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16. Abstract

The Environmental Protection Agency recently released the latest version MOBILE6, its first major update to the MOBILE series since 1996. This model will soon become the required standard for air quality conformity and transportation control measure (TCM) effectiveness analysis. MOBILE6 users can tailor the model to reflect their local conditions by supplying optional input data instead of the model's defaults, which are derived from national average data.

Vehicle registration distribution and vehicle miles traveled (VMT) distribution by vehicle class are two such inputs for which local conditions may vary significantly from national averages. This report describes the development of these two inputs specific to the Dallas Fort Worth region. The data acquisition efforts are presented followed by a description of the process used to arrive at the required inputs.

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DESCRIPTION OF DATA ACQUISITION

AND

DEVELOPMENT OF TRAFFIC INPUTS FOR MOBILE6

by

Chandra R. Bhat, Gozen A. Basar, Sandeep S. Conoor, Monique Stinson, Larissa Wobus

Research Report Number (4377-2)

Research Project (0-4377)
Develop GIS-integrated traffic models for MOBILE6-based Air Quality Conformity and TCM Analysis

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The Environmental Protection Agency recently released the latest version MOBILE6, its first major update to the MOBILE series since 1996. This model will soon become the required standard for air quality conformity and transportation control measure (TCM) effectiveness analysis. MOBILE6 users can tailor the model to reflect their local conditions by supplying optional input data instead of the model's defaults, which are derived from national average data.

Vehicle registration distribution and vehicle miles traveled (VMT) distribution by vehicle class are two such inputs for which local conditions may vary significantly from national averages. This report describes the development of these two inputs specific to the Dallas-Fort Worth region. The data acquisition efforts are presented followed by a description of the processes used to arrive at the required distributions. A brief description of the likely future course of research is also presented.

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1. BACKGROUND

Mobile source emissions constitute a significant fraction of total atmospheric emissions. Under the Clean Air Act (CAA) legislations it is mandatory for states with non-attainment areas to prepare mobile source emissions budgets in order to achieve progress toward attainment. Transportation conformity determinations are necessary in order to assess the impact of transportation control measures (TCMs) and to establish that mobile source emissions are within the State Implementation Plan (SIP) budgets. These determinations are carried out using an emissions forecasting model. Most states and metropolitan planning organizations use MOBILE, which is the U.S. Environmental Protection Agency's (EPA's) model for on-road mobile emissions estimation procedures.

The North Central Texas Council of Governments (NCTCOG), the metropolitan planning organization of the Dallas-Fort Worth (DFW) area, is responsible for developing and maintaining the mobile-source emissions inventories in the area. The U.S. EPA designates the counties of Collin, Dallas, Denton, and Tarrant within the DFW planning area as serious non-attainment areas. The NCTCOG models the mobile source emissions for this area using the version MOBILE5 of the MOBILE Emissions Factor model.

In January 2002 the EPA released an updated version of its mobile source emissions model, MOBILE6. The latest of the MOBILE series is a software application program that provides estimates of current and future emissions from highway motor vehicles. MOBILE6 calculates average in-use fleet emission factors for the three criteria pollutants: hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x). These pollutants are calculated for gas, diesel, and natural gas fueled vehicles for calendar years 1952 to 2050. Users can provide "optional" input data for the model that reflects their local conditions. If no optional input data is provided, MOBILE will access its default values, which are derived from national average data.

The accuracy of the MOBILE output is directly dependent on the accuracy of the input data. Different regions have unique characteristics and consequently the use of national average data may not be appropriate for all inputs. Using these national default values in most cases underutilizes the capabilities of the MOBILE6 model. Accordingly, the EPA and the U.S. Department of Transportation (DOT) advise non-attainment areas to use local data in their emissions modeling procedure, if possible. MOBILE6 has a greatly expanded vehicle classification scheme and provides a greater number of optional inputs than previous models. These changes enable the user to enter inputs at a finer spatio-temporal scale and ultimately derive more accurate emissions estimates.

