Improved Data Collection and Evaluation for MOBILE6 Based Conformity Analysis of Transportation Projects

for

The Alabama Department of Transportation

By

Dr. Derek G. Williamson and Mr. Maosheng Yao
Department of Civil and Environmental Engineering
The University of Alabama
Tuscaloosa, Alabama 35473-0205

Prepared by

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University Transportation Center for Alabama
The University of Alabama, The University of Alabama in Birmingham,
and The University of Alabama at Huntsville

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16. Abstract

In response to federal air quality programs, state transportation and air quality agencies are obligated to estimate emissions from on-road vehicle fleets. The U.S. Environmental Protection Agency has developed the MOBILE models which estimate vehicle emission factors. However, local data describing vehicle activity and fleet characterization is rarely available in a format appropriate for the MOBILE models. This project was conducted to produce a methodology for the Alabama Department of Transportation (ALDOT) to collect and use local fleet data in support of MOBILE6-based emission inventories. To be beneficial to ALDOT, the proposed methodology had to utilize data and resources that were already being collected as part of other programs. Additionally, any software developed as part of the methodology had to be user friendly, written in Visual Basic, updatable, and easily integrated into existing programs and electronic infrastructure.

This project focused on vehicle counts as a surrogate for local vehicle miles traveled (VMT) data. VMT distributions by vehicle class are important input data to the MOBILE models. In compliance with federal standards, ALDOT already collects high-quality traffic data for the Highway Performance Management System (HPMS). HPMS classified traffic count data was selected as the source of local vehicle counts. However, HPMS uses a different classification system than the MOBILE5b and MOBILE 6 models. Therefore, conversion factors were needed to convert HPMS traffic data (14 classes) into the eight MOBILE 5b classes and the 30 MOBILE 6 classes. While the EPA has already published HPMS to MOBILE 5b conversion factors, HPMS to MOBILE 6 conversion factors were unavailable and were developed during this project. Given the shear volume of traffic data needed for emissions estimates, manual conversions were infeasible and a software package had to be developed.

The HPMS2MOBILE software package was developed during this project. This software takes in HPMS-formatted vehicle counts and produces MOBILE 5b and MOBILE 6 classified counts. The HPMS2MOBILE software and associated users guide (Appendix 2) is the ultimate product of this research project. The conversion factors used by this software to translate HPMS to MOBILE classes are stored in text files and may be easily updated as vehicle data regulatory programs change.

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Executive Summary

In response to federal air quality programs, state transportation and air quality agencies are obligated to estimate emissions from on-road vehicle fleets. The U.S. Environmental Protection Agency has developed the MOBILE models which estimate vehicle emission factors. The distribution of miles traveled by each class of vehicle (i.e., passenger car, diesel school bus, semi-tractor trailer, etc.) in a local fleet strongly influences emission estimates, and is used as input to the MOBILE models. However, local data describing VMT distribution are rarely available in a format appropriate for the MOBILE models. Classified vehicle counts are more readily available and, hence, were used as a surrogate for local vehicle miles traveled (VMT) data. The goal of this project was to develop a methodology for collecting local classified traffic count data and translating that data into a format suitable for input into the MOBILE5b and MOBILE6 emissions models.

Since the Alabama Department of Transportation (ALDOT) already collects vehicle counts through the Highway Performance Management System (HPMS), classified traffic count data was selected as the source of local vehicle counts. However, HPMS uses a different classification system than the MOBILE5b and MOBILE6 models. Therefore, a set of conversion factors were generated to convert HPMS traffic data (14 classes) into the eight MOBILE5b classes and the 30 MOBILE6 classes. Given the sheer volume of traffic data needed for emissions estimates, manual conversions were infeasible and a software package had to be developed.

The HPMS2MOBILE software package was developed to translate HPMS-formatted vehicle counts into MOBILE5b and MOBILE6 classified counts. The software was developed with input from ALDOT to insure its compatibility with existing programs and software maintenance procedures. The conversion factors used by this software to translate HPMS to MOBILE classes are stored in text files and may be easily updated as vehicle data regulatory programs change. The HPMS2MOBILE software and associated users guide (Appendix 2) are the ultimate product of this research project, and they enhance ALDOT's ability to incorporate local fleet composition data into emissions inventories and the conformity process.

Section 1.0
Introduction, Problem Statement, and Overall Approach

1.1 Introduction

In response to federal air quality programs, state transportation and air quality agencies are obligated to estimate emissions from vehicle fleets. The United States Environmental Protection Agency (EPA) has developed the MOBILE model system to help perform emission inventories. This model provides emission factors (grams/mile) for three major pollutants for each of several vehicle types. The EPA has often requested state agencies to use data describing the local vehicle fleet when running the MOBILE models. Collecting local data requires both financial resources and the development of collection methodologies. This project is responsive to the needs of transportation planners in the Alabama Department of Transportation (ALDOT) and other transportation agencies by providing a set of tools to help in the collection and use of local data for MOBILE modeling.

1.2 Problem Statement

As the need for local fleet composition data in MOBILE6 emissions estimates increase, innovative and efficient methods for obtaining such data are critical. Unfortunately, fleet characterization data in a form appropriate for MOBILE6 is not readily available in Alabama. ***The primary goal of this project was to develop and demonstrate a methodology for obtaining vehicle classification data that could be used in MOBILE6 emissions estimates.*** The secondary goal of this project was to maximize the feasibility of integrating the developed methodology into the existing ALDOT planning infrastructure.

1.3 Overall Approach

The overall approach of this research is to: (1) identify a source of fleet classification data (Section 3.2), (2) develop a series of methodologies for translating from source data formatting into appropriate formats for the MOBILE models (Section 3.3), (3) incorporate the developed methodologies into a new software package that will automate the translation of the chosen classification data into data suitable for input into the MOBILE5b and MOBILE6 models (Sections 3.4 and 4.2), and (4) indicate how this research approach to collecting MOBILE data could be integrated within existing programs at ALDOT (Section 4.4).

Section 2.0
Background

Air quality is a growing concern for transportation agencies throughout the country. Conformity assessment (evaluating vehicular emission inventories of ozone-forming chemicals) is a requirement in the planning process for transportation projects within areas not meeting National Ambient Air Quality Standards (NAAQS) for ozone. Conformity assessment involves two steps: (1) evaluating vehicular emission inventories of ozone-forming chemicals (volatile organic compounds (VOC) and Nitrogen Oxides (NOx)), and (2) insuring that new projects do not significantly increase these emissions inventories. Emission inventories are also two-step procedures. The first step is to characterize the fleet activity by estimating the vehicle miles traveled (VMT) for each class of vehicle (i.e., passenger car, light duty truck, school bus, etc.), within the area of interest. The second step is to use a software package to estimate VOC and NOx emission factors (grams pollutant/vehicle mile traveled) for each vehicle class (NRC, 2000). To obtain an estimate of the emissions for each chemical of interest, the VMT is multiplied by the chemical-specific emissions factor for each vehicle class and the emissions for all classes are summed, as shown in Equation 1.

$$\text{Emissions (grams)} = \sum_{1}^{\text{all classes}} \text{EmissionsFactor (grams/mile)} \times \text{VMT (miles)} \quad (1)$$

Ozone conformity assessment and emission inventories are a regulatory and planning challenge for state DOT's throughout the Southeast, including ALDOT. Two developments are expected to tremendously increase the challenge posed by conformity assessments in Alabama. The first is an increase in the number of cities/counties subject to conformity, and the second is the adoption of a new emissions model by EPA and FHWA.

With respect to ozone conformity in Alabama, only transportation projects in Birmingham (Shelby and Jefferson Counties) are currently subject to the conformity process. However, when the new 8-hour ozone standard is implemented, state policy makers suggest that up to 11 other counties may be designated as non-attainment with the new NAAQS (Seigelman, 2000). Areas most likely to exceed the 8-hour standard include: Mobile, Huntsville, Phenix City, parts of Clay County, and possibly Montgomery. Given the meteorological conditions in Alabama, as the number of ozone monitoring stations increases, it is expected that the number of non-attainment areas will grow. If the number of conformity assessments increases, the burden placed on the ALDOT Planning Bureau and local Metropolitan Planning Organizations (MPOs) will increase sharply.

The second challenge to conformity assessment in Alabama is a set of changes in the emissions modeling procedure. This development will increase the workload associated with conformity assessment. Conformity assessment is accomplished through the use of a federally mandated software package entitled "MOBILE," which is used to estimate emission factors for VOCs and NOx. The U.S. EPA and the Federal Highway Administration (FHWA) have been in the process of updating MOBILE for the last several years. The newest version of the MOBILE model was officially released in January 2002. State and local transportation and air quality agencies are in the process of shifting from MOBILE5 to MOBILE6. The switchover is a matter of policy, but is expected to take place in a phased approach, depending on the exact regulatory use of the model. In shifting to MOBILE6, the EPA is placing more emphasis on using local fleet characterization data in the conformity process. Fleet characterization includes descriptions of vehicle ages, fuel type, and miles traveled by vehicle class.

The increased use of local data represents an institutional change in the conformity process for Alabama. Currently, local data is not routinely collected and "default" information is used to describe the vehicle fleet in the Birmingham area. The default data consists mostly of published national values describing fleet age and composition as well as a local, one-time parking lot counts of vehicle types in Birmingham (Fulks, 2001). However, with increased administrative pressure to collect and use local data, continuing to use default data in executing MOBILE6 may become problematic. Previous EPA and FHWA policy in the Southeast has been to strongly discourage the use of default data (Fulks, 2001). If using local data becomes necessary, the collection and manipulation of such data will place an additional burden on ALDOT personnel working on conformity (the Metropolitan Planning Section of the Planning Bureau).

Section 3.0
Methodology

3.1 Overview

The research methodology supports the goals of this project (Section 1.2), and, consequently, is driven by two concerns: (1) the development of software to translate locally-collected fleet characterization data into a format recognized by the MOBILE models, and (2) the incorporation of ALDOT concerns into the software design and construction to promote incorporation of the software into the ALDOT conformity infrastructure. Development of the translation software consists of several steps: (1) selecting an appropriate source of local fleet data (Section 3.2), (2) implementing established algorithms to translate the data (Section 3.3), and (3) developing a user friendly interface that will allow a variety of output options (Section 3.4). Input from ALDOT personnel was solicited and incorporated into each of the above three steps. Demonstration of this software is accomplished using a set of data collected by ALDOT.

3.2 Fleet Classification Source Data

3.2.1 Desired Data Characteristics

Given the limited resources to perform emissions inventories, it is necessary that any methodology to enhance the collection of local data be cost effective. Moreover, the work must produce tools that can be smoothly integrated into existing state data collection procedures. A previous report (Williamson and Chidanamarri, 2000) described constraints that can inhibit the collection and use of local fleet characterization data including: institutional barriers to sharing of data, inconsistent format of electronic data at the county level, inconsistent data entry, and a VIN classification system that effectively prevents extracting information without expensive proprietary data searches. Based on this previous work, the ideal source for fleet characterization data can be defined as having the following characteristics: (1) a rigorously defined vehicle classification system, (2) readily available in a consistent electronic format, (3) can be translated into MOBILE6 format by using an automated (software) system consisting of an EPA/FHWA recognized algorithm, (4) routinely collected using FHWA approved methodologies, and (5) collected through a well funded program that has the flexibility to perform additional data collection as needed for conformity. The data source that meets all of these constraints is the Highway Performance Monitoring System (HPMS) classified traffic counting program. Details describing how HPMS satisfies all the above constraints are provided as part of the discussion in the remainder of Section 3.2 and in Sections 3.3 and 3.4 of this report.

