRegionID	fuelYearID	monthGroupID	fuelFormulationID	marketShare
100000000	2017	7	28001	1
100000000	2017	8	90	1
100000000	2017	8	3479	0.965115
100000000	2017	8	3481	0.034885
100000000	2017	8	25005	1
100000000	2017	8	27002	1
100000000	2017	8	28001	1
100000000	2017	9	90	1
100000000	2017	9	3479	0.965115
100000000	2017	9	3481	0.034885
100000000	2017	9	25005	1
100000000	2017	9	27002	1
100000000	2017	9	28001	1
100000000	2017	10	90	1
100000000	2017	10	3483	0.965115
100000000	2017	10	3484	0.034885
100000000	2017	10	25005	1
100000000	2017	10	27002	1
100000000	2017	10	28001	1
100000000	2017	11	90	1
100000000	2017	11	3471	0.965115
100000000	2017	11	3473	0.034885
100000000	2017	11	25005	1
100000000	2017	11	27001	1
100000000	2017	11	28001	1
100000000	2017	12	90	1
100000000	2017	12	3471	0.965115
100000000	2017	12	3473	0.034885
100000000	2017	12	25005	1
100000000	2017	12	27001	1
100000000	2017	12	28001	1

Table 5 – Existing Fuel Formulation Data (includes Low RVP)

fuelFormulationID	fuelSubtypeID	RVP	sulfurLevel	ETOHVolume
10	10	6.9	30	0
20	20	0	11	0
30	30	0	7.6	0
50	51	7.7	11	85
90	90	0	0	0
96	10	8.7	338	0
97	10	6.6	150	0
98	10	6.9	30	0
99	10	6.9	90	0
3471	12	12.96	10	10
3473	15	11.96	10	15
3479	12	8.8	10	10
3481	15	7.8	10	15
3483	12	9.75	10	10
3484	15	9.75	10	15
25005	21	0	15	0
27001	51	10.5	8	74
27002	51	7.7	8	74
28001	30	0	7.6	0

Table 6 – Proposed Fuel Supply Data (does not include Low RVP)

fuelRegionID	fuelYearID	monthGroupID	fuelFormulationID	marketShare
100000000	2017	1	90	1
100000000	2017	1	3471	0.965115
100000000	2017	1	3473	0.034885
100000000	2017	1	25005	1
100000000	2017	1	27001	1
100000000	2017	1	28001	1
100000000	2017	2	90	1
100000000	2017	2	3471	0.965115
100000000	2017	2	3473	0.034885
100000000	2017	2	25005	1
100000000	2017	2	27001	1
100000000	2017	2	28001	1
100000000	2017	3	90	1
100000000	2017	3	3471	0.965115
100000000	2017	3	3473	0.034885
100000000	2017	3	25005	1
100000000	2017	3	27001	1
100000000	2017	3	28001	1
100000000	2017	4	90	1
100000000	2017	4	3483	0.965115

fuelRegionID	fuelYearID	monthGroupID	fuelFormulationID	marketShare
100000000	2017	4	3484	0.034885
100000000	2017	4	25005	1
100000000	2017	4	27002	1
100000000	2017	4	28001	1
100000000	2017	5	90	1
100000000	2017	5	3470	0.965115
100000000	2017	5	3472	0.034885
100000000	2017	5	25005	1
100000000	2017	5	27002	1
100000000	2017	5	28001	1
100000000	2017	6	90	1
100000000	2017	6	3470	0.965115
100000000	2017	6	3472	0.034885
100000000	2017	6	25005	1
100000000	2017	6	27002	1
100000000	2017	6	28001	1
100000000	2017	7	90	1
100000000	2017	7	3470	0.965115
100000000	2017	7	3472	0.034885
100000000	2017	7	25005	1
100000000	2017	7	27002	1
100000000	2017	7	28001	1
100000000	2017	8	90	1
100000000	2017	8	3470	0.965115
100000000	2017	8	3472	0.034885
100000000	2017	8	25005	1
100000000	2017	8	27002	1
100000000	2017	8	28001	1
100000000	2017	9	90	1
100000000	2017	9	3470	0.965115
100000000	2017	9	3472	0.034885
100000000	2017	9	25005	1
100000000	2017	9	27002	1
100000000	2017	9	28001	1
100000000	2017	10	90	1
100000000	2017	10	3483	0.965115
100000000	2017	10	3484	0.034885
100000000	2017	10	25005	1
100000000	2017	10	27002	1
100000000	2017	10	28001	1
100000000	2017	11	90	1
100000000	2017	11	3471	0.965115
100000000	2017	11	3473	0.034885
100000000	2017	11	25005	1
100000000	2017	11	27001	1
100000000	2017	11	28001	1
100000000	2017	12	90	1
100000000	2017	12	3471	0.965115