The input requirements for MOBILE6 can be classified as follows: external conditions, vehicle fleet characteristics, activity related inputs, state programs, fuel inputs, alternative emission regulations, and control measures. This report discusses in detail two of the primary traffic related inputs, namely vehicle fleet characteristics and activity related inputs, and is organized as follows: Section 2 discusses the traffic related inputs vehicle registration distribution and vehicle miles traveled (VMT) distribution. Section 2.1 describes the data acquisition and Section 2.2 describes the modeling efforts toward development of these inputs for MOBILE6. Section 3 discusses the future work for this project.

2. TRAFFIC RELATED INPUT NEEDS

This section discusses the needs of the MOBILE6 model in terms of traffic related inputs. The latest revision to the MOBILE series of models poses some important challenges in improving traffic related inputs. MOBILE6 allows a high temporal resolution during the day for all traffic indicators. Specifically, hourly input can be provided for each hour of the day instead of 24-hour averages. Secondly, MOBILE6 fleet characterization data projections of future vehicle fleet size and fraction of travel are based on several dimensions such as vehicle age, mileage accumulation rate, and twenty-eight vehicle classes (expanded from eight classes in MOBILE5).

A description of the input requirements and default inputs for MOBILE6 is available in Research Report 0-4377-1[1]. Details of the input format are available in the MOBILE6 User's Guide [2].

In this report we focus on two important traffic related inputs: registration distribution by age and vehicle class, and hourly link-specific vehicle miles traveled (VMT) distribution by vehicle class.

Vehicle registration distribution by age and vehicle class:

Registration distribution refers to the distribution of the regional in-use vehicle fleet among age and various vehicle classes. MOBILE6 allows the user to input twenty-five age fractions for each of the sixteen composite vehicle types (See Table 1, Appendix). These age fractions represent the fraction of vehicles of each class for each age group. Granell et al. [3] examined the variation in regional composition of vehicles. They found that there are several local factors affecting vehicle purchase decisions including socioeconomic characteristics, land use patterns, and local roadway management practices.

VMT distribution by vehicle class:

The MOBILE5 model allowed users to enter the fractions of VMT for eight vehicle classes. The user could only specify a single value for the entire day, for each of the eight vehicle classes. This value represented the average fraction of each vehicle class over a 24-hour period. In contrast, the MOBILE6 model allows the user to enter hour-specific values for the fractions of VMT for a greatly expanded twenty-eight vehicle classes (See Table 2, Appendix). Now, for each roadway link in a study region, instead of average daily values, a user is able to enter twenty-four fractions (each representing an hour of the day) for each vehicle class. These fractions must add up to one across all vehicle classes for each hour, and also across all times of the day for each vehicle class. Because of these new capabilities of MOBILE6, the variation of traffic volumes and vehicle mix over the day, and the implications for mobile source emissions can now be modeled.

2.1 Data Acquisition

Vehicle registration data for the Dallas-Fort Worth area were used to develop the registration distribution by age and vehicle class. For the development of VMT distribution by time of day, hourly vehicle counts from Austin were used in conjunction with existing link specific VMT data for the DFW area. Geographic Information System (GIS) maps of the required areas were obtained from the U.S. Census Bureau web site [4].

2.1.1 Vehicle Registration Distribution by Age and Vehicle Class

Registration data for the vehicles owned in the Dallas-Fort Worth region were obtained from the Texas Department of Transportation's (TxDOT) Vehicles and Titles Registration (VTR) division. The information collected by the VTR includes the following:

- Addresses of the current and former owners of the vehicle
- The make and model of the vehicle
- The gross weight of the vehicle
- The registration class code[1]
- Year of registration
- A variable that indicates if the fuel type (diesel/gas) of the vehicle

[1] This is a code that classifies the vehicles into various categories for registration purposes. For example, registration class code 25 represents passenger vehicles under 6000 lbs.

The information is available for each county. Data for the Collin, Dallas, Denton, Ellis, Johnson, Kaufmann, Parker, Rockwall, and Tarrant counties in the Dallas-Fort Worth area were acquired. The GIS road network maps for each of these counties were obtained from the U.S. Census Bureau web site. These county level maps were combined to obtain the road network map for the DFW region. A GIS map of the transportation analysis zones (TAZs) in the DFW area was available from an earlier research effort (TxDOT Project 0-1838).

