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FHWA Technical Report

Annual Vehicle Miles Travelled and Related Data

Procedures Used to Derive Data Elements Contained in Highway Statistics Table VM-1 for Years 2009 and after and 2007 and 2008 Historical Data

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Part 1

National Vehicle Miles Travelled by Roadway Functional Class and Vehicle Type

Background

Prior to the publication of the 2009 Highway Statistics, vehicle miles travelled (VMT) related data elements in table VM-1 were based on a modeling procedure with initial inputs from the Highway Performance and Monitoring System (HPMS) data and constrains established from the Vehicle Inventory and Use Survey (VIUS) data. It has been noticed that VMT by vehicle type and roadway functional class data under this historical procedure were drifting away from what is being directly reported through the HPMS system. When the original historical method was developed (early 90s), the modeling logic was necessary due to potential traffic data quality issues and the availability of the Vehicle Inventory and Use Survey (VIUS) data. With the advancements in traffic data collection instruments, implementation of institutionalized processes and procedures by State highway agencies in data collection, the gaining of practical experience in traffic data collection, and the discontinuation of the VIUS (last one was carried out in 2002), the data modeling method is deemed no longer appropriate. In addition, in order to reflect rapid changes in economic conditions, and goods movement and passenger travel pattern changes, State highway agency directly reported data without being further modeled will be more logical and timely. The proposed new procedure is to retire the original methodology and adopt State direct reporting results.

Method

Step 1

Obtain both VM-4 and VM-2 data from the HPMS data (sample attached). These data should have already passed HPMS's data quality review.

Step 2

A: Conduct independent data quality review on both data sets in areas of growth rate and percentages (%) changes from past years by using growth trend data from both HPMS and the Travel Monitoring and Analysis System (TMAS system). 5% or higher changes from past year shall serve as an indicator that more in-depth analysis shall be conducted in order to determine data quality issue.

B: Both roadway centerline and lane lengths by functional classes shall be reviewed, compared and contrasted with the VMT data at the State level geography. In the event that issues are identified, inquiries to responsible State highway agencies shall be made in coordination through HPMS division.

C: Attempts must be made to secure any missing value from State highway agencies first. When such an attempt is determined to be not feasible for timeliness, simple arithmetic average for a particular parameter from neighboring States can be used in place of the missing value. However, actual value shall be obtained from State highway agencies within 6 months from issue discovery and appropriate modification shall be made to any published data accordingly to various data release schedules.

Step 3

For a given State, once the VM-4 and VM-2 data have been passes the data quality check, the VM-2 data can be split further by multiplying all corresponding cells from VM-4. Final VMT by the five roadway functional classes (rural interstate, other rural arterial, other rural, urban interstate and other urban) and six vehicle classes (light duty vehicle - Short Wheelbase, motorcycles, buses, light duty vehicle - Long Wheelbase, single unit truck, and combination truck) can be computed by simply aggregating the multiplication results.

Step 4

Once data from all States and the District of Columbia are processed through Step 3, simple addition of all corresponding VMT categories for all States will be the national VMT by roadway functional class and vehicle types.