3.2.2 HPMS Overview

The HPMS is a national system for collecting, maintaining, and reporting data detailing, "…the extent, condition, performance, use, and operating characteristics of the Nation's highways," (HPMS Field Manual, 2000). Obtaining comprehensive, high quality data for HPMS reporting is critical to the financial stability of every state's department of transportation because HPMS data are used for planning and apportioning various federal highway funds, including Transportation Equity for the 21st Century funds. Hence, HPMS provides a stable source of consistently formatted, high quality data for vehicle classification. Additionally, the U.S. EPA recognizes the HPMS as a quality source of local fleet data (EPA, 2002).

While a variety of different types of data are collected as part of the HPMS system, the data relevant to this research is traffic count data. Moreover, there are specific provisions of the HPMS system for traffic counting stations in and around ozone non-attainment areas (HPMS Handbook, 2000). Such stations are commonly referred to as donut stations in HPMS parlance.

3.2.3 HPMS Traffic Count Data

Two types of traffic counts are performed for HPMS: total traffic counts and classified counts. For the purposes of fleet characterization, the classified counts are of primary interest. Classified HPMS counts in Alabama are divided into 14 "bins," the first thirteen are listed in Table 3-1, and the fourteenth is an "unknown" bin where vehicle class cannot be determined. Classifications are made according to the HPMS field manual and federal traffic counting guidelines (Traffic Monitoring Guide, 2001). Classification is based on vehicle length and number of axles per vehicle. This methodology is well established, has required QA/QC procedures, and has established levels of statistical confidence (FHWA 2001; Turney, 2001).

3.2.4 Alabama DOT Traffic Counting Infrastructure

In addition to being recognized as a source of high quality data, it is critical that the selected source of characterization data be supported by a reliable and well-funded infrastructure in Alabama. As stated in Section 3.2.2, maintaining the HPMS system is critical to receiving federal funding and, hence, is a reliable and relatively well-funded effort within ALDOT. Traffic counting for HPMS reporting is performed by the traffic group within the ALDOT Planning Bureau. Permanent and temporary stations for collecting total and classified traffic counts exist throughout the state. Under HPMS mandate, Alabama must report classified counts at more than 2,300 HPMS sections statewide, with each section being counted once every three years. These counts are made with portable units consisting of a series of road tubes. Hence, a sustained, year-round effort of setting up, taking down, and maintaining portable classified count stations is administered by the state's Traffic Engineer (Turney, 2001).

Classified stations are a relatively new addition to permanent count stations in Alabama. Currently, there are between six and eight permanent classified counting stations operating, with the Abbeville station operating over the longest time (approximately two years). The state has recently (Summer 2002) purchased 20 classification units that will use embedded road loops and piezoelectric sensors to collect classification data for up to eight lanes simultaneously. The state will also install ten more Weigh-in-Motion (WIM) stations that will also be able to perform

HPMS classification counts. It is the intention of ALDOT to continue installing these permanent, continuous classification stations throughout the state, until approximately 30 to 40 are in place (Turney, 2002)

Table 3-1: HPMS vehicle codes and descriptions

Vehicle Bin Code	Description
1	**Motorcycles (Optional)**: All two- or three-wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and are steered by handle bars rather than a wheel. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheeled motorcycles. This vehicle type may be reported at the option of the State, but should not be reported with any other vehicle type.
2	**Passenger Car**s: All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers. Vehicles registered as passenger cars that are pickups , panels, vans, etc. (described as vehicle type "3") should be reported as vehicle type "3".
3	**Other Two-Axle, Four-Tire, Single-Unit Vehicle** s: All two-axle, four-tire vehicles, other than passenger cars. Included in this classification are pickups, panels, vans and other vehicles such as campers, motor homes, ambulances, hearses, and carryalls. Other two-axle, four-tire single-unit vehicles pulling recreational or other light trailers are included in this classification.
4	**Buse**s: All vehicles manufactured as traditional passenger-carrying buses with two-axles, six-tires and three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. All two-axle, four-tire minibuses should be classified as other two-axle, four-tire, single-unit vehicles (type "3"). Modified buses should be considered as trucks and be appropriately classified.
5	**Two-Axle, Six-Tire, Single-Unit Truck**s: All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having two axles and dual rear wheels.
6	**Three-Axle, Single-Unit Truck** s: All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having three axles.
7	**Four-or-More Axle, Single-Unit Truck**s: All vehicles on a single frame with four or more axles.
8	**Four-or-Less Axle, Single-Trailer Truck**s: All vehicles with four or less axles consisting of two units, one of which is a tractor or straight truck power-unit.
	Five-Axle, Single-Trailer Trucks: All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power-unit.
10	**Six-or-More Axle, Single-Trailer Truck**s: All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power-unit.
11	**Five-or-Less Axle, Multi-Trailer Truck**s: All vehicles with five or less axles consisting of three or more units, one of which is a tractor or straight truck power-unit.
12	**Six-Axle, Multi-Trailer Truck**s: All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power-unit.
13	**Seven-or-More Axle, Multi-Trailer Truck** s: All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power-unit.
14	**Miss Count.** Vehicles that could not be accurately assigned to the 13 defined classes.

(FHWA, 2001)

3.3 Translating HPMS COUNTS to MOBILE6 Counts

For the reasons explained in Section 3.2, the authors selected HPMS as the source of local vehicle classification data to use with the MOBILE model in developing locally relevant emission inventories. Unfortunately, HPMS classifies vehicles by length and number of axles, while MOBILE classifies data based on vehicle weight and fuel type. The Alabama HPMS system divides vehicles into 14 "bins" or classes (Table 3-1). MOBILE5b divides vehicles into eight classes (Table 3-2), while MOBILE6 divides vehicles into 30 classes (Table 3-3). Therefore, it is necessary to translate the locally-collected HPMS data into appropriate classes for use in the MOBILE models. The overall approach was to first use conversion factors to translate the HPMS counts into equivalent MOBILE5b counts then divide the MOBILE5b counts into the corresponding MOBILE6 counts, as illustrated in Figure 3-1. An established methodology already existed for translating HPMS into MOBILE5b counts, and one of the tasks of this research project was to develop a set of similar conversion factors to directly translate HPMS counts into the corresponding MOBILE6 counts. These methodologies are detailed in the next two subsections of this report.

Table 3-2: MOBILE5b vehicle classes (EPA, 1999)

Designation	Description	Gross Vehicle Weight (lb)
MC	Motorcycles	
LDGV	Light-duty gasoline vehicles	0 - 6,000
LDDV	Light-duty diesel vehicles	0 - 6,000
LDGT	Light-duty gasoline trucks	<6,000
LDGT	Light-duty gasoline trucks	6,001-8,500
HDGV	High-duty gasoline vehicles	
LDDT	Light-duty diesel trucks	<8500
HDDV	High-duty diesel vehicles	>8500

Table 3-3: MOBILE6 vehicle classes (EPA, 1999)

Designation	Description	Gross Vehicle Weight (lb)
LDGV	Light-duty gasoline vehicles	0 - 6,000
LDDV	Light-duty diesel vehicles	0 - 6,000
LDGT1	Light-duty gasoline trucks	<6,000
LDGT2	Light-duty gasoline trucks	6,001-8,500
HDGV (classes 2B-3)	Heavy-duty gasoline vehicles	14,000
HDGV (classes 4-8)	Heavy-duty gasoline vehicles	>14,000
HDDV (class 2B)	Light heavy-duty diesel trucks	8,501-10,000
HDDV (class 3)	Light heavy-duty diesel trucks	10,001-14,000
HDDV (classes 4-5)	Light heavy-duty diesel trucks	14,001-19,500
HDDV (classes 6-7)	Medium heavy-duty diesel trucks	19,501-33,000
HDDV (class 8A)	Heavy heavy-duty diesel trucks	33,001-60,000
HDDV (class 8B)	Heavy heavy-duty diesel trucks	>60,000
HDGB (school)	Heavy-duty gasoline school buses	All
HDGB (transit)	Heavy-duty gasoline transit buses	All
HDDB (school)	Heavy-duty diesel school buses	All
HDDB (transit)	Heavy-duty diesel transit buses	All

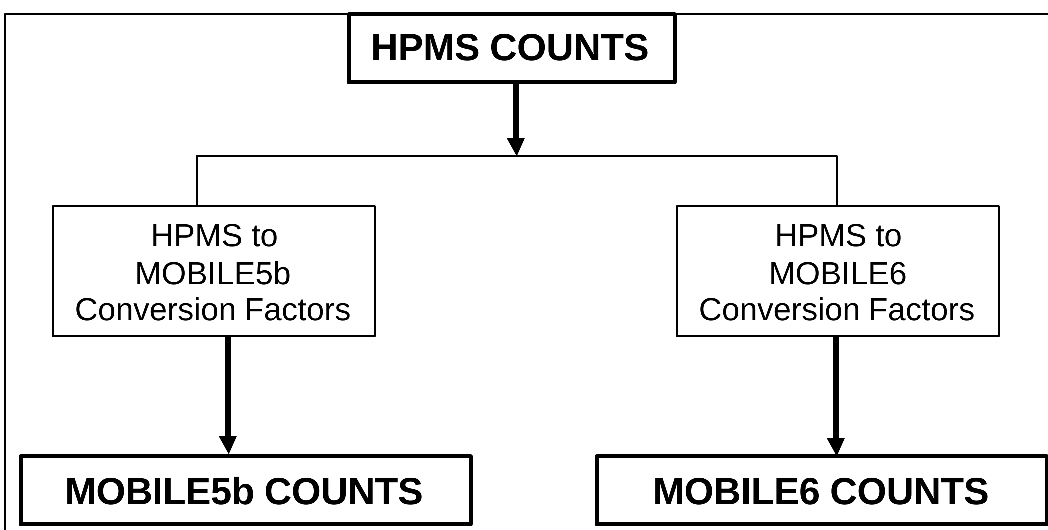

Figure 3-1: schematic of translation approach

3.3.1 Relating HPMS Classes to MOBILE5 Classes

The HPMS counts are translated into the corresponding MOBILE5b counts using an EPA method. Table 3-4 shows the factors for converting from FHWA/HPMS to EPA MOBILE5 vehicle types (NCHRP, 1997). This method was developed on the basis of the default MOBILE5 Vehicle Mile Traveled (VMT) mix fractions and American Automobile Manufactures Association's estimates of the diesel-gasoline split in annual sales of some vehicle classes over the past few years (NCHRP, 1997). Specifically, the 1987 Truck Inventory and Use Survey (TIUS) from the Census Bureau and the Transportation Energy Data Book supplied the data with which Table 3-4 was constructed (Davis and Strang, 1993).