2.1.2 VMT Distribution by Vehicle Class

Four types of data were used to calculate 24-hour average VMT distribution by vehicle class on all links in the Dallas-Fort Worth metropolitan area. These included TxDOT vehicle classification counts, the 1996 GIS road network and zonal coverage file, and zonal level land use characteristics. These four data sources were used to estimate a model developed by Bhat and Nair [5], which predicted the 24-hour average VMT mix (same as VMT distribution by vehicle class) on each link in the study area. The model is discussed in Section 2.2.

Once 24-hour average VMT mixes were obtained for all links in the Dallas-Fort Worth area, these averages were converted to hourly mixes using hourly VMT mix data collected in Austin, Texas. This data was obtained from the City of Austin. The basis and details of the method are discussed in Section 2.2.

2.2 Data Analysis

2.2.1 Vehicle registration distribution by age and vehicle class

Vehicle Classification:

Vehicle records with missing weight or year of registration were dropped from the data set. Additionally, those records missing registration class or the make of the vehicle were discarded. The vehicles in the data set were categorized into the fourteen-vehicle MOBILE6 classification (See Table 1, Appendix) using the registration class codes. Certain registration codes provided no information on the vehicle type. For instance, the category "Exempt" comprises vehicles of various types that are exempt from registration such as fire engines, police cars, official vehicles, and ambulances. For such categories, where the vehicle cannot be classified based on registration class alone, the make and the gross vehicle weights were used to classify the vehicles. For light duty trucks there was no information on the loaded vehicle weights (LVW). Consequently, the classification was based solely on gross vehicle weight rating (GVWR). Light duty trucks were classified into the combined classes Light Duty Trucks 1 (LDT1)+Light Duty Trucks 2 (LDT2), and trucks in Light Duty Trucks 3 (LDT3)+Light Duty Trucks 4 (LDT4). Buses could not be classified into School Buses (HDBS) and Transit and Urban Buses (HDBT), since this information was not available in the data set. As a result buses were categorized into the combined bus class (HDBS+HDBT). In the end the total number of vehicle classes obtained was thirteen.

The age of each vehicle was determined using the "year of registration" field. Twenty-five vehicle categories were created with ages ranging from 1 to 25 and above. All vehicles over 25 years of age were categorized in the final category. The records corresponding to each age-vehicle class combination were stored in separate files. The twenty-five age groups for the thirteen vehicle classes yielded 325 files.

Geo-coding:

Geo-coding is the process of matching each record in the table of addresses to a physical location on the GIS map. The matched records are represented by symbols on the map and are stored in a GIS layer. Figures 1 and 2 illustrate the geo-coding process:

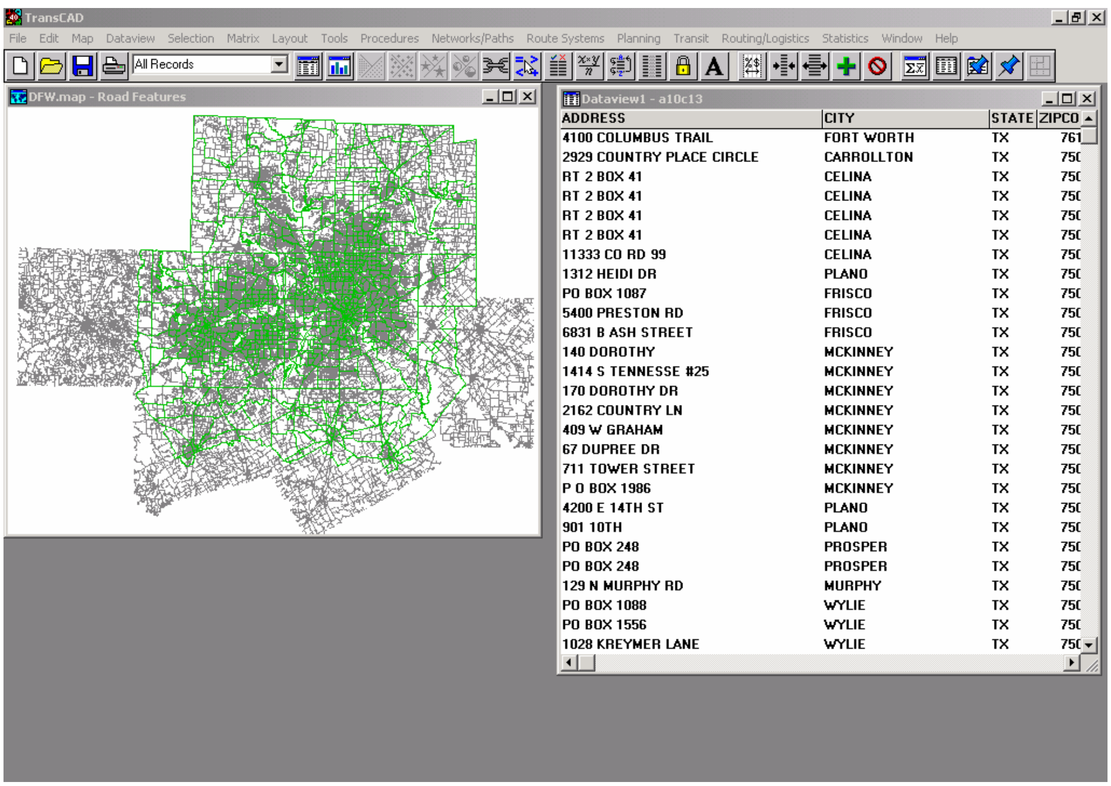

Figure 1: Map of TransCAD DFW region and address table before geo-coding of addresses