Sample VM-2 Data Table from HPMS

JANUARY 2011 (MILLIONS) TABLE VM-2

STATE	RURAL								URBAN								TOTAL
	INTERSTATE	OTHER FREEWAYS AND EXPRESSWAYS	OTHER PRINCIPAL ARTERIAL	MINOR ARTERIAL	MAJOR COLLECTOR	MINOR COLLECTOR	LOCAL	TOTAL	INTERSTATE	OTHER FREEWAYS AND EXPRESSWAYS	OTHER PRINCIPAL ARTERIAL	MINOR ARTERIAL	MAJOR COLLECTOR	MINOR COLLECTOR	LOCAL	TOTAL	
Alabama 2/	5,382		6,271	4,552	3,984	1,656	6,723	28,567	7,199	500	6,604	3,982	1,832		7,377	27,494	56,061
Alaska	860		308	121	456	151	420	2,316	663	-	484	835	343		292	2,617	4,933
Arizona 3/	6,966		2,786	2,323	2,737	516	2,913	18,241	5,920	7,404	12,568	8,015	3,109		6,371	43,387	61,628
Arkansas	4,204	525	3,982	2,915	4,267	752	2,035	18,679	3,985	974	3,514	3,123	1,438	20	1,486	14,540	33,219
California	17,541		16,324	8,982	9,828	2,655	2,873	58,203	68,191	54,324	58,983	48,798	18,485		17,502	266,283	324,486
Colorado	4,287	-	3,892	2,499	1,704	728	1,456	14,565	7,260	4,313	8,907	5,345	2,719		3,167	31,711	46,276
Connecticut	718		811	487	1,025	154	776	3,971	9,562	3,881	3,724	5,190	2,536		2,556	27,449	31,420
Delaware	-		1,330	270	614	108	420	2,742	1,230	443	1,801	968	756		1,140	6,338	9,080
Dist. of Columbia	-		-	-	-	-	-	-	431	353	1,053	740	297		734	3,608	3,608
Florida	9,505	1,902	8,113	4,191	3,693	1,790	6,419	35,612	24,269	12,280	38,822	28,607	20,420		34,649	159,048	194,659
Georgia	9,671		6,067	6,531	5,950	1,753	8,709	38,681	19,203	2,916	12,425	15,480	4,876		15,677	70,577	109,258
Hawaii	113		525	624	285	34	842	2,423	1,786	513	1,877	693	923		1,758	7,550	9,973
Idaho	2,193		2,179	1,069	1,441	243	2,338	9,463	1,291	-	2,083	1,301	456		937	6,068	15,531
Illinois	8,844		3,821	4,652	5,450	418	3,896	27,081	22,670	1,196	21,040	15,561	8,574		9,724	78,765	105,846
Indiana 4/	7,014		4,654	3,334	6,731	1,916	4,925	28,574	9,712	1,304	10,626	7,673	6,087		12,652	48,054	76,628
Iowa	4,679		5,617	2,619	3,407	871	1,561	18,754	2,529	-	3,593	3,262	1,027		1,900	12,311	31,065
Kansas	3,167	-	4,390	2,247	2,716	253	1,680	14,454	3,613	1,775	3,598	2,927	1,184		1,948	15,045	29,499
Kentucky	6,592		7,006	2,867	4,941	2,408	3,493	27,307	5,951	792	5,679	3,612	1,708		2,306	20,048	47,355
Louisiana	5,416		2,503	2,991	4,326	1,484	2,639	19,359	7,187	560	7,521	6,024	2,810		1,402	25,504	44,863
Maine	2,171		1,890	1,745	2,351	855	1,430	10,442	805	156	742	950	971		425	4,049	14,491
Maryland	3,539		3,464	2,208	1,994	1,245	1,641	14,091	13,426	5,555	9,905	6,029	3,308		2,979	41,202	55,293
Massachusetts	1,373		786	589	690	155	691	4,284	15,098	5,687	10,815	8,678	2,855		7,395	50,528	54,812
Michigan	5,276		6,760	7,034	9,042	957	2,375	31,444	15,389	5,457	16,892	15,815	4,890		6,882	65,325	96,769
Minnesota	4,165	5	7,282	4,931	4,266	1,346	2,583	24,578	8,411	3,593	4,554	8,691	2,601	5	4,439	32,294	56,872
Mississippi	3,838		5,470	3,633	4,263	479	6,486	24,169	3,386	489	5,142	2,355	1,639		3,247	16,258	40,427
Missouri	5,951		8,206	3,595	5,029	676	5,557	29,014	12,126	4,801	7,068	5,238	2,810		7,946	39,989	69,003
Montana	2,427		2,261	1,137	1,152	374	983	8,334	360	-	971	524	243		579	2,677	11,011
Nebraska	2,575		3,153	2,423	1,537	241	1,069	10,998	1,364	503	2,688	2,141	582		1,083	8,361	19,359
Nevada	1,959		1,486	512	458	155	522	5,092	3,407	1,759	2,575	3,934	1,104		2,583	15,362	20,454
New Hampshire	1,261	311	1,090	964	1,102	575	399	5,701	1,569	940	1,265	1,854	918		727	7,274	12,975
New Jersey	1,589		1,819	795	1,162	299	574	6,238	13,506	11,630	16,242	11,123	5,024		9,266	66,791	73,029
New Mexico	4,383		3,154	1,582	1,177	597	3,870	14,763	2,682	21	4,177	1,524	1,229		1,617	11,250	26,013
New York	6,088		3,807	4,800	4,213	9,424	4,631	32,963	20,440	16,882	19,071	20,659	8,817		14,659	100,528	133,491
North Carolina 5/	6,133	38	7,567	5,306	8,842	3,459	7,847	39,193	14,579	5,751	12,578	12,009	5,495	29	14,626	65,067	104,260
North Dakota	1,465		1,787	729	1,043	-	883	5,907	395	-	677	551	236		388	2,247	8,154
Ohio	8,991	-	6,349	4,327	8,898	1,984	5,819	36,367	22,170	5,414	12,606	13,346	7,732		13,006	74,275	110,642
Oklahoma	5,088	-	4,955	2,878	5,599	180	2,746	21,444	4,761	2,741	5,631	5,544	1,278		5,598	25,553	46,997
Oregon	4,239		4,457	2,083	2,260	592	1,472	15,103	4,447	1,357	4,906	3,668	2,322		2,169	18,869	33,972
Pennsylvania 6/	10,373	1,986	4,301	7,039	4,552	2,166	7,342	37,759	14,004	6,246	17,082	13,001	8,084		7,704	66,121	103,880
Rhode Island	404		128	134	148	36	23	873	1,742	1,237	2,154	1,177	777		290	7,377	8,250
South Carolina	7,411		3,482	5,000	5,743	295	2,321	24,252	5,989	838	7,294	5,245	3,436		2,076	24,878	49,130
South Dakota	1,999	-	1,669	1,040	934	122	588	6,352	616	38	592	1,433	245		331	3,254	9,607
Tennessee	8,733		5,396	5,113	2,977	2,764	3,132	28,115	11,729	1,978	10,820	8,199	2,961		6,424	42,111	70,226
Texas	14,869		19,960	11,596	12,929	2,620	5,630	67,604	39,269	30,135	37,120	29,051	17,627		9,605	162,807	230,411
Utah	3,167		1,680	864	969	226	1,039	7,945	5,993	310	3,079	3,454	1,456		4,027	18,319	26,264
Vermont	1,202		701	1,036	1,536	218	1,086	5,779	365	71	424	387	247		373	1,867	7,646
Virginia	9,029		6,135	5,366	5,420	560	3,421	29,931	14,962	3,856	12,188	10,336	4,033		5,621	50,996	80,927
Washington	4,514		4,058	1,991	3,857	1,099	1,168	16,687	10,793	5,238	8,721	7,415	3,187		4,376	39,730	56,417
West Virginia	2,867		2,499	1,501	3,012	365	1,058	11,302	2,789	80	1,976	2,189	690		580	8,304	19,606
Wisconsin	5,173	1,607	7,029	5,178	5,361	1,219	2,044	27,611	5,267	4,133	10,289	6,723	2,227		1,907	30,546	58,157
Wyoming	2,470		1,697	636	728	726	642	6,899	472	10	773	340	517		557	2,669	9,568
U.S. Total	241,873	6,373	215,057	151,038	176,799	53,899	135,189	980,227	474,963	220,434	455,918	375,719	179,122	54	267,064	1,973,274	2,953,501
Puerto Rico	488		182	271	139	144	96	1,320	5,191	1,064	3,690	3,560	2,271		1,944	17,720	19,040
Grand Total	242,361	6,373	215,239	151,309	176,938	54,043	135,285	981,547	480,154	221,498	459,608	379,279	181,393	54	269,008	1,990,994	2,972,541

For footnotes, see Footnotes Pages.