The conversion factors provide a quick method for state and local analysts to convert their own vehicle classification data (obtained through HPMS) to MOBILE5 vehicle classes (NCHRP, 1997). For example, if an HPMS station counted 100 "2-axle, 6-tire, single unit trucks," the conversion factors from Table 3-4 can be used to apportion those 100 vehicles as: 10.69 LDGT1's, 9.92 LDGT2's , 50.36 HDGV's, 1.89 LDDT's, and 27.14 HDDV's. Obviously, fractional counts are not possible; the translated counts are ultimately rounded by the software developed in this research.

While the HPMS/MOBILE5 conversion factors already exist, this research marks the first time an automated system has been available to ALDOT personnel to translate HPMS source data directly into MOBILE5b input. While some consulting firms are purported to have this capability, the authors are not aware of any similar product which is generally available.

Table 3-4: Vehicle classification conversion from HPMS to MOBILE5

HPMS/Mobile 5	Motorcycle	LDGV	LDDV	LDGT1	LDGT2	HDGV	LDDT	HDDV
Motorcycles	100.00	-	-	-	-	-	-	-
Passenger cars	-	98.80	1.20	-	-	-	-	-
2 Axle, 4 Tire single unit				90.62	3.99	1.76	2.99	0.65
Buses	-	-	-	-	20.09	-	79.91	-
2 Axle, 6 Tire single unit	-	-	-	10.69	9.92	50.36	1.89	27.14
3 Axle single unit	-	-	-	0.71	0.01	14.44	0.01	84.83
4+ Axle single units	-	-	-	0.06	0.45	4.56	0.36	94.57
¾ Axle single trailer	-	-	-	0.06	0.02	5.13	0.01	94.77
5 Axle single trailer	-	-	-	0.00	-	1.01	0.02	98.97
6+ Axle single trailer	-	-	-	0.00	-	0.95	-	99.05
4/5 Axle multi trailer	-	-	-	-	-	-	-	100.00
6- Axle multi trailer	-	-	-	-	-	-	-	100.00
7+ Axle Multi trailer	-	-	-	-	-	-	-	100.00

NCHRP, 1997. Note a "-" entry indicates that there is no match between these classes.

3.3.2 Relating HPMS to MOBILE6 Classes

When developing this methodology, there was no complete set of conversion factors to translate HPMS classes into MOBILE6 classes. Therefore, the conversion factors were developed from more basic information in a fashion analogous to the (EPA and FHWA approved) HPMS to MOBILE5 factors.

The first step was to translate from HPMS to MOBILE5b. The 5b classes were then qualitatively mapped to their corresponding MOBILE6 classes, using Table 3-5. Data from the TIUS report and the EPA (1999) were used to quantitatively translate the mapped MOBILE5b classes to MOBILE6. In addition, information describing fuel sales (diesel vs. gasoline) was used as part of the procedure to assign HPMS classes to corresponding MOBILE6 classes. Table 3-6 contains the generated factors to directly convert HPMS (13 classes) into MOBILE6 counts (30 classes). ***Table 3-6 is the key product of this research and allows automated software translation from HPMS to MOBILE6 data types.***

Table 3-5: Matching of vehicle types between MOBILE5 and MOBILE6

MOBILE5 Vehicle Type	MOBILE6 Individual Vehicle Types in the MOBILE5 Type
LDGV	LDGV
LDGT1	LDGT1 & LDGT2
LDGT2	LDGT3 & LDGT4
HDGV	HDGV2B, HDGV3, HDGV4, HDGV5, HDGV6, HDGV7, HDGV8A, HDGV8B & HDGB
LDDV	LDDV
LDDT	LDDT1, LDDT2, LDDT3, & LDDT4
HDDV	HDDV2B, HDDV3, HDDV4, HDDV5, HDDV6, HDDV7, HDDV8A, HDDV8B, HDDBT & HDDBS
MC	MC

(EPA, 1999)

An example using the data from Table 3-6 to assign HPMS data from one class into its component MOBILE6 classes is illustrated in Figure 3-2. A more detailed discussion of the steps undertaken and data used to generate Table 3-6 is provided in Appendix 1.

Table 3-6: Vehicle type conversion from HPMS to MOBILE6 (%)

MOBILE6 Vehicle Type	Motor cycles	Passenger cars	2 Axle, 4 Tire single Unite	Buses	2 Axle, 6 Tire single Unit	3 Axle Single Units	4+ Axle single unit	¾ Axle single trailer	5-Axle single Trailer	6+Axle single trailer	4/5 Axle Multi trailer	6- Axle Multi trailer	7+ Axle Multi Trailer
MC	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LDGV	0.000	98.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LDGT1	0.000	0.000	20.870	0.000	2.461	0.164	0.014	0.014	0.000	0.000	0.000	0.000	0.000
LDGT2	0.000	0.000	69.750	0.000	8.229	0.547	0.046	0.046	0.000	0.000	0.000	0.000	0.000
LDGT3	0.000	0.000	2.733	13.770	6.795	0.007	0.308	0.014	0.000	0.000	0.000	0.000	0.000
LDGT4	0.000	0.000	1.257	6.330	3.125	0.003	0.142	0.006	0.000	0.000	0.000	0.000	0.000
HDGV2B	0.000	0.000	1.460	0.000	41.670	11.870	3.775	4.244	0.834	0.789	0.000	0.000	0.000
HDGV3	0.000	0.000	0.052	0.000	1.487	0.424	0.135	0.151	0.030	0.028	0.000	0.000	0.000
HDGV4	0.000	0.000	0.017	0.000	0.476	0.136	0.043	0.048	0.010	0.009	0.000	0.000	0.000
HDGV5	0.000	0.000	0.057	0.000	1.627	0.463	0.147	0.166	0.033	0.031	0.000	0.000	0.000
HDGV6	0.000	0.000	0.123	0.000	3.513	1.001	0.318	0.358	0.070	0.067	0.000	0.000	0.000
HDGV7	0.000	0.000	0.050	0.000	1.438	0.410	0.130	0.146	0.029	0.027	0.000	0.000	0.000
HDGV8A	0.000	0.000	0.000	0.000	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HDGV8B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HDGB	0.000	0.000	0.005	0.000	0.150	0.043	0.014	0.015	0.003	0.003	0.000	0.000	0.000
LDDV	0.000	1.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LDDT1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LDDT2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LDDT3	0.000	0.000	2.050	54.750	1.296	0.007	0.247	0.007	0.014	0.000	0.000	0.000	0.000
LDDT4	0.000	0.000	0.942	25.170	0.596	0.003	0.113	0.003	0.006	0.000	0.000	0.000	0.000
HDDV2B	0.000	0.000	0.127	0.000	5.291	16.540	18.440	18.480	19.290	19.310	19.490	19.490	19.490
HDDV3	0.000	0.000	0.038	0.000	1.587	4.962	5.531	5.543	5.788	5.793	5.849	5.849	5.849
HDDV4	0.000	0.000	0.036	0.000	1.493	4.668	5.204	5.215	5.446	5.451	5.503	5.503	5.503
HDDV5	0.000	0.000	0.017	0.000	0.718	2.244	2.502	2.508	2.618	2.621	2.646	2.646	2.646
HDDV6	0.000	0.000	0.073	0.000	3.042	9.508	10.600	10.620	11.090	11.100	11.210	11.210	11.210
HDDV7	0.000	0.000	0.104	0.000	4.357	13.620	15.180	15.210	15.890	15.900	16.050	16.050	16.050
HDDV8A	0.000	0.000	0.063	0.000	2.613	8.167	9.105	9.124	9.523	9.536	9.628	9.628	9.628
HDDV8B	0.000	0.000	0.144	0.000	6.031	18.850	21.020	21.060	21.990	22.010	22.220	22.220	22.220
HDDBT	0.000	0.000	0.006	0.000	1.758	5.495	6.126	6.139	6.411	6.417	6.478	6.478	6.478
HDDBS	0.000	0.000	0.042	0.000	0.248	0.776	0.865	0.867	0.906	0.907	0.915	0.915	0.915

Note: "0.000" in Table 6 indicates that HPMS vehicle type has no matching with the corresponding MOBILE6 vehicle type.

3.3.3 Quality Assurance

The conversion factors developed in this research and presented in Table 3-6 provide the basis for all subsequent translation of HPMS to MOBILE6 classes, and conclusions based on such translations. Therefore, it is necessary to validate the conversion factors. But the factors are a product of this research and there is no equivalent set available from other sources for verification purposes. While validation through comparison to an independent technique is not possible, other quality assurance steps were used to establish confidence in the validity of Table 3-6.

First, the methodology itself is based on the HPMS to MOBILE5b translation process that has been approved and sanctioned by both the EPA and the FHWA (Section 3.3.1). The same data sources and procedures that the EPA used to produce Table 3-4 were applied to produce Table 3-6. The first step of generating Table 3-6 conversion factors was utilizing the HPMS to MOBILE5 conversion factors (Table 3-4). The methodology for developing VMT distributions based on vehicle age, mileage accumulation rates, and fuel sales came from an EPA report (EPA, 1999) that has been validated many times through the EPA and FHWA review processes.

After Table 3-6 was developed, the EPA released technical support documentation for the MOBILE6 model (EPA, 2002) that included a detailed discussion of dividing vehicles into different classes. That discussion utilized the same set of approaches used within this research, further supporting this translation methodology within the MOBILE6 context.