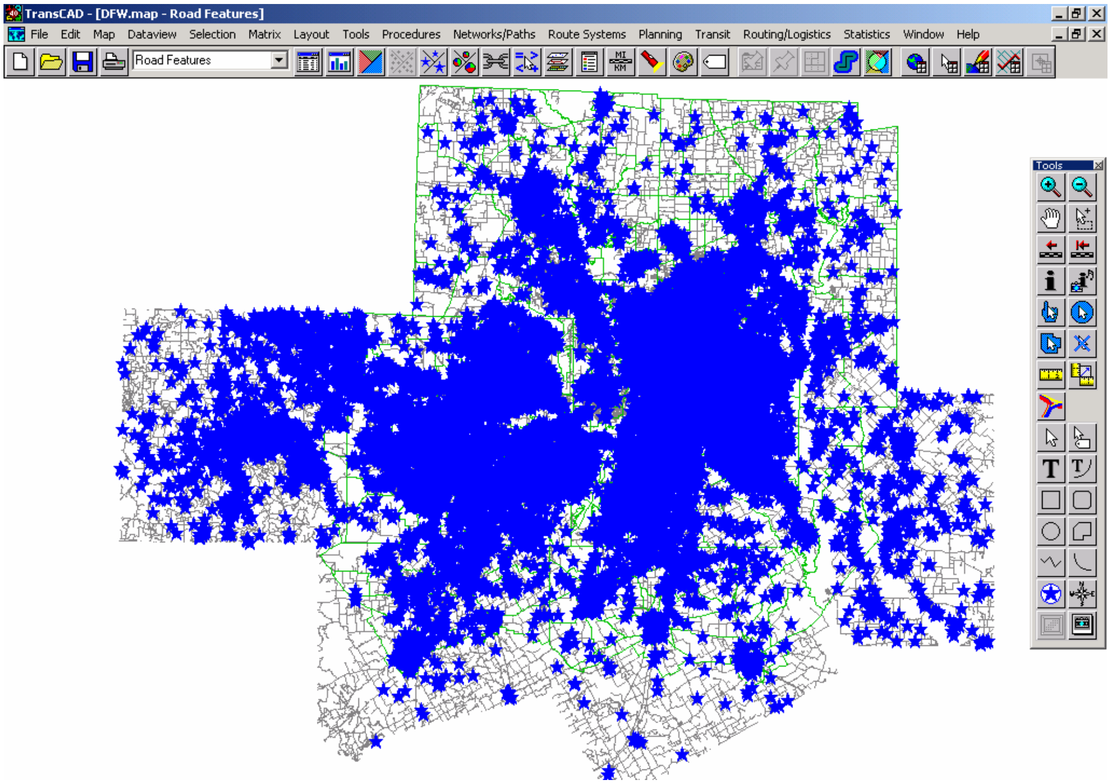

Figure 2: TransCAD map of DFW region after geo-coding of address table

Each of the 325 files obtained using the procedure above was geo-coded onto the DFW road network map using the GIS platform TransCAD. During the geo-coding process, a number of records could not be matched to map locations. A possible reason for this is errors in the input addresses, such as incorrect address formats or incomplete addresses. The addresses collected by the VTR were recorded at the time of purchase of the vehicle. The data set included a few vehicles that had been purchased in other cities and states and this contributed to the unmatched records. The figures for unmatched records for each category are available in Table 3 of the Appendix. The spatial variation across zones of the age-vehicle class distributions cannot be captured for the unmatched records. However, a comparison of the vehicle class-specific age distributions for the entire DFW area and for the unmatched segment indicates that for most vehicle classes the distribution for the unmatched segment is quite similar to that for the DFW area. Plots of these comparisons are shown in Graphs 1 – 13 of the Appendix. Ultimately the distribution of vehicle age and class across the geo-coded segment may be taken to represent the distribution across the entire vehicle population.

Aggregation within TAZs and development of fractions:

The Dallas-Fort Worth planning region consists of 858 Transportation Analysis Zones (TAZs). Each of the 325 output GIS maps obtained from the above geo-coding process was overlaid with the TAZ map layer and the number of geo-coded points within each zone were aggregated. These aggregate values represent the number of vehicles belonging to each age-vehicle class category for each of the TAZs. A data table of the aggregate values across twenty-five age groups for each vehicle class was assembled. From these values the fractions of vehicles in each age group are easily be calculated by dividing each value by the sum of values across the twenty-five age groups. As mentioned earlier the light duty truck classes were combined into two classes since loaded vehicle weight data was unavailable. The combined classes LDT1+LDT2 and LDT3+LDT4 are broken up into LDT1, LDT2, LDT3, and LDT4 using the procedure in the MOBILE6 User's Guide for conversion of MOBILE5 registration input into MOBILE6 format. The combined class LDT1+LDT2 represents the LDT Group 1 class of MOBILE5. The combined class LDT3+LDT4 corresponds to the LDT Group 2 class. The adjustment factors A, B, C, and D were assumed to be for the year 2003 and were obtained from Appendix D of the MOBILE6 User's Guide. The number of transit and school buses were assumed to be equal and the bus fractions were assigned in equal proportions to the two MOBILE6 classes HDBS and HDBT.

The final product of the above procedure is the set of twenty-five age fractions for sixteen classes of vehicles for each of the 858 transportation analysis zones (TAZs) in the DFW area for the year 2003. The distributions for future years can be predicted using a fractional-split multinomial model that will be estimated in subsequent research.

2.2.2 VMT Distribution by Vehicle Class

MOBILE6 requires hourly VMT mix inputs, as opposed to the 24-hour averages MOBILE5 required. Hourly VMT mix data was not available for the Dallas-Fort Worth study area, and the MOBILE6 User's Guide recommends using the same value for each hour (meaning use the 24-hour average for each hour) in the event this happens. Proceeding as the MOBILE6 User's Guide suggests underutilizes the capabilities of MOBILE6. Our goal was to find a way to capture the hourly variation in Dallas-Fort Worth without having the actual data available.

The Bhat & Nair fractional split model was applied to the Dallas-Fort Worth study area to obtain 24-hour average VMT mixes. Their model predicts fractional vehicle split on links as a function of:

- Roadway classification of the link
    - Freeways, major arterials, minor arterials, collectors, and local/residential roads
- Physical attributes of the link
    - Whether the road is divided

    - Number of lanes
- Operating conditions of the link
    - Free speed
- Attributes of the traffic analysis zone in which the link lies
    - Degree of urbanization of the zone
    - Airport presence
    - Presence of churches, schools, and hospitals
    - Zone acreage in retail and office space
    - Acreage in manufacturing plants and warehousing

The result of the model was the 24-hour average VMT mix for six vehicle classifications (autos, sports utility vehicles, pick-ups and vans, motorcycles, buses, trucks) for each link in the Dallas-Fort Worth study area.

After applying this model, it was necessary to find a method to vary this average data across all hours of the day. As mentioned previously, hourly VMT mix data was not available for the Dallas-Fort Worth study area, but this data was obtained for the city of Austin. The hourly VMT mix for Austin was for five vehicle classifications (autos, sports utility vehicles, pick-ups and vans, motorcycles, buses, trucks)[2]. The data was also collected on four different road types: major arterial, minor arterial, collector, and highway.