fuelRegionID	fuelYearID	monthGroupID	fuelFormulationID	marketShare
100000000	2017	12	3473	0.034885
100000000	2017	12	25005	1
100000000	2017	12	27001	1
100000000	2017	12	28001	1

Table 7 – Proposed Fuel Formulation Data (does not include Low RVP)

fuelFormulationID	fuelSubtypeID	RVP	sulfurLevel	ETOHVolume
10	10	6.9	30	0
20	20	0	11	0
30	30	0	7.6	0
50	51	7.7	11	85
90	90	0	0	0
96	10	8.7	338	0
97	10	6.6	150	0
98	10	6.9	30	0
99	10	6.9	90	0
3470	12	9.7	10	10
3471	12	12.96	10	10
3472	15	8.7	10	15
3473	15	11.96	10	15
3483	12	9.75	10	10
3484	15	9.75	10	15
25005	21	0	15	0
27001	51	10.5	8	74
27002	51	7.7	8	74
28001	30	0	7.6	0

Temperature and Relative Humidity

Annual temperature and relative humidity data was obtained from the NOAA National Climatic Data Center for Cincinnati/Northern Kentucky International Airport for the Cincinnati area and Dayton International Airport for the Dayton area. To get the correct format for MOVES, the data was entered into the U.S. EPA Meteorological Data Converter spreadsheet that was designed to convert Mobile6 data to MOVES. The July hourly temperature and relative humidity distribution profile for the Cincinnati and Dayton areas can be seen in Table 8.

Table 8 – Temperature and Relative Humidity Data for July

Hour	Cincinnati Temperature	Cincinnati Relative Humidity	Dayton Temperature	Dayton Relative Humidity
1	76.5	81.3	75.2	76.2
2	75.2	84.2	74.4	77.3
3	74.5	85.0	73.3	80.3
4	74.1	86.8	72.2	83.5
5	73.1	88.5	71.3	85.6
6	72.7	88.9	70.9	86.3
7	72.4	89.5	70.8	87.6
8	75.0	85.5	73.6	83.0
9	78.0	78.2	76.7	74.9
10	80.9	71.0	79.6	68.2
11	83.3	65.9	82.4	61.3
12	85.1	62.1	84.5	55.8
13	86.9	57.7	86.2	52.1
14	87.9	55.1	87.7	48.2
15	89.1	52.4	88.0	48.5
16	90.1	50.3	88.4	47.0
17	89.6	50.7	88.4	46.3
18	88.7	51.9	88.0	46.7
19	87.7	54.3	86.7	49.8
20	85.7	59.4	84.6	55.0
21	82.7	65.9	81.0	62.2
22	80.1	73.1	78.9	67.2
23	78.8	76.1	77.3	70.6
24	77.8	78.0	76.6	72.1

Ramp Fraction

Ramp fractions were derived using the base year travel demand model vehicle hours traveled (VHT) fractions. Ramp fractions can be seen in Table 9. Base year fractions were kept the same for future years.

Table 9 – Ramp Fractions

Area	roadTypeID	roadDesc	rampFraction
Cincinnati	2	Rural Restricted Access	0.0028
	4	Urban Restricted Access	0.027
Dayton	2	Rural Restricted Access	0.04
	4	Urban Restricted Access	0.11

Source Type Population

Source type population is based on a combination of local and MOVES default data. Local data was obtained from the Ohio Department of Public Safety (ODPS) BMV Motor Vehicle Registrations by county and vehicle type.