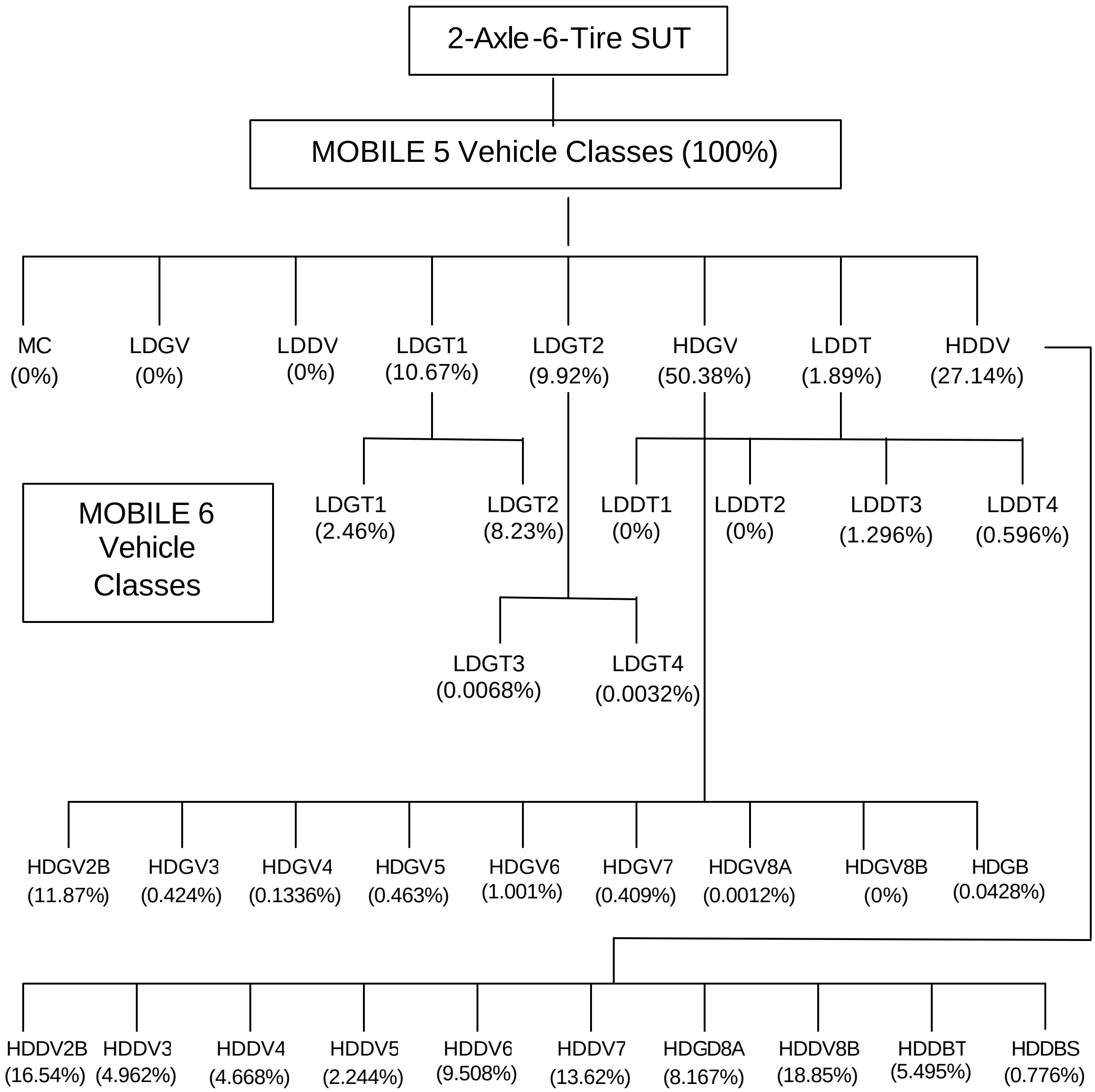

Figure 3-2: Conversion methodology demonstrated using the 2-Axle-6-Tire-SUT vehicle class

3.4 Automated Translating Software

While Table 3-6 provides the technical information for translating HPMS counts to MOBILE6 counts, manual translation is not practical on a scale necessary to perform mobile source emission inventories and conformity assessments. Therefore, a software package was developed to automate the translation process (application of Table 3-6). The automated translation software is expected to prove useful for any modeling, inventory, or conformity task that would benefit from translating HPMS to MOBILE6 travel data.

To insure maximum utility to ALDOT, input was solicited from key personnel in the Planning Bureau and Metropolitan Planning Section. As a result, a more flexible product was developed, which can be readily supported by ALDOT's computational infrastructure. Several of the key properties identified by ALDOT included: (1) input data should be in the HPMS "C" card format, (2) the program coding should be in the "Visual Basic" language, and (3) the conversion factors should not be hard coded into the main software program, but should be assembled in a text file for ease of updating.

Section 4.0
Products and Results

The primary objective of this research was to produce (and validate) software tools that could be integrated into ALdDOT's environmental and planning infrastructure. MOBILE modeling was performed only to the extent necessary to insure compatibility of the developed software tools with the MOBILE input formatting requirements. As most of the effort of this research went into development of the methodologies and software to implement the methodologies, much of the details of their development were provided in the Methodology Section (3.0). The Products and Results Section is devoted to descriptions of the HPMS2MOBILE software product, considerations for using translated HPMS data, and integration of the techniques developed in this research into the ALDOT planning and conformity infrastructure.

The basic product of this research is an automated technique to directly convert readily available HPMS classified counts into (otherwise hard to obtain) classified vehicle fleet data appropriate for input to MOBILE6. The heart of the automated translation is a table of conversion factors (Section 4.1). Section (4.2) describes the software product of this research. Section 4.3 presents several points that should be considered when using the translated classification data and associated MOBILE model runs. Finally, Section 4.4 provides suggestions for how to incorporate local HPMS data into the existing ALDOT conformity infrastructure.

4.1 Translation Table

The translation table developed in Section 3.3 and Appendix 1, is the critical (and until this research project, missing) information necessary to use HPMS data to support emissions inventories and air conformity assessments in Alabama. The translation table is a straightforward tool for converting from HPMS vehicle counts to the equivalent MOBILE6 vehicle counts. *An assumption inherent in this translation is that the vehicle mix stays constant in the vicinity of the counting station and, therefore, the vehicle mix is equal to the VMT mix in the vicinity of the counting station.* The appropriateness of this assumption is discussed in Section 4.3.

4.2 Software

The Visual Basic program, "HPMS2MOBILE," is the primary deliverable from this ALDOT research project. Descriptions of the program design, input features, output formats, and updating procedures are provided in this section. A more detailed description of the program, its use, and installation are provided in the "HPMS2MOBILE Users Guide" (Appendix 2). Overall flow of the program is illustrated in Figure 4-1 and is based on the methodology presented in Section 3.3. The HPMS2MOBILE software was developed using Visual Basic, and compiled for use in Microsoft Windows environments. It has several conversion options for the user. The conversion factors are separated from the software and loaded at run time, allowing for easy updating.

When the program is started, the user is prompted with a user friendly interface (Figure 4-2) showing a number of options. These options allow the user to exit the program or translate the HPMS data to MOBILE5 or MOBILE6 data by selecting the time period to be translated, the input file and output files, and the locations of the conversion factor files. There are two methods for translating counts from multiple stations: (1) setting up input files to include all stations for which translations are desired (in "C" card format), or (2) performing separate runs of the software for each station.

The daily or hourly traffic of individual MOBILE vehicle classes for each traffic direction (within the same station) are displayed in output files generated by this software. In addition, the total MOBILE vehicle traffic volume is displayed for each traffic direction of the user-specified time period. For MOBILE6 vehicle data, the vehicle counts for 30 vehicle types will be displayed, and for MOBILE5, the counts for 8 vehicle types will be displayed. Examples of MOBILE5 and MOBILE6 output files generated using the data from Abbeville, Alabama are included in Appendix 3. Due to the number of MOBILE6 classes, it is usually easier to review the data in the electronic output file, as opposed to printed copies.

The software was designed such that the conversion factors between HPMS and MOBILE can be easily updated without affecting the software itself. The conversion factors are based on collected traffic flow data and regulatory materials. As traffic flow and regulatory guidance change, conversion factors will also change. By having the conversion factors in separate text files (instead of hard coded into the HPMS2MOBILE software), they can be easily updated by institutional users with a text editor. The translation text files are named cm5 (HPMS to MOBILE5) and cm6 (HPMS to MOBILE6) and are located in the directory "aldot\conversion-factors," (as discussed in the installation instructions in the Users Guide (Appendix 2)). *The ability to easily update the data files is absolutely critical to the integration of HPMS data into the ALDOT conformity infrastructure.* To update the conversion table, Tables 3-4 and 3-6 should be consulted for the corresponding vehicle conversion factors. It is imperative that there is only one space between the conversion factors in the text files, and appropriate care should be taken when updating the conversion factors to maintain the existing format.

4.3 Considerations in Using HPMS Data for MOBILE6 Modeling

The HPMS2MOBILE software produces MOBILE5b or MOBILE6 classified counts. It is important to note that HPMS provides *counts*. Hence, classification is in terms of an individual HPMS class count as a fraction of the total vehicle counts. That is, HPMS deals with classification as a vehicle mix (VM), while the MOBILE model is ultimately concerned with classification as a Vehicle Miles Traveled (VMT) mix. Therefore, MOBILE classification is in terms of an individual class's miles traveled as a fraction of miles traveled for the entire fleet. Hence, either the translated VM data must be used in conjunction with other techniques to estimate the VMT mix, or an assumption must be made to translate counts (VM) to miles traveled (VMT mix). Such an assumption would state that vehicle mix stays constant in the vicinity of the counting station and, therefore, the vehicle mix is equal to the VMT mix in the vicinity of the counting station.

