Memorandum

July 20, 2010

To: MOVES Task Force

From: Eulalie Lucas
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Subject: Results of MOVES2010 Model Ramp Analysis

Introduction

Staff completed two MOVES model runs to test two different approaches for estimation of ramp emissions. Ramps are considered part of the restricted access roadtypes therefore VMT for unrestricted facility types were excluded. Both approaches are listed in the MOVES2010 technical guidance for SIPs and Conformity under Section 3.6.5 for the Default Approach and Section 3.8 the VMT-based approach. Following execution using default data, the VMT Approach required two separate MOVES runs with ramp fraction set to 0 using only freeway VMT, and set to 1 using only ramp VMT. See attachments to this memo.

Results

Emission estimates for year 2005 for Montgomery County for VOC, NOx and for VMT are listed in Table 1. Since our analysis is VMT related only emissions associated with the running component of the trip cycle are show here. Results indicate that while ramps represent only 2.6 % of the VMT, activity on ramps account for 5.1 % of emissions. Both approaches have benefits as well as dis-benefits. Emission estimates using default data show higher emissions but there is less runtime and less analysis required. The VMT Approach shows lower emissions, however, users will have to account for additional runtime as well as separation of data by ramp and non-ramp, e.g., VMT, VMT distributions and vehicle types.

Recommendation

Given similarity of results between the two methods, and ease of calculation with the Default Approach, staff recommends continued use of the Default Approach for future emissions work.

Table 1

2005 Montgomery County Ozone Day Emission Comparison for Ramp Scenarios

Restricted Access Facilities

		Default	VMT Approach		Difference	
		VHT=8%	Non_ramp	Ramp	Absolute	%
VMT			7,930,289	207,983 (2.6%)		
VOC T/d	Running	1.83	1.66	0.08 (5.1%)		
	Total	1.83	1.75		-0.09	-4.7%
NO x T/d	Running	13.03	12.12	0.52 (4.3%)		
	Total	13.03	12.64		-0.38	-3.0%

3.6.4 Creating a Distribution from a Single Average Speed

If only a single average speed is available for a particular road type and that average speed is not identical to the average speed in a particular speed bin, users should apply the following formula for creating the appropriate speed distribution among two adjacent speed bins.

The general formula is:

VHT Fraction A in Speed Bin with closest average speed lower than observed average speed + VHT Fraction B in Speed Bin with closest average speed higher that observed average speed = 1

VHT Fraction A = 1 – [(observed average speed – average speed of lower speed bin) / (average speed of higher speed bin – average speed of lower speed bin)]

VHT Fraction B = 1- [(average speed of higher speed bin – observed average speed) / (average speed of higher speed bin – average speed of lower speed bin)]

Or more simply: VHT Fraction B = 1 – VHT fraction A

The following example can be used as a guideline. If the single average speed for a roadway is 28.7 miles per hour, the average speed distribution will be split between the 25 and 30 bins with values of .26 and .74, respectively. These values are found with the following equations:

VHT Fraction A in 25 mph Speed Bin + VHT Fraction B in 30 mph Speed Bin = 1

A = 1 – (28.7 mph Avg. Speed – 25 mph (Bin Speed)) / (30 mph Bin Speed – 25 mph Bin Speed) = 0.26

B = 1 – (30 mph Bin Speed – 28.7 mph Avg. Speed) / (30 mph Bin Speed – 25 mph Bin Speed) = 0.74,

Or more simply, B = 1 - A

3.6.5 Average Speed Distributions for Ramps

The Average Speed Distribution for ramps should be included within the Average Speed Distribution for highways, but it must be properly weighted according to the VHT. To do this, the VHT and VMT for highways and ramps can be found separately using local data or the formula above if only a single average speed is known. The resulting VHT and VMT for each type of roadway can then be summed to find the combined total VHT and VMT on the roadways. The total VMT can then be divided by the total VHT to find a combined average speed and the equations above can then be used to calculate an average speed distribution.

For example, assume the user has data that 1.00 million miles were driven on urban ramps with an average speed of 34.6 mph (the MOBILE6.2 default value) and 10.0 million miles were driven on urban highways with an average speed of 52.0 mph. The combined speed distribution would be found as follows:

VHT on Ramps: 1.00 million miles / 34.6 mph = 28,900 hours

VHT on Highways: 10.0 million miles / 52.0 mph = 192,000 hours

Combined VHT: 28,900 hours + 192,000 hours = 220,900 hours

Combined VMT: 1.00 million miles + 10.0 million miles = 11.0 million miles

Combined Average Speed: 11.0 million miles / 220,900 hours = 49.8 miles per hour

Using the equations above, the average speed distribution for 49.8 mph is 0.96 in the 50 mph speed bin and 0.04 in the 45 mph speed bin.