Sample VM-4 Data

MAY 2011

TABLE VM-4
SHEET 1 OF 2

STATE	INTERSTATE SYSTEM							OTHER ARTERIALS							OTHER						
	MOTOR-CYCLES	PASSENGER CARS	LIGHT TRUCKS	BUSES	SINGLE-UNIT TRUCKS	COMBINATION TRUCKS	TOTAL	MOTOR-CYCLES	PASSENGER CARS	LIGHT TRUCKS	BUSES	SINGLE-UNIT TRUCKS	COMBINATION TRUCKS	TOTAL	MOTOR-CYCLES	PASSENGER CARS	LIGHT TRUCKS	BUSES	SINGLE-UNIT TRUCKS	COMBINATION TRUCKS	TOTAL
Alabama 2/	0.6	58.1	17.5	0.4	7.4	15.9	99.9	0.8	54.5	28.1	2.4	5.7	8.5	100.0	1.5	67.2	21.2	1.9	4.1	4.0	99.9
Alaska	0.3	56.3	30.9	0.2	9.5	2.8	100.0	0.2	57.2	32.8	0.1	8.9	0.8	100.0	0.1	61.1	32.2	0.1	6.3	0.3	100.1
Arizona 2/	0.7	51.3	17.9	0.4	6.1	23.6	100.0	3.0	55.3	27.1	0.8	6.7	7.1	100.0	2.3	54.0	29.3	0.8	8.2	5.4	100.0
Arkansas	0.0	43.0	20.0	1.0	3.0	33.0	100.0	1.0	57.0	29.0	1.0	2.0	10.0	100.0	1.0	58.0	31.0	0.0	2.0	7.0	99.0
California	0.4	66.3	19.0	0.2	3.8	10.3	100.0	1.4	64.8	23.7	0.1	4.2	5.8	100.0	2.2	42.1	32.6	3.3	6.6	13.2	100.0
Colorado	0.0	70.0	19.0	0.0	2.0	9.0	100.0	1.0	67.0	28.0	0.0	2.0	3.0	101.0	2.0	51.0	39.0	1.0	4.0	4.0	101.0
Connecticut	0.0	73.1	14.5	0.3	3.7	8.4	100.0	1.0	73.0	20.1	0.1	3.1	2.7	100.0	1.4	74.8	20.9	0.0	2.1	0.8	100.0
Delaware	-	-	-	-	-	-	-	0.6	73.9	15.7	0.7	4.0	5.1	100.0	0.9	70.5	24.2	0.3	2.6	1.5	100.0
Dist. of Columbia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida	0.3	60.8	20.8	0.6	4.1	13.4	100.0	0.6	61.3	25.5	0.4	5.0	7.1	100.0	0.7	60.8	28.0	0.6	4.5	5.5	100.0
Georgia	0.4	61.1	16.7	0.7	3.0	18.1	100.0	0.5	67.1	22.5	0.5	4.0	5.3	99.9	0.8	68.9	23.2	0.5	4.1	2.6	100.1
Hawaii	0.5	79.4	14.9	0.2	2.6	2.4	100.0	0.8	82.3	13.0	0.6	2.2	1.1	100.0	1.0	71.8	25.0	0.3	1.4	0.5	100.0
Idaho	0.4	36.5	28.7	0.3	4.6	29.5	100.0	1.0	45.3	40.2	0.4	7.2	5.8	100.0	0.9	44.3	41.0	0.2	6.7	7.0	100.0
Illinois	0.7	61.7	8.5	1.0	3.2	24.9	100.0	0.7	79.1	7.9	0.6	3.9	7.9	100.1	0.9	82.6	8.2	1.0	4.0	3.3	100.0
Indiana	0.4	49.6	15.3	1.0	3.1	30.6	100.0	0.8	59.4	22.7	0.6	4.2	12.3	100.0	1.0	65.8	25.2	0.4	3.8	3.8	100.0
Iowa	0.5	49.4	10.7	0.7	2.2	36.5	100.0	1.0	56.8	21.1	1.0	6.1	14.0	100.0	1.1	64.3	23.8	0.8	4.8	5.3	100.1
Kansas	1.0	55.0	19.0	0.0	3.0	22.0	100.0	1.0	59.0	25.0	0.0	3.0	12.0	100.0	1.0	57.0	31.0	0.0	4.0	7.0	100.0
Kentucky	0.5	63.2	11.4	0.9	2.5	21.5	100.0	1.1	64.2	21.2	0.9	5.6	7.0	100.0	1.0	65.6	23.7	0.9	5.4	3.3	99.9
Louisiana	0.2	56.3	20.2	0.4	6.0	16.9	100.0	0.2	54.2	26.5	0.5	7.8	10.8	100.0	0.2	56.9	28.5	0.8	6.9	6.7	100.0
Maine	0.3	66.1	19.7	0.2	4.2	9.5	100.0	0.7	70.1	19.4	0.6	4.8	4.4	100.0	0.8	69.2	21.0	0.6	5.1	3.3	100.0
Maryland	0.3	69.1	14.8	1.0	5.0	9.8	100.0	0.4	72.0	17.7	0.6	3.7	5.6	100.0	0.4	68.1	22.3	0.8	5.9	2.5	100.0
Massachusetts	1.7	82.6	6.9	4.1	1.8	2.9	100.0	0.7	79.6	15.4	0.5	2.1	1.7	100.0	1.5	76.7	17.0	0.6	3.2	1.0	100.0
Michigan	0.9	66.8	18.8	0.2	2.5	10.8	100.0	1.1	65.9	23.1	0.3	2.5	7.1	100.0	1.5	68.9	25.8	0.0	1.4	2.4	100.0
Minnesota	1.0	62.0	26.0	0.0	3.0	9.0	101.0	1.0	64.0	27.0	0.0	3.0	5.0	100.0	1.0	67.0	28.0	0.0	2.0	2.0	100.0
Mississippi	0.3	52.8	21.5	0.7	4.4	20.3	100.0	0.3	60.7	24.3	0.7	4.4	9.6	100.0	0.4	64.5	26.4	0.6	4.7	3.4	100.0
Missouri	0.8	52.7	15.6	0.7	3.1	27.1	100.0	0.5	60.0	24.2	0.5	4.4	10.4	100.0	0.3	60.1	28.6	0.3	4.6	6.1	100.0
Montana	0.5	47.6	29.6	0.7	2.9	18.7	100.0	1.6	47.5	38.9	0.6	3.2	8.2	100.0	1.8	45.1	44.5	0.6	4.2	3.8	100.0
Nebraska	0.2	45.8	18.9	0.1	2.2	32.8	100.0	0.6	56.4	30.1	0.1	2.9	9.9	100.0	0.5	48.5	41.1	0.2	3.9	5.7	100.0
Nevada	0.1	67.7	7.2	0.5	2.7	21.8	100.0	0.1	83.3	5.0	0.5	3.8	7.3	100.0	0.4	89.3	2.8	0.4	2.3	4.8	100.0
New Hampshire	1.0	60.0	31.0	0.0	4.0	4.0	100.0	2.0	68.0	21.0	2.0	5.0	3.0	101.0	2.0	66.0	23.0	1.0	5.0	2.0	99.0
New Jersey	0.1	72.2	16.2	0.4	3.1	8.1	100.1	0.2	79.6	14.9	0.3	2.6	2.4	100.0	0.3	69.7	25.3	0.1	2.9	1.7	100.0
New Mexico	6.0	38.6	15.7	5.9	9.5	24.3	100.0	1.5	45.9	28.6	2.7	12.6	8.7	100.0	1.2	54.3	30.8	1.5	8.4	3.8	100.0
New York	0.5	70.3	13.6	0.5	2.1	13.0	100.0	0.7	70.6	20.3	0.5	2.9	5.0	100.0	0.8	70.6	22.7	0.4	3.6	1.9	100.0
North Carolina	0.0	65.0	13.0	1.0	3.0	17.0	99.0	1.0	68.0	18.0	1.0	5.0	8.0	101.0	1.0	67.0	22.0	1.0	6.0	3.0	100.0
North Dakota	3.0	45.7	25.4	1.7	6.8	17.4	100.0	1.9	44.0	31.8	1.4	6.8	14.1	100.0	1.4	44.3	37.3	0.9	6.7	9.4	100.0
Ohio	0.3	57.6	12.3	0.3	3.2	26.3	100.0	0.6	66.5	18.4	0.1	2.7	11.7	100.0	0.8	72.4	20.7	0.1	2.1	3.9	100.0
Oklahoma 3/	0.0	44.0	26.0	1.0	5.0	24.0	100.0	1.0	45.0	32.0	0.0	8.0	13.0	99.0	1.0	50.0	32.0	1.0	8.0	8.0	100.0
Oregon	0.5	45.9	23.8	0.2	3.7	25.9	100.0	1.0	51.4	32.0	0.8	6.8	8.0	100.0	0.9	50.7	37.8	0.7	7.3	2.6	100.0
Pennsylvania 2/	1.1	48.1	12.4	0.0	17.5	20.9	100.0	0.9	53.8	18.7	0.0	18.6	8.0	100.0	0.9	48.1	28.9	0.0	17.1	5.1	100.1
Rhode Island	0.1	60.4	26.2	0.6	3.1	9.6	100.0	0.6	76.1	19.1	0.1	1.9	2.2	100.0	0.6	76.3	20.3	0.1	1.8	0.9	100.0
South Carolina	0.5	68.9	13.9	0.7	2.5	13.5	100.0	0.6	72.0	17.8	0.5	3.6	5.5	100.0	0.6	67.3	21.4	0.5	4.6	5.6	100.0
South Dakota	2.0	55.0	22.0	0.0	19.0	3.0	101.0	1.0	53.0	29.0	0.0	14.0	2.0	99.0	2.0	40.0	48.0	0.0	9.0	2.0	101.0
Tennessee	1.1	58.0	16.2	0.6	3.7	20.4	100.0	1.6	64.0	26.3	0.1	2.9	5.1	100.0	0.4	72.1	24.2	0.1	1.9	1.3	100.0
Texas 3/	0.3	50.7	20.0	0.6	4.0	23.4	99.0	0.6	53.4	29.0	0.4	6.0	10.6	100.0	0.7	49.3	35.0	0.6	7.0	7.5	100.0
Utah	0.8	45.4	21.4	0.8	8.2	23.4	100.0	0.7	48.5	22.3	0.8	12.3	15.4	100.0	0.6	50.1	22.4	1.2	14.0	11.7	100.0
Vermont	0.8	68.3	15.3	1.4	4.4	9.8	100.0	1.7	66.4	22.2	1.0	5.2	3.5	100.0	1.4	66.1	25.6	0.7	4.9	1.3	100.0
Virginia	0.3	65.2	15.4	0.7	1.4	17.0	100.0	0.5	70.7	21.3	0.6	1.8	5.1	100.0	0.6	70.7	24.2	0.7	2.1	1.7	100.0
Washington	0.3	57.3	24.1	0.3	5.6	12.5	100.0	0.5	57.9	28.3	0.3	7.1	5.8	100.0	1.0	56.7	31.9	0.2	7.8	2.3	100.0
West Virginia	0.3	65.7	14.9	0.7	4.0	14.4	100.0	1.0	66.3	22.5	0.8	5.0	4.4	100.0	1.0	67.2	24.5	0.8	4.6	1.9	100.0
Wisconsin	0.4	63.3	13.2	1.0	6.5	15.8	100.2	0.9	64.0	20.5	1.0	6.0	7.7	100.1	1.0	59.2	30.5	0.9	5.9	2.6	100.1
Wyoming	0.3	34.3	29.9	0.5	1.8	33.2	100.0	0.4	45.5	42.6	0.5	2.3	8.7	100.0	0.3	36.9	50.0	0.5	3.1	9.2	100.0
Puerto Rico	0.5	79.6	10.2	1.6	2.6	5.5	100.0	0.4	75.8	15.7	1.2	4.4	2.5	100.0	0.5	83.4	12.3	0.4	2.5	0.9	100.0