For the Cincinnati area, Ohio BMV's vehicle registration data was used as the source type population for source types 11, 21, 31, 32, 42 and 43. For the rest of source types 41, 51, 52, 53, 54, 61 and 62, default data was used.

For the Dayton area, registration data was used for source types 11, 21, 31, 32, 42, 43, 52 and 53. Default data was used for source types 41, 51, 54, 61 and 62.

Future year source type growth rate is based on travel demand model's annual household growth rates. Table 10 shows source type populations for 2017.

Table 10 – Source Type Population

sourceTypeID	sourceTypeName	Cincinnati Area	Dayton Area
11	Motorcycle	73,007	44,622
21	Passenger Car	1,400,460	629,285
31	Passenger Truck	590,323	284,719
32	Light Commercial Truck	40,297	7,335
41	Intercity Bus	484	316
42	Transit Bus	87	102
43	School Bus	3,888	1,891
51	Refuse Truck	435	229
52	Single Unit Short-haul Truck	390	245
53	Single Unit Long-haul Truck	384	448
54	Motor Home	5,205	1,105
61	Combination Short-haul Truck	5,153	3,306
62	Combination Long-haul Truck	5,907	3,801

I/M Program

There is no I/M program in the Cincinnati or Dayton areas.

Vehicle Age Distribution

Vehicle age distribution information was derived using the same data used for the source type population. For the Cincinnati area, Ohio BMV's vehicle registration data was used as the source type population for source types 11, 21, 31, 32, 42 and 43. For the rest of source types 41, 51, 52, 53, 54, 61 and 62, default data was used.

For the Dayton area, registration data was used for source types 11, 21, 31, 32, 42, 43, 52 and 53. Default data was used for source types 41, 51, 54, 61 and 62.

The U.S. EPA Age Distribution Projection Tool was used to “grow” the base year data to year 2017. Table 11 shows the vehicle age distribution for the Cincinnati area. The distributions for the Dayton area can be found in the electronic input submittal files.

Table 11 – Vehicle Age Distribution for the Cincinnati area

sourceTypeID	ageID	ageFraction
11	0	0.002
11	1	0.019
11	2	0.053
11	3	0.069
11	4	0.077
11	5	0.074
11	6	0.061
11	7	0.078
11	8	0.064
11	9	0.054
11	10	0.043
11	11	0.036
11	12	0.028
11	13	0.023
11	14	0.022
11	15	0.018
11	16	0.016
11	17	0.015
11	18	0.010
11	19	0.008
11	20	0.007
11	21	0.009
11	22	0.008
11	23	0.012
11	24	0.017
11	25	0.018
11	26	0.014
11	27	0.017
11	28	0.025
11	29	0.017
11	30	0.086

sourceTypeID	ageID	ageFraction
21	0	0.012
21	1	0.033
21	2	0.044
21	3	0.053
21	4	0.053
21	5	0.057
21	6	0.057
21	7	0.059
21	8	0.059
21	9	0.054
21	10	0.059
21	11	0.057
21	12	0.051
21	13	0.050
21	14	0.044
21	15	0.045
21	16	0.037
21	17	0.031
21	18	0.026
21	19	0.021
21	20	0.017
21	21	0.013
21	22	0.010
21	23	0.007
21	24	0.006
21	25	0.004
21	26	0.003
21	27	0.002
21	28	0.001
21	29	0.001
21	30	0.035

Table 11 – Vehicle Age Distribution for the Cincinnati area - continued

sourceTypeID	ageID	ageFraction
31	0	0.010
31	1	0.028
31	2	0.050
31	3	0.057
31	4	0.066
31	5	0.081
31	6	0.080
31	7	0.073
31	8	0.073
31	9	0.060
31	10	0.062
31	11	0.060
31	12	0.052
31	13	0.043
31	14	0.038
31	15	0.039
31	16	0.030
31	17	0.026
31	18	0.017
31	19	0.013
31	20	0.009
31	21	0.008
31	22	0.007
31	23	0.005
31	24	0.004
31	25	0.003
31	26	0.002
31	27	0.001
31	28	0.000
31	29	0.000
31	30	0.004