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[2] Note the only difference in vehicle classifications between Austin and Dallas-Fort Worth is that Austin has sports utility vehicles (SUV's) and pick-ups and vans (PUV's) all in one category while Dallas-Fort Worth has separate categories for SUV's and PUV's.

The assumption was made that the hourly VMT mix variation is similar in metropolitan areas, and that, specifically, Dallas-Fort Worth VMT mix varies by hour as Austin's does. This is to say that the relationship between each hour's VMT mix and the 24-hour average for a specific type of link, is the same in Austin as it is in the Dallas-Fort Worth area. The lack of data from the Dallas-Fort Worth area regarding temporal variation in VMT mix constrained us to make this assumption. However, our methodology is general and can be applied to obtain VMT mix by time of day from DFW data once information on VMT mix variations by time of day become available from the DFW region. In the absence of DFW specific data on VMT mix variations by time of day, we applied the Austin hourly VMT mix variation to the Dallas-Fort Worth 24-hour mix for each link. Weights for each link were obtained as follows, and applied to the Dallas-Fort Worth data:

$$Fract_{i,l,t,Dallas} = \frac{Fract_{i,t,r,Austin}}{\overline{Fract_{i,r,Austin}}} * \overline{Fract_{i,l,Dallas}}$$

i = vehicle type
t = hour
r = road type
l = link #[3]

For the sake of clarity, a simple example follows.

[3] Note: Each link in the Dallas-Fort Worth area is categorized into one of four road types. The weights for the DFW links are calculated based on Austin hourly VMT mix variation from the same road type.

Let us consider a link picked at random from Dallas-Fort Worth, and refer to it as link #1. Link #1 is classified as a minor arterial and its 24-hour average auto mix is 20 percent. We need the auto mix between 1 a.m. and 2 a.m. We refer to the Austin data, and calculate a weight that is then applied to link #1. In order to calculate a weight from the Austin data, we divide the Austin minor arterial auto mix from 1 a.m. to 2 a.m. (50 percent) by the Austin 24-hour average auto mix for minor arterials (25 percent). A weight of 2 is obtained and then multiplied by the Dallas-Fort Worth 24-hour average auto mix. The resulting auto mix for link #1 in Dallas-Fort Worth from 1 a.m. to 2 a.m. is now 40 percent.

A problem that arose when applying these weights to the Dallas-Fort Worth data was that the VMT mix fractions for each vehicle type did not necessarily equal 1. To remedy this problem, the motorcycle, truck, and bus categories were constrained to their 24-hour averages across all hours, and the auto and SUV/PUV categories were varied by hour (weights from Austin were applied to these vehicle classifications). This was deemed acceptable because, according to the Austin data, the three categories constrained to their 24-hour values did not vary much from hour to hour, and their relative VMT mix was small compared to the auto and SUV/PUV categories.

After the motorcycle, truck, and bus categories were constrained to their 24-hour average values, the auto and SUV/PUV mixes were weighted and scaled to equal the remainder of the mix[4] to ensure that all VMT mixes equal 1.

After hourly mixes were obtained for the Dallas-Fort Worth data for the five vehicle categories, the mixes were first converted to MOBILE5 and then converted to

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[4] SUV/PUV mix + auto mix = 1- (bus mix + truck mix + motorcycle mix).

MOBILE6 using the MOBILE6 User's Guide. Links were chosen at random to show an example of the hourly variation of VMT mix for autos and SUV/PUV's. To view the hourly VMT mix variation, please refer to Graphs 14 and 15 in the Appendix.