For footnotes, see Footnotes Page.

End of Part 1

Part 2

An Enhanced Vehicle Classification Method for Counting Numbers of Vehicles in Various Vehicle Groups

Background

Currently, all HPMS VMT by vehicle type data collected by State highway agencies are based on FHWA's 13 vehicle wheel base (axle spacing) and the number of axles criteria. However, the number of registered vehicles under various State registration laws and regulations may not necessary match the FHWA's wheel base and axle criteria. In the past, the split of the number of registered vehicles to FHWA's vehicle classification was primarily based on the Vehicle Inventory and Use Survey (VIUS). However, the discontinuation of the VIUS after the 2002 edition hampered the continued usage of such information. A new data source is needed to replace the information used to be provided by VIUS

The R. L. Polk Vehicle Registration data provides a national administrative data for all registered vehicles with information on both body type and wheelbase. This dual character of the registration data provides the mechanism to align the axle-spacing vehicle classification with vehicle body type information.

Method

The proposed method is to utilize the R. L. Polk Vehicle Registration's axle spacing (wheelbase), body type, and gross vehicle weight rating (GVWR) data to establish vehicle split percentage data for Light Duty Vehicle – Short Wheelbase, Light Duty Vehicle – Long Wheelbase, Single Unit Truck and Combination Truck. This Polk based percentage data are then applied to State supplied total registered vehicle data to obtain final count of each of the four vehicles.