sourceTypeID	ageID	ageFraction
32	0	0.018
32	1	0.046
32	2	0.087
32	3	0.070
32	4	0.071
32	5	0.036
32	6	0.035
32	7	0.037
32	8	0.037
32	9	0.041
32	10	0.049
32	11	0.055
32	12	0.043
32	13	0.041
32	14	0.038
32	15	0.060
32	16	0.048
32	17	0.038
32	18	0.030
32	19	0.018
32	20	0.021
32	21	0.018
32	22	0.013
32	23	0.013
32	24	0.010
32	25	0.007
32	26	0.005
32	27	0.002
32	28	0.001
32	29	0.001
32	30	0.010

Table 11 – Vehicle Age Distribution for the Cincinnati area - continued

sourceTypeID	ageID	ageFraction
41	0	0.000
41	1	0.031
41	2	0.088
41	3	0.089
41	4	0.077
41	5	0.075
41	6	0.097
41	7	0.064
41	8	0.049
41	9	0.080
41	10	0.075
41	11	0.062
41	12	0.025
41	13	0.027
41	14	0.019
41	15	0.019
41	16	0.013
41	17	0.018
41	18	0.009
41	19	0.018
41	20	0.017
41	21	0.010
41	22	0.004
41	23	0.006
41	24	0.006
41	25	0.001
41	26	0.003
41	27	0.003
41	28	0.003
41	29	0.002
41	30	0.010

sourceTypeID	ageID	ageFraction
42	0	0.000
42	1	0.037
42	2	0.110
42	3	0.037
42	4	0.159
42	5	0.037
42	6	0.061
42	7	0.061
42	8	0.024
42	9	0.110
42	10	0.037
42	11	0.098
42	12	0.037
42	13	0.024
42	14	0.024
42	15	0.012
42	16	0.024
42	17	0.024
42	18	0.037
42	19	0.000
42	20	0.000
42	21	0.012
42	22	0.000
42	23	0.000
42	24	0.000
42	25	0.000
42	26	0.012
42	27	0.000
42	28	0.000
42	29	0.012
42	30	0.012

Table 11 – Vehicle Age Distribution for the Cincinnati area - continued

sourceTypeID	ageID	ageFraction
43	0	0.090
43	1	0.030
43	2	0.055
43	3	0.047
43	4	0.059
43	5	0.072
43	6	0.048
43	7	0.033
43	8	0.067
43	9	0.065
43	10	0.084
43	11	0.086
43	12	0.047
43	13	0.050
43	14	0.024
43	15	0.018
43	16	0.011
43	17	0.023
43	18	0.011
43	19	0.013
43	20	0.012
43	21	0.009
43	22	0.006
43	23	0.008
43	24	0.009
43	25	0.004
43	26	0.003
43	27	0.001
43	28	0.003
43	29	0.002
43	30	0.009

sourceTypeID	ageID	ageFraction
51	0	0.005
51	1	0.049
51	2	0.062
51	3	0.070
51	4	0.087
51	5	0.043
51	6	0.043
51	7	0.054
51	8	0.054
51	9	0.076
51	10	0.022
51	11	0.041
51	12	0.079
51	13	0.054
51	14	0.051
51	15	0.068
51	16	0.033
51	17	0.008
51	18	0.016
51	19	0.003
51	20	0.008
51	21	0.000
51	22	0.003
51	23	0.003
51	24	0.014
51	25	0.000
51	26	0.000
51	27	0.000
51	28	0.003
51	29	0.000
51	30	0.051