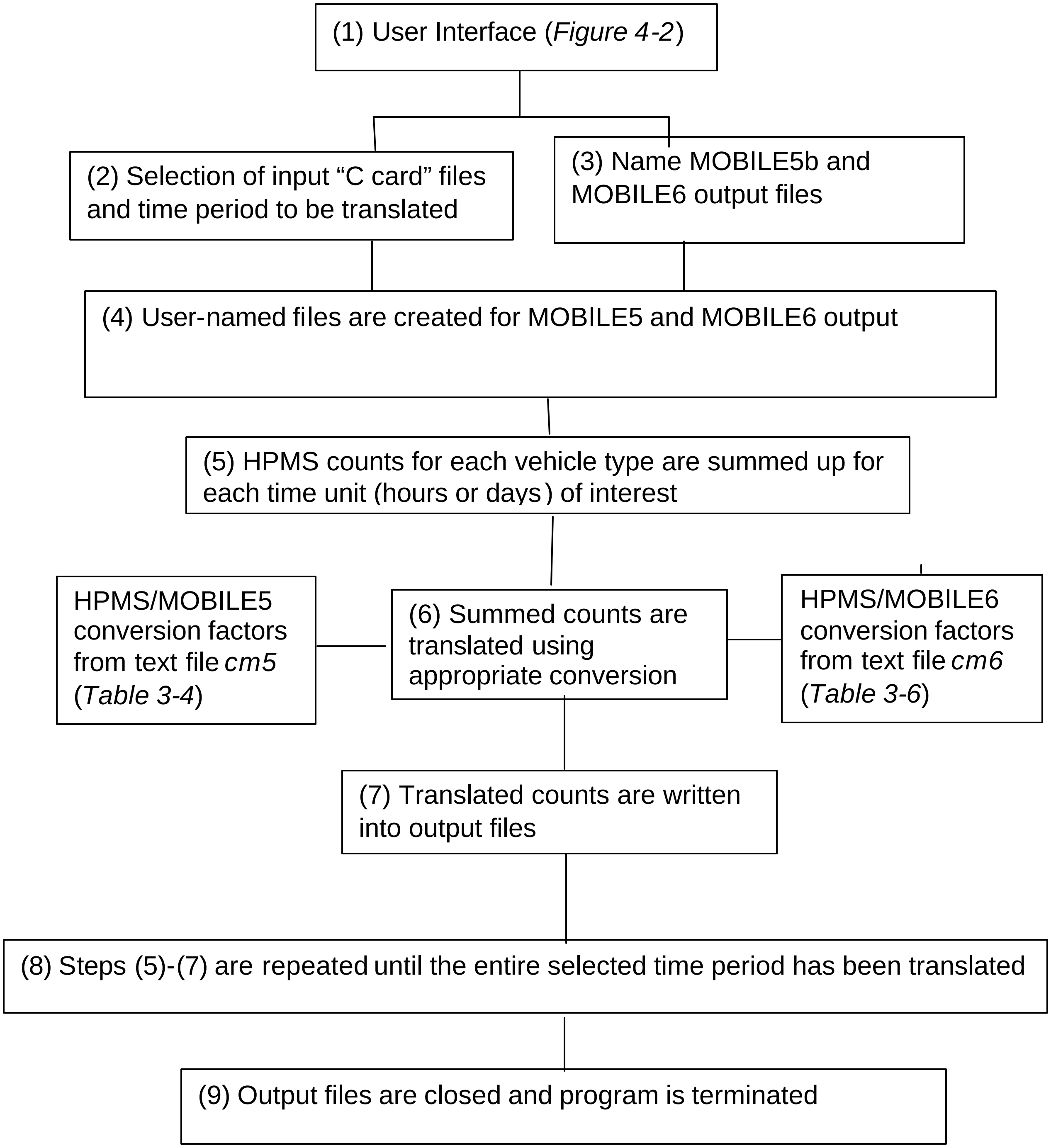

Figure 4-1: HPMS2MOBILE software operations schematic

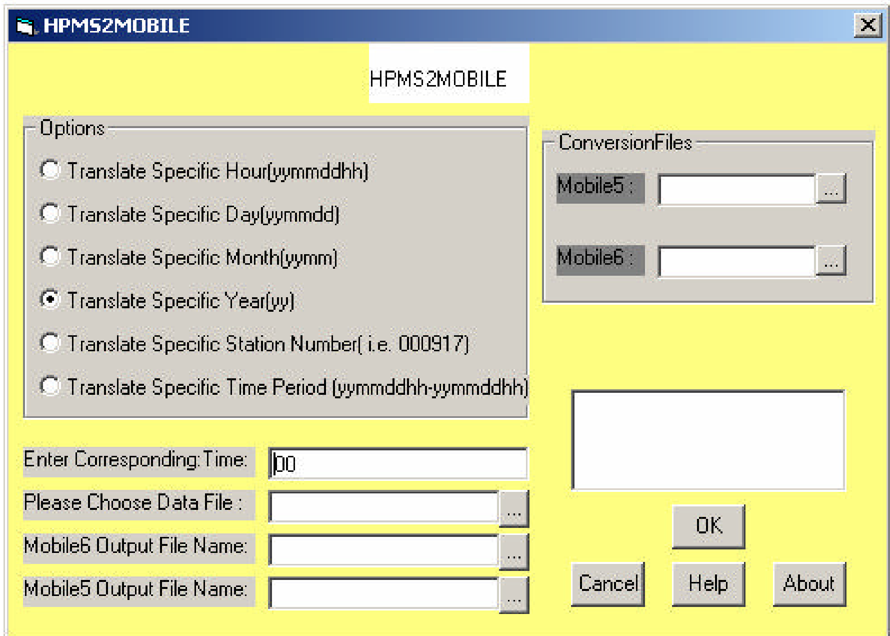

Figure 4-2: HPMS2MOBILE vehicle conversion software

The difference between VM and VMT mix is very important and relates to the appropriate use of the translated data. Theoretically, in the immediate vicinity of a counter, the VMT mix may be defined as the vehicle mix because in a very short road segment all vehicle types are traveling the same distance (the entire road segment). Therefore, the HPMS VM data is an appropriate surrogate for the MOBILE VMT mix if the assumption that the vehicle fleet is constant (i.e., that all vehicle classes travel the same distance) and valid. Such an assumption may be made when no other data is available to indicate how vehicle travel varies by class; such assumptions were made when static parking lot counts were used to define VMT mix in a particular urban area. Without specific travel data, it may be necessary to assume that all vehicle types travel the same distance in the area being inventoried. This assumption of a constant fleet is realistic in several circumstances: (1) when an emissions inventory is performed over a short road segment, (2) when examining the emissions from a limited access roadway, and (3) when HPMS classified counts are distributed with a traffic flow network and VMT mix is calculated by multiplying the count data by average travel distances of each class (from the flow net) within the area to be inventoried.

The critical issue in using HPMS data to provide local fleet characterization data is not the translation process itself, but rather *how* the translated data will be used. This research is focused on the generation of translated data for all the reasons enumerated in Sections 1 and 2. EPA recently issued a guidance document that discusses the specific use of such data in MOBILE modeling and the conformity process (EPA, 2002). Depending on the scope and objectives of a particular mobile-source emissions inventory, translated HPMS classification data could be used directly to represent VMT mix, or could be used with other local data (including registration, age distribution, and traffic flow models) to better define local fleet characterization.

4.4 Integration of HPMS Data into the ALDOT Conformity Infrastructure

This project was conceived, scoped, and executed with the cooperation of personnel in the ALDOT Planning Bureau and the Regional Planning Commission of Greater Birmingham. Most notably, input from Ms. Rebecca Fulks (Metropolitan Planning and Conformity Assessments), Mr. Charles Turney (Assistant Bureau Chief and Traffic Engineer) were solicited to help understand the institutional context of traffic data collection and conformity in ALDOT. Therefore, it is anticipated that the use of HMPS data to help describe local fleet classification can be successfully integrated into the ALDOT conformity process without requiring significant additional resources.

It is not trivial to implement changes in job responsibilities, established data gathering schedules, and planning procedures. Ultimately, the routine use of the HPMS data in conformity assessments and mobile source inventories will require the support of ALDOT Planning Bureau administrative personnel. However, there are a number of elements of this project that are designed specifically to ease the burden of such a procedural change.

As discussed in Section 3.2.4, the collection of traffic counts for HPMS is an established program within ALDOT. The continuous collection of classified counts at approximately 30-40 permanent stations and the routine collection (every 3 years) of classified counts at over 2300 stations are priorities and institutional requirements for the ALDOT Traffic Engineer. While the use of HPMS data in conformity assessments may require additional stations, relocation of existing stations, or both, the overall system is already in place. If more Alabama cities reach non-attainment status with the eight-hour ozone standard, more stations will certainly be needed to collect data necessary to classify local fleets. However, the “donut” provisions in the HPMS system require that states establish such stations. Therefore, the institutional structure for collecting the HPMS classified traffic counts is already in place, and should be capable of providing data for conformity assessments. The largest difficulty is likely to be coordinating data collection and conformity assessment (or inventory) schedules. Another issue will be the manpower needed to access the raw HPMS data and make them available to the personnel performing the conformity assessments; this concern can be minimized by using a standard data format (the “C” card).

The use and maintenance of the HPMS2MOBILE software package will be very straightforward and should be easily implemented. The HPMS2MOBILE users guide addresses installation and common questions regarding the use of the software. The program was written in Visual Basic^{TM} to be run with the Windows^{TM} operating system. Use of HPMS2MOBILE is expected to be straightforward due to its simplicity and menu driven format. Updating the software will be straightforward, as the most likely components to be updated are the conversion factors which are stored in easily modified text files. Finally, the Visual Basic programming language is supported by ALDOT, and software support can be provided through existing infrastructure and personnel.

The simplicity and flexibility of the HPMS2MOBILE software is expected to increase the probability of it being used by transportation planners interested in fleet composition and mobile source air quality impacts. For example, the ability to collate total fleet composition past any counting station for any desired time period will allow planners to look at changing fleet (and hence, emission) composition with time and location. Many “what if” questions, regarding inventories and air quality impacts associated with proposed developments, can be quickly explored using the HPMS2MOBILE software and readily available HPMS data.

Section 5.0
Conclusions and Recommendations

5.1 Project Goal

The primary goal of this project was to develop and demonstrate a methodology for obtaining vehicle classification data that could be used in MOBILE6 emissions estimates. The secondary goal was to assess the feasibility of implementing the developed software into the existing ALDOT planning infrastructure.

5.2 Results

The overall research approach used in this project is summarized in Table 5-1, and the findings from the research are listed following the table.

Table 5-1: Overall research approach

(1) Identify a source of fleet classification data (described in Section 3.2 of this report)
(2) Develop a series of methodologies for translating from source data formatting into appropriate format for the MOBILE models (Section 3.3)
(3) Incorporate the developed methodologies into a new software package that will automate the translation of the chosen classification data into data suitable for input into the MOBILE5b and MOBILE6 models (Sections 3.4 and 4.2)
(4) Indicate how this research approach to collecting MOBILE data could be integrated within existing programs at the Alabama Department of Transportation and Alabama Metropolitan Planning Organizations (Section 4.3)

(1) HPMS classified counts provide a readily available and cost-effective source of local fleet classification data

(2) EPA and FHWA have previously sanctioned the use of HPMS classified count data as a method of providing MOBILE5 fleet classification data and have provided a simple set of conversion factors for translating from HPMS to MOBILE5b,

(3) Exisitng EPA and FHWA methodologies and data sets allowed the construction of a complete set of HPMS to MOBILE6 vehicle class conversion factors,

(4) A Visual Basic Program was written that could read HPMS vehicle count data, divide the counts into either MOBILE5 or MOBILE6 vehicle classes, keep track of the total of each class of vehicle for any specified time period, and output the classification results in a format that could be readily used by transportation planners, and

(5) By soliciting the advice of ALDOT personnel, researchers devised a procedure for providing local fleet classification data that can be integrated into the existing conformity infrastructure without requiring significant additional resources.

5.3 Significance

This project is the result of anticipating Alabama's need for innovative methods of providing local data for conformity assessments. If EPA and FHWA follow past practice and strongly suggest the use of local data in performing MOBILE6 emissions estimates, a variety of methodologies will be needed to supply such data to transportation and air quality planners. In this work, a set of tools was developed to allow Alabama transportation planners to use local HPMS fleet classification data to supply input describing the local fleet composition for MOBILE6.

Section 6.0
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Appendix 1
Generating HPMS to MOBILE6 Conversion Factors

In Section 3.3.2, conversion factors were presented in Table 3-6 for translation of HPMS counts into corresponding MOBILE6 counts. While the use of Table 3-6 is straightforward and an example was supplied in Section 3.3.2, only a cursory description was provided of the steps necessary to construct the table. A complete description of the construction of Table 3-6 is provided in this Appendix. The methodology to generate Table 3-6 is based upon information provided in the EPA Report no. 420-P-99-001, "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6."

Table 3-6 was constructed using the information in Table 3-4 (Section 3.3.1), Table 3-5 (Section 3.3.2), and Tables A1-1 through A1-3. First, the HPMS distribution of vehicles was converted to a MOBILE5 distribution using the conversion factors presented in Table 3-4. Mapping of vehicle classification from MOBILE5 to MOBILE6 was achieved using Table 3-5. Lastly, Table A1-1, Table A1-2, and Table A1-3 were used to calculate the percentages of gasoline-powered vehicles and diesel-powered vehicles of MOBILE6 classes within the corresponding MOBILE5 classes.

Tables A1-1 through A1-3 provide the raw data necessary for generating Tables 3-6, as described herein. Table A1-1 shows the combined vehicle types (gasoline and diesel) used in MOBILE6. The values in Table A1-2 were selected from EPA-used vehicle counts classified by vehicle category and calendar year. Vehicle types shown in Table A1-2 are MOBILE6 combined vehicle categories. According to a national default vehicle count distribution and the EPA projected future years' vehicle distribution, the percentages of LDT1, LDT2, LDT3, and LDT4 within light duty categories remain the same for different calendar years, and also the percentages of heavy-duty sub classes remain the same within heavy-duty vehicle category (EPA, 1999). The values in Table A1-3 were selected from the EPA-used Diesel Fractions in MOBILE6 and are appropriate for the year 1996 and later (EPA, 1999).