3. FUTURE WORK

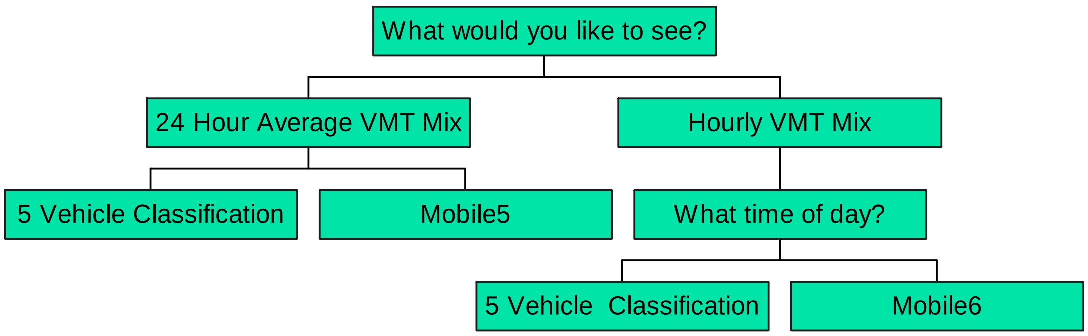
3.1 Vehicle Registration Distribution by Age and Vehicle Class

The procedure described in Section 2 provides the vehicle registration distribution by age for each TAZ in the DFW region for the year 2003. Given the demographic characteristics and land use patterns for each TAZ for some future year, the vehicle age distribution for that TAZ, for that year, can be predicted. This can be done by formulating a fractional split model, similar to the one used by Bhat and Nair, to predict future VMT mix as a function of roadway and zonal characteristics. Land use and demographic characteristics such as population, number of households, employment in various categories, average income, and total income are available for each zone. The registration fractions can be related to these zonal characteristics using the fractional split model structure. This structure accommodates boundary values of registration age fractions (age fractions with zero values), is easy to estimate using commonly available econometric software, and is easy to apply in forecasting future age fractions.

3.2 VMT Distribution by Vehicle Class

At present, a user can click on any link on the Dallas Fort Worth study area road network and view the road characteristics, the 24-hour average VMT mix for both MOBILE5 and the five vehicle classifications (auto, motorcycle, SUV/PUV, truck, bus), as well as the hourly VMT mix for both MOBILE6 and the five vehicle classifications. Although all of this information is available, it is difficult to sort through and takes time for the user to find exactly they are looking for.

We ultimately want a user interface that will facilitate the process of users finding specific data. This future user interface will be developed using the Geographic Information System Developer's Kit (GISDK), and will allow the user to view specific information on each link, without having to sort through hundreds of rows of data. We envision the future user interface to be as follows. When a user clicks on a link, the following sequence of questions will appear, leading the user to specific data:



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APPENDIX

Table 1: Composite Vehicle Classes for Vehicle Registration Data

Number	Abbreviation	Description
1	LDV	Light-Duty Vehicles (Passenger Cars)
2	LDT1	Light-Duty Trucks 1(0-6,000 lbs. GVWR, 0-3,750 lbs. LVW)
3	LDT2	Light-Duty Trucks 2 (0-6,000 lbs. GVWR, 3,751-5,750 lbs. LVW)
4	LDT3	Light-Duty Trucks 3 (6,001-8,500 lbs. GVWR, 0-5,750 lbs. ALVW*)
5	LDT4	Light-Duty Trucks 4 (6,001-8,500 lbs. GVWR, 5751 lbs. and greater ALVW)
6	HDV2B	Class 2b Heavy-Duty Vehicles (8,501-10,000 lbs. GVWR)
7	HDV3	Class 3 Heavy-Duty Vehicles (10,001-14,000 lbs. GVWR)
8	HDV4	Class 4 Heavy-Duty Vehicles (14,001-16,000 lbs. GVWR)
9	HDV5	Class 5 Heavy-Duty Vehicles (16,001-19,500 lbs. GVWR)
10	HDV6	Class 6 Heavy-Duty Vehicles (19,501-26,000 lbs. GVWR)
11	HDV7	Class 7 Heavy-Duty Vehicles (26,001-33,000 lbs. GVWR)
12	HDV8A	Class 8a Heavy-Duty Vehicles (33,001-60,000 lbs. GVWR)
13	HDV8B	Class 8b Heavy-Duty Vehicles (> 60,000 lbs. GVWR)
14	HDBS	School Buses
15	HDBT	Transit and Urban Buses
16	MC	Motorcycles (All)

*ALVW= Alternative Loaded Vehicle Weight: The adjusted loaded vehicle weight is the numerical average of the vehicle curb weight and the gross vehicle weight rating (GVWR)