Step 1

To obtain numbers of vehicles for both "Light Duty Vehicles – Short Wheelbase" and the "Light Duty Vehicles – Long Wheelbase" vehicles from *Polk's Car (both Domestic and Import) Database*

"Light Duty Vehicles – Short Wheelbase" are defined as all light duty vehicles with a wheelbase (axle spacing) less than or equal to 121 inches; The "Light

Duty Vehicles – Long Wheelbase" vehicles are defined as all light duty vehicles having an axle spacing greater than 121 inches.

Step 2

To obtain numbers of vehicles for both "Light Duty Vehicles – Short Wheelbase" and the "Light Duty Vehicles – Long Wheelbase" vehicles from *Polk's Light Truck Database*

The *Light Truck Database* includes vehicles with GVWR up to 13,000 lbs. It covers body types ranging from pickup, van, SUV and other light duty commercial vehicles.

Vehicles contained in *Polk's Light Truck Database* with wheel base less than or equal to 121 inches are all counted as "Light Duty Vehicles – Short Wheelbase;" Vehicles with wheelbase greater than 121 inches are counted as "Light Duty Vehicles – long wheel" vehicles.

Step 3

To obtain "Single Unit Truck" and "Combination Truck" Counts from *Polk's Heavy Truck Database*

Polk's Heavy Truck Database contains trucks with GVWR greater than 10,000 lbs. It is further divided into subgroups based on both body type and GVWR information (see Table below for example). The subgroup "Class 3" vehicle in the database overlaps with the *Light Truck* "Class 3". Consequently "Class 3" in the *Light Truck* database is removed from being considered as light truck.

Combination trucks are these registered as "Tractors" and the remaining ones are considered as "Single Unit Trucks"

Step 4

To Obtain the Percentage Split Data among "Light Duty Vehicles – Short Wheelbase", "Light Duty Vehicles – Long Wheelbase", "Single Unit Truck" and "Combination Truck"

Sum up all vehicle counts data obtained from Steps 1, 2 and 3; and compute percentages of each vehicle types accordingly.

Step 5

To Obtain Bus and Motorcycle Data

Bus and motorcycle data are obtained directly from MV-1

Step 6

To Obtain Final Vehicle Counts Data for All Six Vehicle Types

Use Bus and Motorcycle data directly from Step 5

Multiply the percentage data obtained in Step 4 with the difference between MV-1 total and motorcycle and bus combined to obtain final counts for the remaining four types of vehicles.

End of Part 2

Part 3

Vehicle Stock Model and Reconciliation Model for Fuel Economy

The FHWA has adopted the method developed by Oak Ridge National Laboratory in computing vehicle fuel efficiency for the six vehicle groups at the national level

Vehicle Stock Model and Reconciliation Model for Fuel Economy (MPG)

Prepared by Oak Ridge National Laboratory

Background

Vehicle Stock Models utilize historical data to establish fuel economy of different vehicle categories. The Reconciliation Model utilizes optimization techniques to further enhance the stock models and ensures that fuel consumptions match VMT, total fuel consumed, and continuity from previous years in VM-1 table. The sensitivity analysis shows that the sensitivities of the model are within reasonable ranges and solutions are stable.

The vehicle stock models (Sheets: "Light Duty Vehicle – Short Wheelbase", "Light Duty Vehicle – Long Wheelbase", "Motorcycle", "Bus", and "Truck") are used to estimate preliminary fuel consumption and fuel efficiency by vehicle type. Vehicle stock models use various data sources of different agencies and organizations to estimate the fleet fuel efficiency. Organizations and agencies publish their data once every 1 to 5 years. Here is a brief summary of updating procedures of vehicle stock models.

Light Duty Vehicle – Short Wheelbase and Light Duty Vehicle – Long Wheelbase share the same data source. EPA annually publishes MPG data by model year for cars and light trucks in *Light Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975-2009*[1]. The vehicle population data is from Polk's National Vehicle Population Profile, and this data is available annually. The VMT data is from the NHTS (National Household Travel Survey) program[2],

[1] More information and data can be found at http://www.epa.gov/otaq/fetrends.htm.
[2] More information on National Household Transportation Survey can be found at http://nhts.ornl.gov/ or http://www.bts.gov/programs/national_household_travel_survey/ or http://www.fhwa.dot.gov/policy/ohpi/nhts/index.cfm.

and it is only available for 2001 and 2009. The VMT data for years other than 2001 and 2009 is estimated using linear interpolation of 2001 and 2009. This method will be used for future updating when the NHTS is not available.

The stock model for buses is divided into three categories: transit bus, school bus, and motor coach. The data for transit buses is obtained from the *American Public Transit Association's Transit Fact Book, Appendix A*[3]. Specifically, the sources are as follows: VMT - from Table 6, population - from Table 17, Fuel Type % - from Table 26, Fuel consumed - from Table 32. VMT and population data for school buses is available from the School Bus Fleet website[4] for 1999, 2002, 2003, 2004, 2005, and 2007. Missing VMT and population data is estimated using linear interpolation. MPG data for school buses is from the DOE report *Economic Analysis of Alternative Fuel School Buses*. This report gives MPG by type of school bus: type A, type C, type D. The School Bus Fleet website also gives data on the total number of school buses by type. This population data is used to find a weighted average of MPG for all school buses using the MPG data from the DOE report. Motor coach data is from the *Motorcoach Census*[5]*s* published in 2009, 2008, 2006, and 2005. For years, during which the Motorcoach Census is not published, the VMT, population, and fuel consumption data is estimated using linear interpolation of available years. All calculation methods are in excel files, and further explanation of the data estimating procedure is given in these excel files.

Motorcycles are divided into 5 categories based on the engine size. These engine size categories are defined as: 0-124cc, 125-349cc, 350-449cc, 450-749cc, and 750cc or greater. The MPG data comes from the Total Motorcycle Fuel Economy Guide. VMT and population are from the NHTS. The motorcycle data from the NHTS should be handled the same as the Light Duty Vehicle – Short Wheelbase and Light Duty Vehicle – Long Wheelbase data from the NHTS.

All heavy truck data is from VIUS (Vehicle Inventory and Use Survey)[6][7]. The file includes both 2002 and 2007 data. The missing data is estimated using linear interpolation of these two years. For data by fuel type, fuel type 01 is gasoline and fuel types 02-15 are included in special fuels.