Table A1-1: MOBILE6 combined vehicle types [EPA, 1999]

Combined Vehicle Types	Individual Vehicle Types in the Combined Type
LDV	LDGV&LDDV
LDT1	LDGT1&LDDT1
LDT2	LDGT2&LDDT2
LDT3	LDGT3&LDDT3
LDT4	LDGT4&LDDT4
HDGV2B	HDGV2B&HDDV2B
HDV3	HDGV3&HDDV3
HDV4	HDGV4&HDDV4
HDV5	HDGV5&HDDV5
HDV6	HDGV6&HDDV6
HDV7	HDGV7&HDDV7
HDV8A	HDGV8A&HDDV8A
HDV8B	HDGV8B&HDDV8B
MC	MC
HDBS	HDGB&HDDBS
HDDBT	HDDBT

Table A1-2: Vehicle counts in millions by calendar year, vehicle type [EPA, 1999]

Calendar Year	LDV	LDT1	LDT2	LDT3	LDT4	HDV2B	HDV3	HDV4
2000	113.163	13.071	43.513	13.815	6.353	6.929	0.613	0.454
Calendar Year	HDV5	HDV6	HDV7	HDV8A	HDV8B	MC	HDBS	HDDBT
2000	0.404	1.263	1.332	0.684	1.578	4.219	0.480	0.065

Table A1-3: Diesel fractions by calendar year, vehicle types [EPA, 1999]

Model Year	LDV	LDT1	LDT2	LDT3	LDT4	HDV2B	HDV3
1996 and later	0.001	0.000	0.000	0.013	0.013	0.200	0.677
Model Year	HDV4	HDV5	HDV6	HDV7	HDV8A	HDV8B	HDBS
1996 and later	0.861	0.465	0.630	0.856	0.999	1.000	0.959

With all the information presented in the above tables, it is possible to illustrate the methodology used to generate the individual conversion factors displayed in Table 3-6 and Figure 3-2 (Section 3.3.2). The HPMS vehicle category "2 Axle, 6 Tire Single Unit" in Table 3-6 is used as an example of the detailed calculations involved in converting HPMS vehicle classes to MOBILE6 vehicle classes. Referring to Table 3-4, "2 Axle, 6 Tire Single Unit" is distributed across MOBILE5 vehicle classes as LDGT1 (10.69%), LDGT2 (9.92%), HDGV (50.36%), LDDT (1.89%) and HDDV (27.14%). Table 3-5 shows the matching of MOBILE5 vehicle types with those described in MOBILE6. The HPMS vehicle type "2 Axle, 6 Tire Single Unit," is distributed within MOBILE6 vehicle categories as shown in Table A1-4.

Table A1-4: Matching of HPMS with MOBILE6 vehicle types (EPA, 1999)

2 Axle, 6 Tire Single Unit (Distribution to MOBILE5)	MOBILE6 Individual Vehicle Types in MOBILE5 Category
LDGT1 (10.69%)	LDGT1&LDGT2
LDGT2 (9.92%)	LDGT3&LDGT4
HDGV (50.36%)	HDGV2B, HDGV3, HDGV4, HDGV5, HDGV6, HDGV7, HDGV8A,HDGV8B &HDGB
LDDT (1.89%)	LDDT1, LDDT2, LDDT3 & LDDT4
HDDV (27.14%)	HDDV2B, HDDV3, DDV4, HDDV5, HDDV6, HDDV7, HDDV8A, HDDV8B, HDDBT&HDDBS

The next step is to quantitatively associate MOBILE6 sub-classes to MOBILE5 parent classes (Table A1-4). Ratios of subclass to parent class are used: the ratios of LDGT1, LDGT2 of MOBILE6 within LDGT1 of MOBILE5; the ratios of LDGT3, LDGT4 of MOBILE6 within LDGT2 of MOBILE5; and the ratios of LDDT1, LDDT2, LDDT3 and LDDT4 of MOBILE6 within LDDT of MOBILE5. From Table A1-2, the total vehicle count of light duty trucks is (LDT1+LDT2+LDT3+LDT4) = (13.071+43.513+13.815+6.353) = 76.752. According to Table A1-1 and Table A1-2, the following can be deduced:

LDT1=LDGT1+LDDT1=13.071,

LDT2=LDGT2+LDDT2=43.513,

LDT3=LDGT3+LDDT3=13.815, and

LDT4=LDGT4+LDDT4=6.353.

LDT1 accounts for (13.071/76.752)=17.03% of the total light duty trucks, LDT2 accounts for (43.513/76.752)=56.693% of the total light duty trucks, LDT3 accounts for (13.815/76.752)=17.99% of the total light duty trucks, and LDT4 accounts for (6.353/76.752)=8.277%.

From Table A1-3, it is observed that the diesel fractions of LDT1 and LDT2 are zero, thus the percentages of LDDT1 and LDDT2 are 0.00% of the total light duty trucks (76.752). So LDGT1 and LDGT2 are 17.03% and 56.693% of the total light duty trucks, respectively. Therefore, the ratio of LDGT1 to LDGT2 is 0.231:0.769(0.231=17.03/(17.03+56.693), 0.769=56.693/(17.03+56.693)).

In Table A1-4, LDGT1 and LDGT2 account for 10.69% of "2 Axle, 6 Tire Single Unit" with the ratio of 0.231:0.769 (LDGT1/LDGT2). Therefore, LDGT1 accounts for 0.231*10.69%=2.469% and LDGT2 accounts for 0.769*10.69%=8.2215% of "2 Axle, 6 Tire Single Unit."

From Table A1-3, the diesel fractions of LDT3 and LDT4 are 0.0126, thus the percentages of LDDT3 and LDDT4 are 0.0126*17.99%=0.2268% of 76.752, 0.0126*8.277%=0.10429% of 76.752, respectively. So the percentages of LDGT3 and LDGT4 are (17.99-0.2268)%=17.76% of 76.752, (8.277-0.10429)%=8.173% of 76.752, respectively. Therefore, the ratio of LDGT3 to LDGT4 is 0.685:0.315(0.685=17.76/(17.76+8.173), 0.315= 8.173/(17.76+8.173)), and the ratio of LDDT3 to LDDT4 is:

0.685:0.315 (0.685= 0.2268/(0.2268+0.10429), 0.315=0.10429/(0.2268+0.10429)).

In Table A1-4, LDGT3 and LDGT4 account for 9.92% of “2 Axle, 6 Tire Single Unit” with the ratio of 0.685:0.315, and (LDDT1&LDDT2&LDDT3&LDDT4) accounts for 1.89% with LDDT1=LDDT2=0% and the ratio of LDDT3 to LDDT4 being 0.685:0.315. So the following relationships can be presented:

LDGT3 accounts for (9.92*0.685)%=6.795%,
LDGT4 accounts for (9.92*0.315)%=3.125%,
LDDT3 accounts for (1.89*0.685)%=1.2946%,
LDDT4 accounts for (1.89*0.315)%=0.595% of “2 Axle, 6 Tire Single Unit”.

To summarize, the ratios obtained for light duty vehicles are shown in Table A1-5.

Table A1-5: Ratios of light-duty trucks

	LDT1		LDT2		LDT3		LDT4	
	LDDT1	LDGT1	LDDT2	LDGT2	LDDT3	LDGT3	LDDT4	LDGT4
Ratio	0.000	0.231	0.000	0.769	0.685	0.685	0.315	0.315

A similar procedure should be followed to assign MOBILE5b parent heavy duty vehicle classes to MOBILE6 subclasses. In Table A1-4, HDGV (MOBILE5 Type) accounts for 50.36%, and HDDV (MOBILE5 Type) accounts for 27.14% of “2 Axle, 6 Tire Single Unit”, respectively. Combining Table A2 and Table A3 yields Table A6.

Multiplying the ratios of diesel or gasoline in the Table A1-6 by 27.14%(HDDV) or 50.36%(HDGV) yields diesel vehicle percentage or gasoline vehicle percentage of “2 Axle, 6 Tire Single Unit” accordingly, as shown in Table 6 (Section 3.3.2).

Table 3-6 was generated based on EPA conversions from HPMS to MOBILE5 and vehicle counts and diesel fractions from Fleet Characterization Data for MOBILE6 (EPA, 1999). Every HPMS vehicle category is distributed within the vehicle types of MOBILE6 with an appropriate percentage. Table 3-6 can be used as the tool to translate the available HPMS vehicle classification data into MOBILE6 classes, which will be used for the emission modeling.

Table A1-6: Ratios of Heavy-Duty Trucks

Vehicle Type	Vehicle Counts		Ratio	
	Diesel	Gasoline	Diesel	Gasoline
HDV2B	1.385*	5.544	0.195*	0.8274
HDV3	0.415	0.198	0.059	0.030
HDV4	0.391	0.063	0.055	0.009
HDV5	0.188	0.216	0.027	0.032
HDV6	0.796	0.467	0.112	0.070
HDV7	1.140	0.191	0.161	0.029
HDV8A	0.684	0.001	0.096	0.000
HDV8B	1.578	0.000	0.222	0.000
HDBS	0.460	0.020	0.065	0.003
HDDBT	0.065		0.009	
SUM	7.102**	6.7	1.000	1.000

*Diesel vehicle count was calculated through multiplying the total vehicle counts in Table A1-2 by the diesel fractions of Table A1-3.
**The ratio was calculated as the percentage each sub vehicle type accounts of the heavy-duty diesel or gasoline vehicle categories. For example, 0.195=1.385/7.102.

APPENDIX 2
HPMS2MOBILE USERS GUIDE

A2.1. Overview

The HPMS2MOBILE software was developed as part of an ALDOT sponsored research project (930-475U). The State of Alabama is under regulatory mandate to develop mobile sources (vehicle) emission estimates using the EPA MOBILE system to estimate emission factors. Alabama has been using older and default data to represent the vehicle miles traveled. However, both EPA and FHWA are strongly encouraging the use of local fleet composition data. The purpose of this research was to develop a technique for collecting fleet composition (classification) and travel information in a format suitable for MOBILE6.

ALDOT collects fleet classification data using the HPMS data collecting and reporting program. The HPMS classification scheme is significantly different from that used by EPA. Therefore, this project established a conversion methodology between HPMS and EPA MOBILE6. Appendix 1 illustrates the complete procedure, embedded within the software, to convert HPMS traffic counts to EPA MOBILE6 traffic counts.

A program was written in Visual Basic to automate the conversion process illustrated in Appendix 1. The basic flow of the conversion is shown in Figure A2-1.

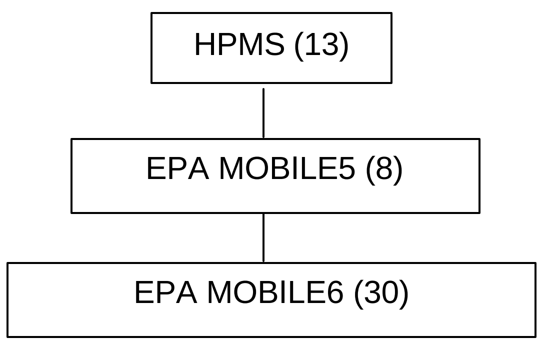

Figure A2-1: Flow work of conversion methodology

A2.2. Conversion Method

EPA has previously established the conversion methodology between HPMS (based on length and the number of the axles) and MOBILE5 (based on fuel and weight). EPA also developed the category relationship between MOBILE5 and MOBILE6. The conversion methodology developed in this research was based on these existing relationships. MOBILE5 has eight vehicle classifications, and MOBILE6 has 30 individual vehicle types and 16 combined vehicle types. HPMS classifies vehicles using 13 vehicle types. A description of the conversion process from HPMS to MOBILE6 was provided in Appendix 1. Figure 3-2 (introduced in Section 3.3.2 of this report) showed the selected vehicle type, “2-Axle-6-Tire-SUT” as an example for demonstrating the conversion methodology. The Figure demonstrates how the HPMS vehicle type “2-Axle-6-Tire-SUT” is split into five MOBIL5 vehicle categories, which are further split into corresponding MOBILE6 vehicle types.