Table 11 – Vehicle Age Distribution for the Cincinnati area - continued

sourceTypeID	ageID	ageFraction
52	0	0.005
52	1	0.049
52	2	0.062
52	3	0.070
52	4	0.087
52	5	0.043
52	6	0.043
52	7	0.054
52	8	0.054
52	9	0.076
52	10	0.022
52	11	0.041
52	12	0.079
52	13	0.054
52	14	0.051
52	15	0.068
52	16	0.033
52	17	0.008
52	18	0.016
52	19	0.003
52	20	0.008
52	21	0.000
52	22	0.003
52	23	0.003
52	24	0.014
52	25	0.000
52	26	0.000
52	27	0.000
52	28	0.003
52	29	0.000
52	30	0.051

sourceTypeID	ageID	ageFraction
53	0	0.000
53	1	0.006
53	2	0.037
53	3	0.009
53	4	0.028
53	5	0.034
53	6	0.019
53	7	0.019
53	8	0.012
53	9	0.016
53	10	0.022
53	11	0.037
53	12	0.009
53	13	0.031
53	14	0.022
53	15	0.037
53	16	0.022
53	17	0.034
53	18	0.012
53	19	0.019
53	20	0.025
53	21	0.037
53	22	0.019
53	23	0.025
53	24	0.006
53	25	0.037
53	26	0.016
53	27	0.019
53	28	0.022
53	29	0.019
53	30	0.351

Table 11 – Vehicle Age Distribution for the Cincinnati area - continued

sourceTypeID	ageID	ageFraction
54	0	0.008
54	1	0.017
54	2	0.038
54	3	0.042
54	4	0.047
54	5	0.058
54	6	0.055
54	7	0.048
54	8	0.041
54	9	0.044
54	10	0.051
54	11	0.054
54	12	0.044
54	13	0.036
54	14	0.035
54	15	0.037
54	16	0.030
54	17	0.023
54	18	0.020
54	19	0.015
54	20	0.018
54	21	0.021
54	22	0.022
54	23	0.022
54	24	0.019
54	25	0.017
54	26	0.016
54	27	0.012
54	28	0.008
54	29	0.006
54	30	0.097

sourceTypeID	ageID	ageFraction
61	0	0.003
61	1	0.017
61	2	0.033
61	3	0.039
61	4	0.051
61	5	0.053
61	6	0.062
61	7	0.063
61	8	0.056
61	9	0.055
61	10	0.059
61	11	0.057
61	12	0.046
61	13	0.049
61	14	0.038
61	15	0.043
61	16	0.043
61	17	0.031
61	18	0.026
61	19	0.023
61	20	0.020
61	21	0.023
61	22	0.021
61	23	0.014
61	24	0.014
61	25	0.010
61	26	0.007
61	27	0.004
61	28	0.003
61	29	0.003
61	30	0.034

Table 11 – Vehicle Age Distribution for the Cincinnati area - continued

sourceTypeID	ageID	ageFraction
62	0	0.008
62	1	0.023
62	2	0.031
62	3	0.091
62	4	0.072
62	5	0.081
62	6	0.056
62	7	0.052
62	8	0.036
62	9	0.055
62	10	0.102
62	11	0.081
62	12	0.060
62	13	0.043
62	14	0.044
62	15	0.044
62	16	0.027
62	17	0.020
62	18	0.012
62	19	0.010
62	20	0.010
62	21	0.008
62	22	0.008
62	23	0.006
62	24	0.005
62	25	0.004
62	26	0.004
62	27	0.000
62	28	0.001
62	29	0.001
62	30	0.005

Road Type Distribution

The road type distribution is based on travel demand forecast model data. These inputs vary by area. Table 12 shows the road type distribution input for the Cincinnati and Dayton areas.

Table 12 – Road Type Distribution

		roadTypeVMTFraction	
sourceTypeID	**roadTypeID**	**Cincinnati Area**	**Dayton Area**
11	2	0.030	0.060
11	3	0.103	0.130
11	4	0.415	0.290
11	5	0.451	0.52
21	2	0.030	0.060
21	3	0.103	0.130
21	4	0.415	0.290
21	5	0.451	0.52
31	2	0.030	0.060
31	3	0.103	0.130
31	4	0.415	0.290
31	5	0.451	0.52
32	2	0.030	0.060
32	3	0.103	0.130
32	4	0.415	0.290
32	5	0.451	0.52
41	2	0.030	0.060
41	3	0.103	0.130
41	4	0.415	0.290
41	5	0.451	0.52
42	2	0.030	0.060
42	3	0.103	0.130
42	4	0.415	0.290
42	5	0.451	0.52
43	2	0.030	0.060
43	3	0.103	0.130
43	4	0.415	0.290
43	5	0.451	0.52
51	2	0.030	0.060
51	3	0.103	0.130
51	4	0.415	0.290
51	5	0.451	0.52
52	2	0.030	0.060
52	3	0.103	0.130