This method is preferred for calculating the average speed on highways instead of finding a weighted and normalized distribution of the ramp and highway speeds individually. This is because MOVES associates ramp drive cycles with the overall average speed distribution input by the user, and cannot differentiate which speeds the user intends to correspond to ramps. For example, if the user input a portion of the speed distribution in the 30 mph speed bin, intending this to represent ramp speeds, MOVES would instead use the drive cycles more generally associated with congested highway activity at 30 mph, and not ramps specifically.

3.7 Road Type Distribution

The fraction of vehicle miles traveled (VMT) by road type varies from area to area and can have a significant effect on overall emissions from on-road mobile sources. EPA expects states to develop and use their own specific estimates of VMT by roadtype. The VMT fractions by road type used in inventory modeling for SIPs and regional conformity analyses should be consistent with the most recent information used for transportation planning.

For each source type, the Road Type Distribution table stores the distribution of VMT by road type (e.g., the fraction of passenger car VMT on each of the road types). EPA has created a series of VMT converters (based on different options for describing the MOBILE6.2 vehicle types), that also incorporate a road type distribution converter. These can be found at www.epa.gov/otaq/models/moves/tools.htm.

As is the case for other MOVES inputs, EPA does not expect that users will be able to develop local road type distributions for all 13 vehicle source types. If local road type distribution information is not available for some source types, states can use the same road type distribution for all source types within an HPMS vehicle class. For example, states could use the same road type distribution for source types 31 and 32 if separate average speed distributions for passenger trucks and light commercial trucks are not available. States could also use the same road type distribution across multiple HPMS vehicle classes if more detailed information is not available.

The Road Type Distribution Importer in MOVES is described in section 2.3.3.4.6 of the MOVES User Guide.

3.7.1 Road Type Distributions in Emission Rate Calculations

If the Emission Rates option is used, MOVES will automatically produce a table of emission rates by road type. Running emissions would then be calculated outside of MOVES by multiplying the emission rates by the VMT on each road type for each source type in each speed bin. In that case, data entered using the Road Type Distribution Importer is ignored by MOVES. However, the CDM still requires a complete road type distribution to work. Users could supply a table with simple dummy values to produce the necessary emission rates. The guidance in this section concerning the use of local road type data still applies whether local road type distributions are applied within MOVES using the Inventory option or outside of MOVES using the Emission Rate option.

3.8 Ramp Fraction

The default ramp fraction on both rural restricted roads (road type 2) and urban restricted roads (road type 4) is 8% of VHT. Use of the Ramp Fraction tab is optional (the default value of 8% will be automatically applied if the user does not import local data). Users who have good local data indicating a different fraction for ramp activity should use it.

The Ramp Fraction tab imports a table that duplicates the roadtype table in the MOVES default database. This table is structured so that the fraction of VHT on ramps for either rural restricted (road type 2) or urban restricted (road type 4) roads is entered in the rampFraction field.

In section 3.6 above, the example given demonstrates how the Ramp Fraction can be calculated using Average Speed and VMT on ramps and highways. In that example, the VHT on ramps was 28,900 and the total was 220,900 hours resulting in a ramp fraction of 0.131 or 13.1%.

An alternative approach is for users to separately model highways and ramps in two RunSpecs, if desired. To do this, activity on highways is modeled by setting Ramp Fraction equal to 0 and activity on ramps by setting Ramp Fraction to 1; for each run, the user would only input appropriate VMT in the Vehicle Type VMT tab (i.e., highway VMT for the first run and ramp VMT for the second). This approach allows users to separate emissions from the highway and ramp that cannot be done if the Ramp Fraction is used as fraction of total highway VMT.

Ramp fraction inputs are not applied when the Emission Rate option is selected and will not affect the rates on rural and urban restricted roads (road types 2 and 4, respectively).

The Ramp Fraction Importer in MOVES is described in section 2.3.3.4.7 of the MOVES User Guide.

3.9 Fuel (Formulation and Supply)

In general, users should first review the default fuel formulation and fuel supply data, and then make changes only where local volumetric fuel property information is available. The lone exception to this guidance is in the case of RVP where a user should change the value to reflect the regulatory requirements and differences between ethanol- and non-ethanol blended gasolines.

MOVES has two tables – called fuelformulation and fuelsupply – that interact to define the fuels used in the area being modeled. The fuelformulation table defines the attributes (such as RVP,