Some of data sources require a fee or membership to download. Updating the stock model requires approximately 40 FTE (full time equivalent). All models can be updated every year if new data is available.

The Reconciliation Model

[3] An electronic copy of the annual Transit Fact Book can be found at http://www.apta.com/resources/statistics/Pages/transitstats.aspx.
[4] More information can be found at http://www.schoolbusfleet.com/.
[5] More information can be found at http://www.buses.org/foundationresearch.
[6] Electronic copies of the Vehicle Inventory and Use Survey results by survey year can be found at http://www.census.gov/svsd/www/vius/products.html.
[7] Estimation of 2007 VIUS Variables, Battelle Memorial Institute, Columbus Ohio, October 2009.

The VMT and MPG reconciliation model (Sheet "VM-1") uses the results of the Vehicle Stock Model and data from Table VM-1 of the previous year, and VMT data from HPMS for the current year to provide fuel efficiency estimates for the current year. The VMT and MPG reconciliation model is implemented using the Excel Solver. The output is fuel efficiency estimates for the current year. The fuel consumed is calculated using VMT data of VM-1 for the current year and the fuel efficiency estimates (MPG, output of this model) for the current year.

The Excel Solver is set up to minimize the deviations of fuel efficiency from the previous year's estimates (published in Table VM-1) and from the results of the vehicle stock model The model is subject to the constraint that fuel consumption estimates must sum to the current year's fuel consumption. The model comes with current year as 2008 and previous year 2007.

The input parameters include results of vehicle stock model (green cells), light green represents output from stock model, and is considered as recommended value. The total fuel consumed from table MF-21 (orange cells) is also an important parameter. The reconciliation model (MPG estimates) is highly sensitive to stock model results. Therefore, it is important to have a set of well-estimated fuel efficiency data from stock model for each vehicle category. Another set of important parameters are MPG from the previous year from MV-1 table.

Other data in VM-1 table that may not have effects on MPG, however, they affect the total fuel consumed. These data are total VMT for each vehicle categories.

The optima solver is programmed into two buttons: solve and reset.

The solve button will start optima procedure, a message pops up to show if a solution has been found. It is possible that solution cannot be achieved after thousands of iterations. This indicates that model is not set up properly. The reset button turns the numbers back to its original values.

Sample of Stock Model for 2008

Light Duty Vehicle – Short Wheelbase:
Vehicle Stock Model
Light Duty Vehicle – SWB

Gasoline					
Model year	Pop_yf	VMT_yf total (miles)	VMT_y per vehicle (miles)	MPG_y f	Fuel consumption_y f total (gallons)
2008/2009	8,771,846	100,861,110,872	11,498	21.8	4,634,581,102
2007	11,148,222	143,287,030,261	12,853	24.0	5,958,919,031

2006	11,206,791	146,351,496,759	13,059	23.2	6,299,539,012
2005	11,460,983	136,591,662,040	11,918	23.3	5,863,562,291
2004	10,829,564	120,437,203,952	11,121	22.7	5,296,929,122
2003	10,642,021	117,111,550,267	11,005	22.8	5,135,299,290
2002	10,958,497	117,957,872,865	10,764	22.6	5,227,127,200
2001	10,450,060	109,938,511,016	10,520	23.0	4,770,475,801
2000	11,337,902	109,536,437,535	9,661	22.7	4,816,660,305
1999	10,202,527	94,423,734,106	9,255	22.5	4,191,970,766
1998	9,429,798	84,397,020,771	8,950	22.9	3,679,269,375
1997	8,929,375	74,913,181,283	8,390	23.0	3,252,677,671
1996	7,877,145	67,037,047,046	8,510	23.2	2,889,667,779
1995	8,427,365	63,782,928,635	7,569	23.1	2,762,952,029
1994	7,117,556	50,626,719,126	7,113	22.6	2,235,731,649
1993	6,344,347	45,573,192,604	7,183	23.3	1,958,798,935
1992	5,362,405	31,770,922,693	5,925	22.8	1,395,601,874
1991	4,845,331	32,265,308,218	6,659	23.0	1,402,289,920
1990	4,213,227	26,340,879,765	6,252	23.0	1,144,716,898
1989	3,852,916	21,236,197,413	5,512	22.8	930,897,789
1988	3,149,104	15,313,679,693	4,863	23.0	666,085,854
1987	2,589,966	13,360,375,059	5,159	22.4	595,175,924
1986	2,074,771	9,585,970,873	4,620	22.6	423,345,683
1985	1,424,693	6,263,573,316	4,396	22.1	283,552,890
1984 and older	4,495,767	16,256,082,987	3,616	19.4	837,266,157

Gasoline	
Total VMT (miles)	1,755,219,689,154
Total MPG	22.9
Total fuel consumed (gallons)	76,653,094,347

Avg MPG	**23.1**
Total VMT (miles)	1,874,151,754,974
Total fuel consumed (gallons)	81,045,200,237

Motorcycle:

Vehicle Stock Model

Motorcycle

under 125 cc					
Model year	Pop_ye	VMT_ye total	VMT_ye per vehicle	MPG_ye	Fuel consumption_yf

		(miles)	(miles)		total (gallons)
2008	7,018	15,232,744	2,171	96.7	157,526
2007	11,670	22,478,517	1,926	96.7	232,456
2006	27,224	54,126,100	1,988	90.0	601,401
2005	11,679	22,757,072	1,949	118.0	192,857
2004	15,103	22,603,839	1,497	118.0	191,558
2003	4,962	7,124,068	1,436	118.0	60,373
2002	3,383	4,685,579	1,385	118.0	39,708
2001	4,633	35,822,283	7,732	118.0	303,579
2000	6,065	7,599,873	1,253	118.0	64,406
1999	6,363	12,303,852	1,934	118.0	104,270
1998 and older	91,445	209,884,285	2,295	118.0	1,778,680

Total VMT (miles)	414,618,213
Total MPG	111.3
Total fuel consumed (gallons)	3,726,814

Bus

Vehicle Stock Model

Bus

Gasoline				
Bus Type	Pop_f	VMT_f	Fuel consumption_f	MPG_f
School	18,748	186,186,656	--	6.36
Transit	333	11,882,500	3,800,000	3.13
Motorcoach	0	--	--	--