sourceTypeID	roadTypeID	roadTypeVMTFraction	
		Cincinnati Area	Dayton Area
52	4	0.415	0.290
52	5	0.451	0.52
53	2	0.030	0.060
53	3	0.103	0.130
53	4	0.415	0.290
53	5	0.451	0.52
54	2	0.030	0.060
54	3	0.103	0.130
54	4	0.415	0.290
54	5	0.451	0.52
61	2	0.030	0.060
61	3	0.103	0.130
61	4	0.415	0.290
61	5	0.451	0.52
62	2	0.030	0.060
62	3	0.103	0.130
62	4	0.415	0.290
62	5	0.451	0.52
11	1	0	0
21	1	0	0
31	1	0	0
32	1	0	0
41	1	0	0
42	1	0	0
43	1	0	0
51	1	0	0
52	1	0	0
53	1	0	0
54	1	0	0
61	1	0	0
62	1	0	0

Vehicle Type VMT and VMT Fractions

MOVES' VMT inputs are subdivided into four sections that include HPMSVtype year VMT, monthly VMT fractions, daily VMT fractions and hourly VMT fractions. The VMT for 2017 is based on the data predicted by the travel demand model. The vehicle type percentages of the total VMT were based on ODOT's weigh-in-motion (WIM) data. Since there are not enough WIM stations for lower class facilities in the area, a statewide average of all ODOT WIM data collectors was used. Table 13 contains the annual VMT for the Cincinnati and Dayton areas.

Table 13 – HPMSVtype VMT Data

HPMSVtypeID	Cincinnati Area	Dayton Area
10	135,685,000	37,945,568
25	14,766,040,000	8,855,326,021
40	17,100,000	21,342,480
50	24,302,600	157,775,675
60	396,928,000	374,588,435

Monthly and daily VMT fractions used MOVES default data. The hourly VMT fractions were derived from ODOT WIM data. Hourly VMT fractions vary for each of the five MOVES road types but do not change for each of the 16 MOVES source types. A part of the hour VMT fraction input file can be seen in Table 14. The entire file is too large to include in this document.

Table 14 – Hourly VMT Fractions

sourceTypeID	roadTypeID	dayID	hourID	Cincinnati hourVMTFraction	Dayton hourVMTFraction
11	1	2	1	0.0214739	0.0089
11	1	2	2	0.0144428	0.00564
11	1	2	3	0.0109684	0.00424
11	1	2	4	0.00749451	0.00427
11	1	2	5	0.00683855	0.00695
11	1	2	6	0.0103588	0.01798
11	1	2	7	0.0184304	0.03806
11	1	2	8	0.0268117	0.057
11	1	2	9	0.0363852	0.05773
11	1	2	10	0.0475407	0.05538
11	1	2	11	0.0574664	0.05554
11	1	2	12	0.0650786	0.05558
11	1	2	13	0.0713228	0.05584
11	1	2	14	0.0714917	0.06051
11	1	2	15	0.0717226	0.06765
11	1	2	16	0.0720061	0.07755
11	1	2	17	0.0711487	0.08428
11	1	2	18	0.0678874	0.0797
11	1	2	19	0.0617718	0.06012
11	1	2	20	0.0516882	0.04522
11	1	2	21	0.0428658	0.03646
11	1	2	22	0.0380302	0.02912
11	1	2	23	0.0322072	0.02142
11	1	2	24	0.0245677	0.01486
11	2	2	1	0.01672	0.0089
11	2	2	2	0.01798	0.00564
11	2	2	3	0.02101	0.00424
11	2	2	4	0.02236	0.00427
11	2	2	5	0.02801	0.00695
11	2	2	6	0.04621	0.01798