A2.3. The HPMS2MOBILE Software Package

A2.3.1 Installation

The HPMS2MOBILE Software was developed using Visual Basic, and compiled for use in Microsoft Windows environments. It has several conversion options. The conversion factors are separated from the software and loaded at run time. To install the software, find and click the setup icon located in the directory named “aldot/software,” and then follow the screen instructions. After the setup is complete, the shortcut HPMS2MOBILE programs folder is accessible on the start menu.

A2.3.2 Execution

To run the software, go to the start menu, find the programs folder, and follow the steps shown below to complete the execution:

(1) Find and click the HPMS2MOBILE icon in the programs folder, and a window will open,

(2) Pick one of the six options to translate the HPMS,

(3) Enter the time period using the indicated format,

(4) Select the input file, which is formatted using FHWA HPMS vehicle classification,

(5) Either write the output file names for MOBILE5 and MOBILE6, or choose the file names using the browser button provided,

(6) Choose the conversion factor files named cM5 (MOBILE5) and cM6 (MOBILE6) located in the directory: aldot\conversion-factors. WARNING: Be sure to choose the correct conversion file for each entry, or the program will not work,

(7) Click the OK button.

A2.3.3 Operations

When the program is started, the user will be prompted with a user-friendly interface (Figure A2-2) showing a number of options. These options allow the users to: translate the HPMS data to MOBILE6 data by specifying the time period, select input file and output files, locate the conversion factors files, and exit the program.

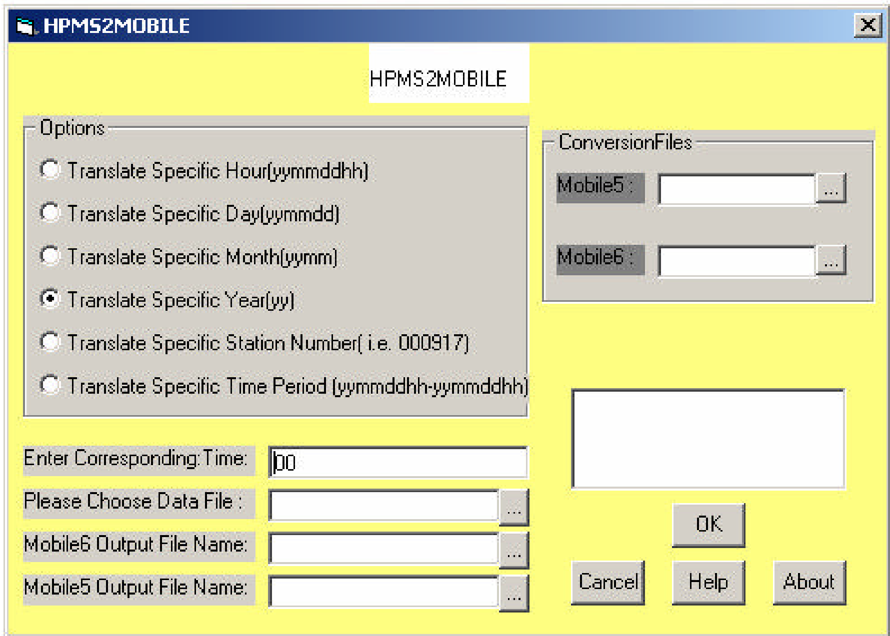

Figure A2-2: HPMS2MOBILE vehicle conversion software

There are six conversion options available: **1**. Translate Specific Hour, **2**. Translate Specific Day, **3**. Translate Specific Month, **4**. Translate Specific Year, **5**. Translate Specific Station Number, and **6**. Translate Any Specified Time Period.

For **Option 1**, the program will ask the user to input the specific hour by using the defined format of yymmddhh (year-month-day-hour) in the corresponding text box. The system reads all the record data in the user-selected input file that match the user-specified time period, and translates those selected HPMS data records into MOBILE data (both MOBILE6 and MOBILE5) according to the different traffic directions. The output data will be grouped by different stations and traffic directions.

For **Option 2**, the specific day is input in the format of yymmdd (year-month-day). The system reads all the record data in the user-selected input file that match the user-specified time period, and translates those selected HPMS data records into MOBILE data (both MOBILE6 and MOBILE5) according to the different traffic directions. The output shows the hourly MOBILE data for this user-chosen day, grouped by the different stations and traffic directions.

For **Option 3**, the specific month is input in the format of yymm (year-month). The system reads all the record data in the user-selected input file that match the user-specified year and month, and translates those selected HPMS data records into MOBILE data (both MOBILE6 and MOBILE5) according to the different traffic directions. The output shows daily traffic for all the MOBILE vehicle classes on each day within the specified month by different stations and traffic directions.

For **Option 4**, the specific year is input in the format of yy (year). The system reads all the record data in the user-selected input file that match the user-specified year, and translates those selected HPMS data records into MOBILE data (both MOBILE6 and MOBILE5) according to the different traffic directions. The output shows the daily traffic of every month for all the MOBILE vehicle classes by different stations and traffic directions.

For **Option 5**, the specific station number is input by the user (for example, 000917), and the system reads all the record data in the user selected input file that match the user-specified station number, and translate those selected HPMS data records into MOBILE data (both MOBILE6 and MOBILE5) according to the different traffic directions. The output will show the daily traffic for all the MOBILE vehicle classes by the different traffic directions within the same user specified station.

For **Option 6**, the user inputs the time period to translate HPMS data into MOBILE data, and the system reads all the data records in the user-selected input file to locate the data within this time period, and translates them into MOBILE vehicle classes. The output shows the daily traffic by different stations and traffic directions.

After the user picks one of these six options, the software reads the input file and uses the loaded conversion factors in Table 3-6 to translate those selected HPMS data records into MOBILE data. The software will output the results to the user specified output files.

A2.3.4 Output of Software. In the MOBILE output files, the daily or hourly traffic of individual MOBILE vehicle class for each traffic direction at the same station will be displayed. In addition to this, the total MOBILE vehicle traffic volume will also be displayed for each traffic direction of the user specified time period. For MOBILE6 vehicle data, the vehicle counts for 30 vehicle types will be displayed, and for MOBILE5, the information for eight vehicle types will be displayed.

The output file of the software also contains HPMS data information such as station ID, time period of data, HPMS data source, and how many records were converted, together with those traffic directions with no data available. An example of a partial output file is shown in Table A2-1. For more output information, examples of the output files in Appendix 3 of this document should be consulted.

Table A2-1: Partial example of HPMS2MOBILE output

mmdd	MC	LDGV	LDGTl	LDGT2	LDGT3	LDGT4	HDGV2B	HDGV3	HDGV4	HDGV5	HDGV6	HDGV7
0702	20.000	4612.9	169.03	564.92	25.923	11.922	26.824	0.9571	0.3065	1.0464	2.2607	0.9258
0703	19.000	4653.4	208.44	696.65	33.227	15.281	46.774	1.6690	0.5343	1.8251	3.9425	1.6143
0704	30.000	5715.5	198.76	664.31	29.938	13.769	30.975	1.1052	0.3539	1.2083	2.6105	1.0691
0705	34.000	5567.3	262.38	876.93	43.096	19.821	68.670	2.4502	0.7843	2.6796	5.7883	2.3699

A2.4. Updating Software

The HPMS2MOBILE software was designed such that the conversion factors between HPMS and MOBILE can be easily updated without affecting the software itself. The complete source files for the software can be found in the directory “aldot\software\source.” The conversion factors files are located in the directory “aldot\conversion-factors,” and are shown in Appendix 4.

To update the conversion text files, Tables 3-1 and 3-3 in this document must be consulted for the original vehicle conversion factors. It is imperative that there is only one space between the conversion factors in the conversion files, and appropriate care should be taken when updating the conversion factors to maintain the original formatting.

Appendix 3
Example Output Files

Table A3-1: Example HPMS2MOBILE output file for Mobile 5b data

```
                 Below are converted Mobile5 vehicle data
                          Traffic Direction:1
==================================================================
      mmdd MC      LDGV   LDDV   LDGTl  LDGT2  HDGV   LDDT   HDDV
      ----------------------------------------------------------------
      0702 20.000  4612.9 56.028 733.96 37.845 32.387 34.326 97.563
      0703 19.000  4653.4 56.520 905.10 48.507 56.515 41.271 264.70
      0704 30.000  5715.5 69.420 863.08 43.707 37.400 37.854 127.05
      0705 34.000  5567.3 67.620 1139.3 62.916 82.982 51.992 435.90
      0706 22.000  4235.5 51.444 902.23 53.061 70.618 51.171 470.02
      0707 24.000  4803.6 58.344 1000.0 56.670 72.865 51.972 423.54
      0708 43.000  5776.8 70.164 1050.3 53.025 44.479 46.508 143.76
      0709 29.000  5504.1 66.852 992.91 49.410 41.531 41.371 138.88
      0710 16.000  3620.0 43.968 838.94 49.769 70.102 46.692 419.59
      0711 18.000  3124.0 37.944 706.71 45.146 69.852 47.133 507.23
      0712 19.000  3268.3 39.696 772.23 46.208 73.010 41.330 492.30
      0713 12.000  3651.6 44.352 840.95 50.549 64.591 55.304 467.69
      0714 24.000  4493.4 54.576 1022.5 60.579 71.705 64.681 387.56
      0715 18.000  5279.8 64.128 938.25 48.325 47.976 39.781 140.77
       0716 0      53.352 0.6480 13.007 0.8562 1.7673 0.4755 1.8949

      sum  328.00  64360. 781.70 12719. 706.58 837.78 651.86 4518.5

                          Traffic Direction:5
==================================================================
      mmdd MC      LDGV   LDDV   LDGTl  LDGT2  HDGV   LDDT   HDDV
      ----------------------------------------------------------------
      0702 27.000  4700.9 57.096 705.09 37.270 32.779 35.786 102.14
      0703 12.000  3972.7 48.252 759.65 41.324 50.866 34.807 227.43
      0704 14.000  3100.3 37.656 561.80 28.860 30.046 23.057 135.29
      0705 25.000  4080.4 49.560 878.66 51.081 75.489 44.090 358.77
      0706 16.000  3904.5 47.424 838.96 51.671 68.707 53.898 400.86
      0707 26.000  5080.3 61.704 1115.0 61.040 74.640 53.351 388.03
      0708 27.000  5431.0 65.964 996.61 51.027 46.745 44.027 151.69
      0709 24.000  3991.5 48.480 691.43 36.018 36.276 29.869 116.48
      0710 11.000  3574.5 43.416 804.16 52.179 75.798 56.147 378.80
      0711 14.000  3142.8 38.172 673.63 41.990 69.534 37.346 428.57
      0712 9.0000  3365.1 40.872 790.12 48.123 78.484 40.576 450.78
      0713 17.000  4019.1 48.816 881.49 51.417 66.821 50.370 413.00
      0714 34.000  5672.1 68.892 1166.1 64.246 81.594 54.446 423.68
      0715 19.000  5936.8 72.108 1059.1 52.422 43.549 43.570 143.38
       0716 0      50.388 0.6120 8.1558 0.3591 0.1887 0.2697 3.0276

      sum  275.00  60023. 729.02 11930. 669.03 831.52 601.61 4122.0

              -----------------------------------------------------------
      TotalMC     LDGV   LDDV   LDGTl  LDGT2  HDGV   LDDT   HDDV
        603.00  124383 1510.7 24649. 1375.6 1669.3 1253.4 8640.5
=================================================================
                           Data Information
=================================================================
                      Station Number:000917
           Time Period of Data(yymmddhh):00--00/07/16/00
         Data source:C:\msyao\aldot\examples\input-files\AL00.cla
        Data Translated:total 1348 records have been translated.
                Not counted 14th HPMS counts:15666
                               Time:
```