Gasoline	
Total VMT	198,069,156
Total MPG	6.4
Total fuel consumed	31,162,927

Bus Avg MPG	**7.228834388**
Total VMT (miles)	8,161,851,889
Total fuel consumed (gallons)	1,129,068,872

Light Duty Vehicle – Long Wheelbase

Vehicle Stock Model

Light Duty Vehicle - Long Wheelbase

Gasoline					
Model year	Pop_yf	VMT_y total	VMT_y per vehicle	MPG_ yf	Fuel consumption_yf total (gallons)
2009/2010	490,823	8,302,028,293	16,915	16.4	505,327,709
2008	1,511,046	26,278,102,301	17,391	15.7	1,672,092,713
2007	1,761,843	25,542,058,580	14,497	17.2	1,484,628,535
2006	2,016,145	26,364,317,770	13,077	17.1	1,544,572,231
2005	2,237,680	29,096,652,482	13,003	16.4	1,779,342,429
2004	2,538,051	30,195,311,434	11,897	16.4	1,844,410,599
2003	2,393,927	29,936,950,005	12,505	16.5	1,814,131,970
2002	2,182,686	22,721,579,335	10,410	16.6	1,370,538,837
2001	2,350,926	23,971,717,596	10,197	16.9	1,422,135,543
2000	2,089,451	21,203,154,187	10,148	17.1	1,241,054,159
1999	1,980,056	17,447,818,511	8,812	16.3	1,072,052,576
1998	1,643,877	12,522,781,257	7,618	16.8	743,199,765
1997	1,766,682	13,565,469,463	7,679	17.0	798,195,697
1996	1,266,492	8,586,436,595	6,780	16.9	508,184,509
1995	1,397,928	9,559,176,040	6,838	16.6	575,274,294
1994	1,306,538	7,731,254,647	5,917	16.7	463,079,121
1993	918,145	6,576,242,724	7,163	16.6	396,209,297
1992	757,934	3,722,535,200	4,911	16.5	226,081,455
1991	599,113	3,496,336,014	5,836	16.8	207,824,583
1990	695,995	4,127,957,751	5,931	16.5	250,774,030
1989	709,058	3,055,978,447	4,310	16.3	187,776,510
1988	622,462	2,329,741,301	3,743	17.1	136,406,666
1987	372,340	1,222,623,990	3,284	16.5	74,185,195
1986	454,184	1,555,326,044	3,424	16.7	93,405,649
1985 and older	2,047,007	5,829,435,940	2,848	15.4	379,410,149

Gasoline	
Total VMT	344,940,985,907

Total MPG	16.6
Total fuel consumed	20,790,294,221

Avg MPG	**17.2**
Total VMT (miles)	433,434,710,727
Total fuel consumed (gallons)	25,246,547,879

Vehicle Stock Model					
Heavy Truck					
Single-unit 2-axle 6-tire or more					
Gasoline					
Model year	Pop_yf	VMT_y pe	VMT_yf total (r	MPG_yf	Fuel Consume
2007/2008	2,764	36,928	102,085,200	6.3	16,286,520
2006	6,177	40,487	250,080,230	6.4	39,306,469
2005	8,385	37,195	311,871,413	6.3	49,340,173
2004	9,560	36,025	344,405,971	6.5	52,919,404
2003	4,498	33,464	150,536,243	6.1	24,514,714
2002	6,841	23,318	159,517,266	6.1	25,947,254
2001	4,661	22,026	102,664,600	5.8	17,854,110
2000	5,797	19,970	115,754,544	6.4	18,046,486
1999	6,503	15,287	99,410,777	6.5	15,212,964
1998	2,731	15,522	42,397,690	6.5	6,538,403
1997	1,432	12,809	18,343,310	6.7	2,755,583
1996	1,607	13,864	22,276,582	6.2	3,583,907
1995	1,152	12,811	14,763,692	6.3	2,334,666
1994	2,089	10,850	22,662,040	5.9	3,865,289
1993	1,309	10,551	13,812,309	5.6	2,452,773
1992	1,678	9,549	16,025,371	5.6	2,859,634
1991 and older	126,140	4,748	598,907,187	5.8	103,819,094
Gasoline					
Total VMT	2,385,514,425				
Total MPG	6.15				
Total fuel consume	387,637,442				
Single-unit truck Avg MPG		**7.369322**			
Combination					
Gasoline					
Model year	Pop_yf	VMT_y pe	VMT_yf total (r	MPG_yf	Fuel Consume
2007/2008	0	54,365	0	5.1	0
2006	2	57,661	124,933	4.9	25,248
2005	29	52,652	1,507,563	5.0	302,473
2004	29	42,875	1,227,602	5.0	246,695
2003	0	37,609	0	4.9	0
2002	409	32,816	13,406,138	4.9	2,722,992
2001	261	27,451	7,173,932	4.9	1,468,632
2000	29	25,305	724,550	5.0	145,859
1999	235	20,699	4,865,452	5.0	982,686
1998	0	19,079	0	4.9	0
1997	29	16,108	461,204	4.9	94,925
1996	59	13,486	801,503	5.0	159,413
1995	29	11,046	316,279	4.9	63,978
1994	200	11,263	2,252,369	4.9	458,004
1993	888	9,735	8,641,055	4.9	1,768,137
1992	109	10,396	1,135,546	4.7	239,231
1991 and older	8,884	6,134	54,492,812	4.9	11,046,741
Gasoline					
Total VMT	97,130,939				
Total MPG	4.92				
Total fuel consume	19,725,013				
Combination truck Avg MPG		**5.955711**			

Heavy Truck

Vehicle Stock Model

Heavy Truck

Single-unit 2-axle 6-tire or more					
Gasoline					
Model year	Pop_yf	VMT_y per truck (miles)	VMT_yf total (miles)	MPG_yf	Fuel Consumed_yf total (gallons)
2007/2008	2,764	36,928	102,085,200	6.3	16,286,520
2006	6,177	40,487	250,080,230	6.4	39,306,469
2005	8,385	37,195	311,871,413	6.3	49,340,173
2004	9,560	36,025	344,405,971	6.5	52,919,404
2003	4,498	33,464	150,536,243	6.1	24,514,714
2002	6,841	23,318	159,517,266	6.1	25,947,254
2001	4,661	22,026	102,664,600	5.8	17,854,110
2000	5,797	19,970	115,754,544	6.4	18,046,486
1999	6,503	15,287	99,410,777	6.5	15,212,964
1998	2,731	15,522	42,397,690	6.5	6,538,403
1997	1,432	12,809	18,343,310	6.7	2,755,583
1996	1,607	13,864	22,276,582	6.2	3,583,907
1995	1,152	12,811	14,763,692	6.3	2,334,666
1994	2,089	10,850	22,662,040	5.9	3,865,289
1993	1,309	10,551	13,812,309	5.6	2,452,773
1992	1,678	9,549	16,025,371	5.6	2,859,634
1991 and older	126,140	4,748	598,907,187	5.8	103,819,094