sourceTypeID	roadTypeID	dayID	hourID	Cincinnati hourVMTFraction	Dayton hourVMTFraction
11	2	2	7	0.07629	0.03806
11	2	2	8	0.08333	0.057
11	2	2	9	0.06708	0.05773
11	2	2	10	0.05593	0.05538
11	2	2	11	0.05196	0.05554
11	2	2	12	0.05138	0.05558
11	2	2	13	0.05066	0.05584
11	2	2	14	0.05	0.06051
11	2	2	15	0.05082	0.06765
11	2	2	16	0.0556	0.07755
11	2	2	17	0.06496	0.08428
11	2	2	18	0.05598	0.0797
11	2	2	19	0.03709	0.06012
11	2	2	20	0.02458	0.04522
11	2	2	21	0.02028	0.03646
11	2	2	22	0.01888	0.02912
11	2	2	23	0.01708	0.02142
11	2	2	24	0.01581	0.01486
11	3	2	1	0.01366	0.00655
11	3	2	2	0.01848	0.0037
11	3	2	3	0.02462	0.00304
11	3	2	4	0.02877	0.00363
11	3	2	5	0.03484	0.00792
11	3	2	6	0.05591	0.02343
11	3	2	7	0.08161	0.04899
11	3	2	8	0.08788	0.06319
11	3	2	9	0.06491	0.05402
11	3	2	10	0.05372	0.05121
11	3	2	11	0.05089	0.0528
11	3	2	12	0.04916	0.05608
11	3	2	13	0.04913	0.05814
11	3	2	14	0.04715	0.05875
11	3	2	15	0.04586	0.06676
11	3	2	16	0.05129	0.07812
11	3	2	17	0.0534	0.08469
11	3	2	18	0.05113	0.08152
11	3	2	19	0.04212	0.05852
11	3	2	20	0.0279	0.04343
11	3	2	21	0.02111	0.03606
11	3	2	22	0.01943	0.02829
11	3	2	23	0.0154	0.01883
11	3	2	24	0.01163	0.01233
11	4	2	1	0.01783	0.00752
11	4	2	2	0.01878	0.0044
11	4	2	3	0.02059	0.00354
11	4	2	4	0.02206	0.00374
11	4	2	5	0.02678	0.00705

sourceTypeID	roadTypeID	dayID	hourID	Cincinnati hourVMTFraction	Dayton hourVMTFraction
11	4	2	6	0.04016	0.02123
11	4	2	7	0.06433	0.054
11	4	2	8	0.07881	0.0768
11	4	2	9	0.06506	0.06545
11	4	2	10	0.05347	0.05114
11	4	2	11	0.05016	0.04692
11	4	2	12	0.05114	0.04916
11	4	2	13	0.05241	0.05112
11	4	2	14	0.05156	0.0534
11	4	2	15	0.05351	0.06105
11	4	2	16	0.05978	0.07421
11	4	2	17	0.06293	0.08321
11	4	2	18	0.05581	0.08385
11	4	2	19	0.03896	0.06062
11	4	2	20	0.02788	0.04229
11	4	2	21	0.02331	0.03442
11	4	2	22	0.02337	0.0292
11	4	2	23	0.02291	0.02137
11	4	2	24	0.0184	0.01431
11	5	2	1	0.01435	0.00678
11	5	2	2	0.02131	0.00378
11	5	2	3	0.02244	0.00295
11	5	2	4	0.02529	0.0029
11	5	2	5	0.03002	0.00498
11	5	2	6	0.04187	0.01422
11	5	2	7	0.06496	0.03449
11	5	2	8	0.07258	0.05728
11	5	2	9	0.06796	0.05435
11	5	2	10	0.0588	0.04991
11	5	2	11	0.05253	0.05261
11	5	2	12	0.05797	0.06098
11	5	2	13	0.05852	0.06457
11	5	2	14	0.05439	0.06387
11	5	2	15	0.0583	0.06812
11	5	2	16	0.05919	0.07672
11	5	2	17	0.05405	0.08274
11	5	2	18	0.04903	0.08284
11	5	2	19	0.0364	0.06344
11	5	2	20	0.02765	0.04866
11	5	2	21	0.02145	0.0407
11	5	2	22	0.01962	0.03083
11	5	2	23	0.01826	0.01966
11	5	2	24	0.01306	0.01262