Table A3-2: Example HPMS2MOBILE of partial* output file for Mobile 6 data

Below are converted Mobile6 vehicle data

Traffic Direction:1

mmdd	MC	LDGV	LDGTl	LDGT2	LDGT3	LDGT4	HDGV2B	HDGV3	HDGV4	HDGV5	HDGV6	HDGV7		
0702	20.000	4612.9	169.03	564.92	25.923	11.922	26.824	0.9571	0.3065	1.0464	2.2607	0.9258	0.0031	0
0703	19.000	4653.4	208.44	696.65	33.227	15.281	46.774	1.6690	0.5343	1.8251	3.9425	1.6143	0.0052	0
0704	30.000	5715.5	198.76	664.31	29.938	13.769	30.975	1.1052	0.3539	1.2083	2.6105	1.0691	0.0036	0
0705	34.000	5567.3	262.38	876.93	43.096	19.821	68.670	2.4502	0.7843	2.6796	5.7883	2.3699	0.0075	0
0706	22.000	4235.5	207.78	694.43	36.347	16.716	58.441	2.0852	0.6674	2.2805	4.9261	2.0169	0.0063	0
0707	24.000	4803.6	230.31	769.73	38.819	17.853	60.299	2.1515	0.6887	2.3530	5.0826	2.0810	0.0066	0
0708	43.000	5776.8	241.89	808.43	36.321	16.705	36.835	1.3144	0.4209	1.4369	3.1044	1.2713	0.0042	0
0709	29.000	5504.1	228.66	764.23	33.845	15.566	34.395	1.2273	0.3930	1.3417	2.8988	1.1871	0.0040	0
0710	16.000	3620.0	193.20	645.72	34.092	15.679	58.008	2.0698	0.6625	2.2637	4.8896	2.0019	0.0062	0
0711	18.000	3124.0	162.75	543.94	30.926	14.223	57.787	2.0618	0.6599	2.2552	4.8712	1.9943	0.0061	0
0712	19.000	3268.3	177.84	594.38	31.653	14.557	60.395	2.1549	0.6897	2.3569	5.0910	2.0843	0.0064	0
0713	12.000	3651.6	193.67	647.27	34.627	15.925	53.436	1.9066	0.6103	2.0852	4.5042	1.8441	0.0058	0
0714	24.000	4493.4	235.50	787.07	41.498	19.085	59.342	2.1174	0.6778	2.3156	5.0019	2.0480	0.0065	0
0715	18.000	5279.8	216.08	722.16	33.102	15.224	39.722	1.4174	0.4538	1.5498	3.3479	1.3709	0.0045	0
0716	0	53.352	2.9956	10.011	0.5864	0.2697	1.4628	0.0522	0.0167	0.0571	0.1233	0.0504	0.0001	0
sum	328.00	64360.	2929.3	9790.2	484.00	222.60	693.37	24.740	7.9201	27.055	58.443	23.930	0.0767	0

Traffic Direction:5

mmdd	MC	LDGV	LDGTl	LDGT2	LDGT3	LDGT4	HDGV2B	HDGV3	HDGV4	HDGV5	HDGV6	HDGV7		
0702	27.000	4700.9	162.38	542.70	25.530	11.741	27.144	0.9686	0.3101	1.0589	2.2877	0.9368	0.0031	0
0703	12.000	3972.7	174.94	584.69	28.307	13.018	42.097	1.5021	0.4808	1.6427	3.5484	1.4528	0.0046	0
0704	14.000	3100.3	129.38	432.41	19.768	9.0920	24.878	0.8877	0.2842	0.9706	2.0968	0.8586	0.0028	0
0705	25.000	4080.4	202.35	676.30	34.990	16.092	62.455	2.2285	0.7133	2.4373	5.2646	2.1554	0.0067	0
0706	16.000	3904.5	193.21	645.73	35.395	16.278	56.864	2.0289	0.6494	2.2190	4.7931	1.9625	0.0061	0
0707	26.000	5080.3	256.79	858.25	41.812	19.229	61.770	2.2040	0.7055	2.4103	5.2066	2.1318	0.0068	0
0708	27.000	5431.0	229.52	767.09	34.952	16.075	38.708	1.3812	0.4422	1.5101	3.2623	1.3359	0.0044	0
0709	24.000	3991.5	159.23	532.19	24.672	11.347	30.039	1.0719	0.3431	1.1720	2.5318	1.0367	0.0034	0
0710	11.000	3574.5	185.19	618.95	35.744	16.438	62.724	2.2381	0.7163	2.4479	5.2872	2.1647	0.0067	0
0711	14.000	3142.8	155.13	518.48	28.763	13.228	57.533	2.0528	0.6570	2.2453	4.8497	1.9855	0.0061	0
0712	9.0000	3365.1	181.96	608.14	32.964	15.160	64.941	2.3172	0.7416	2.5344	5.4742	2.2412	0.0069	0
0713	17.000	4019.1	203.00	678.47	35.221	16.198	55.295	1.9729	0.6315	2.1577	4.6609	1.9083	0.0060	0
0714	34.000	5672.1	268.56	897.58	44.008	20.239	67.529	2.4095	0.7713	2.6351	5.6920	2.3305	7.4254	0
0715	19.000	5936.8	243.93	815.25	35.908	16.515	36.066	1.2869	0.4121	1.4068	3.0395	1.2448	0.0042	0
0716	0	50.388	1.8783	6.2775	0.2459	0.1131	0.1564	0.0055	0.0017	0.0060	0.0131	0.0054	0.0000	0
sum	275.00	60023.	2747.5	9182.5	458.28	210.77	688.20	24.556	7.8609	26.854	58.008	23.751	0.0756	0

TotalMC	LDGV	LDGTl	LDGT2	LDGT3	LDGT4	HDGV2B	HDGV3	HDGV4	HDGV5	HDGV6	HDGV7		
603.00	124383	5676.8	18972.	942.29	433.37	1381.5	49.297	15.781	53.910	116.45	47.681	0.1524	0

Data Information

Station Number:000917
Time Period of Data(yymmddhh):00--00/07/16/00
Data source:C:\msyao\aldot\examples\input-files\AL00.cla
Data Translated: total 1348 records have been translated.
Not counted 14th HPMS counts:15666
Time:

*This table displays only the first 12 MOBILE6 classes; the full output file contains data columns for all 30 Mobile 6 classes

Appendix 4
HPMS2MOBILE Translation Table Text Files

```
100 0 0 0 0 0 0 0
0 98.8 1.2 0 0 0 0 0
0 0 0 90.62 3.99 1.76 2.99 0.65
0 0 0 0 20.09 0 79.91 0
0 0 0 10.7 9.92 50.36 1.89 27.14
0 0 0 0.71 0.01 14.44 0.01 84.83
0 0 0 0.06 0.45 4.56 0.36 94.57
0 0 0 0.06 0.02 5.13 0.01 94.77
0 0 0 0 0 1.01 0.02 98.97
0 0 0 0 0 0.95 0 99.05
0 0 0 0 0 0 0 100
0 0 0 0 0 0 0 100
0 0 0 0 0 0 0 100
```

Figure A4-1: CM5 text file containing HPMS to MOBILE5 conversion factors

```
100 0 0 0 0 0 0 0 0 0 0 0 0
0 98.8 0 0 0 0 0 0 0 0 0 0 0
0 0 20.87 0 2.461 0.1635 0.0138 0.0138 0 0 0 0 0
0 0 69.75 0 8.229 0.5465 0.0462 0.0462 0 0 0 0 0
0 0 2.733 13.77 6.795 0.0068 0.3082 0.0137 0 0 0 0 0
0 0 1.257 6.33 3.125 0.0032 0.1418 0.0063 0 0 0 0 0
0 0 1.46 0 41.67 11.87 3.775 4.244 0.834 0.7893 0 0 0
0 0 0.0521 0 1.487 0.4235 0.1347 0.1514 0.0297 0.0282 0 0 0
0 0 0.0167 0 0.4758 0.1355 0.0431 0.0484 0.0095 0.009 0 0 0
0 0 0.0569 0 1.627 0.4634 0.1474 0.1657 0.0325 0.0308 0 0 0
0 0 0.123 0 3.513 1.001 0.3183 0.3578 0.0703 0.0665 0 0 0
0 0 0.0504 0 1.438 0.4095 0.1302 0.1464 0.0288 0.0272 0 0 0
0 0 0.0002 0 0.0041 0.0012 0.0004 0.0004 0.0001 0.00008 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0.0047 0 0.1503 0.0428 0.0136 0.0153 0.003 0.00285 0 0 0
0 1.2 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 2.05 54.75 1.296 0.0068 0.2467 0.0068 0.0137 0 0 0 0
0 0 0.942 25.17 0.596 0.0032 0.1134 0.0032 0.0063 0 0 0 0
0 0 0.1267 0 5.291 16.54 18.44 18.48 19.29 19.31 19.49 19.49 19.49
0 0 0.038 0 1.587 4.962 5.531 5.543 5.788 5.793 5.849 5.849 5.849
0 0 0.0357 0 1.493 4.668 5.204 5.215 5.446 5.451 5.503 5.503 5.503
0 0 0.0172 0 0.718 2.244 2.502 2.508 2.618 2.621 2.646 2.646 2.646
0 0 0.0729 0 3.042 9.508 10.6 10.62 11.09 11.1 11.21 11.21 11.21
0 0 0.1044 0 4.357 13.62 15.18 15.21 15.89 15.9 16.05 16.05 16.05
0 0 0.0626 0 2.613 8.167 9.105 9.124 9.523 9.536 9.628 9.628 9.628
0 0 0.1444 0 6.031 18.85 21.02 21.06 21.99 22.01 22.22 22.22 22.22
0 0 0.0059 0 1.758 5.495 6.126 6.139 6.411 6.417 6.478 6.478 6.478
0 0 0.0421 0 0.248 0.776 0.865 0.8674 0.9058 0.9065 0.9152 0.9152 0.9152
```

Figure A4.2: CM6 text file containing HPMS to MOBILE6 conversion factors