Gasoline	
Total VMT	2,385,514,425
Total MPG	6.15
Total fuel consumed	387,637,442

Single-unit truck Avg MPG **7.369322**

Combination					
Gasoline					
Model year	Pop_yf	VMT_y per truck (miles)	VMT_yf total (miles)	MPG_yf	Fuel Consumed_yf total (gallons)
2007/2008	0	54,365	0	5.1	0
2006	2	57,661	124,933	4.9	25,248
2005	29	52,652	1,507,563	5.0	302,473
2004	29	42,875	1,227,602	5.0	246,695

2003	0	37,609	0	4.9	0
2002	409	32,816	13,406,138	4.9	2,722,992
2001	261	27,451	7,173,932	4.9	1,468,632
2000	29	25,305	724,550	5.0	145,859
1999	235	20,699	4,865,452	5.0	982,686
1998	0	19,079	0	4.9	0
1997	29	16,108	461,204	4.9	94,925
1996	59	13,486	801,503	5.0	159,413
1995	29	11,046	316,279	4.9	63,978
1994	200	11,263	2,252,369	4.9	458,004
1993	888	9,735	8,641,055	4.9	1,768,137
1992	109	10,396	1,135,546	4.7	239,231
1991 and older	8,884	6,134	54,492,812	4.9	11,046,741

Gasoline	
Total VMT	97,130,939
Total MPG	4.92
Total fuel consumed	19,725,013

Combination truck Avg MPG **5.955711**

Reconcilation Model

ANNUAL VEHICLE DISTANCE TRAVELED IN MILES AND RELATED DATA - 20XX 1/
BY HIGHWAY CATEGORY AND VEHICLE TYPE

TABLE VM-1

YEAR	ITEM	PASSENGER CARS	MOTOR-CYCLES	BUSES	OTHER 2-AXLE 4-TIRE VEHICLES 3/	SINGLE-UNIT 2-AXLE 6-TIRE OR MORE TRUCKS 4/	COMBINATION TRUCKS	SUBTOTALS: PASSENGER CARS AND OTHER 2-AXLE 4-TIRE VEHICLES	SUBTOTALS: SINGLE-UNIT 2-AXLE 6-TIRE OR MORE AND COMBINATION TRUCKS	ALL MOTOR VEHICLES 2/
	Motor-Vehicle Travel: (millions of vehicle-miles)									
Current	Interstate Rural									
Previous										
2009	Other Arterial Rural									
Previous										
2009	Other Rural									
Previous										
2009	All Rural									
Previous										
2009	Interstate Urban									
Previous										
2009	Other Urban									
Previous										
2009	All Urban									
Previous										
2009	Total Rural and Urban	2,032,374	20,504	13,534	620,986	121,088	169,105	2,653,360	290,193	2,977,591
Previous		2,011,363	19,527	14,798	617,258	126,729	183,834	2,628,621	310,563	2,973,509
2009	Number of motor vehicles	193,977,122	7,929,724	841,993	42,644,831	6,202,891	2,616,049	236,621,953	8,818,940	254,212,610
Previous	registered 5/	196,817,650	7,752,926	843,308	41,734,136	6,185,018	2,584,627	238,551,786	8,769,644	255,917,664
2009	Average miles traveled	10,477	2,586	16,073	14,562	19,521	64,641	11,213	32,906	11,713
Previous	per vehicle	10,219	2,519	17,548	14,790	20,490	71,126	11,019	35,413	11,619
2009	Person-miles of travel 6/	3,217,285	23,301	286,915	898,451	121,088	169,105	4,115,737	290,193	4,716,146
Previous	(millions)	3,177,954	24,799	313,749	1,070,127	126,729	183,834	4,248,081	310,563	4,897,191
2009	Fuel consumed	85,559,036	474,909	1,868,786	35,766,843	16,341,600	28,128,858	121,325,879	44,470,458	168,140,031
Previous	(thousand gallons)	84,742,620	459,371	2,059,292	35,781,330	17,145,119	30,577,571	120,523,950	47,722,690	170,765,303
2009	Average fuel consumption per	441	61	2,237	844	2,641	10,752	514	5,047	661
Previous	vehicle (gallons) 7/	431	59	2,442	850	2,772	11,831	505	5,442	667
2009	Average miles traveled per	23.8	43.2	7.2	17.4	7.4	6.0	21.9	6.5	17.7
Previous	gallon of fuel consumed 7/	23.7	42.5	7.2	17.3	7.4	6.0	21.8	6.5	17.4

SOLVE RESET

1/ The 50 states and the District of Columbia report travel by highway category, number of motor vehicles registered, and total fuel consumed. The travel and fuel data by vehicle type and stratification of trucks are estimated by the Federal Highway Administration (FHWA). Estimation procedures include use of State supplied data, the 2002 Census of Transportation Vehicle Inventory and Use Survey (VIUS), and other sources.

2/ Totals by highway category are from table VM-2. Some changes between rural and urban roadways can be attributed to 2002 census boundary changes.

3/ Other 2-Axle 4-Tire Vehicles which are not passenger cars. These include vans, pickup trucks, and sport/utility vehicles.

4/ Single-Unit 2-Axle 6-Tire or More Trucks on a single frame with at least two axles and six tires.

5/ Truck registration figures are from tables MV-1 and MV-9 with truck distribution estimated by the FHWA.

6/ Vehicle occupancy is estimated by the FHWA from the 2001 National Household Travel Survey (NHTS); For heavy trucks, 1 motor vehicle miles travelled = 1 person-miles traveled.

7/ Total fuel consumption figures are from tables MF-21 and MF-27. Distribution by vehicle type is estimated by the FHWA based on miles per gallon for both diesel and gasoline powered vehicles using State-supplied data, the 2002 VIUS, and other sources with nominal inputs for motorcycles and buses.

----------END of Publication FHWA-PL-11-031----------

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