Table 2: Complete MOBILE6 Vehicle Classification for Hourly VMT Mix

Number	Abbreviation	Description
1	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
2	LDGT1	Light-Duty Gasoline Trucks 1(0-6,000 lbs. GVWR, 0-3,750 lbs. LVW)
3	LDGT2	Light-Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3,751-5,750 lbs. LVW)
4	LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVWR, 0-5,750 lbs. ALVW*)
5	LDGT4	Light-Duty Gasoline Trucks 4 (6,001-8,500 lbs. GVWR, 5751 lbs. and greater ALVW)
6	HDGV2B	Class 2b Heavy-Duty Gasoline Vehicles (8,501-10,000 lbs. GVWR)
7	HDGV3	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)
8	HDGV4	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)
9	HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)
10	HDGV6	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)
11	HDGV7	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)
12	HDGV8A	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)
13	HDGV8B	Class 8b Heavy-Duty Gasoline Vehicles (> 60,000 lbs. GVWR)
14	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)
15	LDDT12	Light-Duty Diesel Trucks 1(0-6,000 lbs. GVWR)
16	HDDV2B	Class 2b Heavy-Duty Gasoline Vehicles (8,501-10,000 lbs. GVWR)
17	HDDV3	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)
18	HDDV4	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)
19	HDDV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)
20	HDDV6	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)
21	HDDV7	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)
22	HDDV8A	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)
23	HDDV8B	Class 8b Heavy-Duty Gasoline Vehicles (> 60,000 lbs. GVWR)
24	MC	Motorcycles (Gasoline)
25	HDGB	Gasoline Buses (School, Transit and Urban)
26	HDDBT	Diesel Transit and Urban Buses
27	HDDBS	Diesel School Buses
28	LDDT34	Light-Duty Diesel Trucks 3 and 4 (6001-8500 lbs. GVWR)

*ALVW= Alternative Loaded Vehicle Weight: The adjusted loaded vehicle weight is the numerical average of the vehicle curb weight and the gross vehicle weight rating (GVWR)

Table 3: Geo-coding Results

	LDV			LDT1+LDT2			LDT3+LDT4			HDV2b		
Age	**Matched**	**Unmatched**	**Total**	**Matched**	**Unmatched**	**Total**	**Matched**	**Unmatched**	**Total**	**Matched**	**Unmatched**	**Total**
1	124,882	31,320	156,202	98,679	20,624	119,303	14,048	5,829	19,877	1,395	920	2,315
2	121,715	24,083	145,798	79,436	16,044	95,480	10,259	3,781	14,040	933	604	1,537
3	117,213	21,390	138,603	65,374	14,240	79,614	7,389	2,939	10,328	486	296	782
4	149,061	25,878	174,939	65,958	14,503	80,461	6,879	3,029	9,908	478	500	978
5	121,431	19,270	140,701	64,150	13,754	77,904	4,289	2,145	6,434	382	404	786
6	118,630	17,288	135,918	50,724	10,180	60,904	3,746	1,784	5,530	258	162	420
7	104,989	15,053	120,042	43,167	8,365	51,532	2,760	1,246	4,006	291	150	441
8	101,545	14,963	116,508	40,605	8,446	49,051	1,961	1,080	3,041	295	164	459
9	99,272	14,827	114,099	33,906	7,330	41,236	1,941	855	2,796	335	159	494
10	89,803	13,649	103,452	33,862	7,894	41,756	2,056	959	3,015	324	154	478
11	76,789	11,818	88,607	30,894	6,747	37,641	1,817	855	2,672	268	148	416
12	64,769	10,277	75,046	23,570	4,966	28,536	1,277	578	1,855	238	293	531
13	58,077	9,134	67,211	27,448	5,911	33,359	1,902	969	2,871	363	163	526
14	49,900	8,037	57,937	23,568	5,224	28,792	1,917	878	2,795	384	119	503
15	38,740	6,214	44,954	20,556	4,567	25,123	1,916	792	2,708	350	114	464
16	22,673	3,851	26,524	12,856	2,974	15,830	1,119	461	1,580	213	86	299
17	15,747	2,742	18,489	10,973	2,596	13,569	1,066	410	1,476	207	70	277
18	11,670	2,030	13,700	8,621	2,049	10,670	634	235	869	133	72	205
19	9,179	1,542	10,721	5,684	1,371	7,055	553	225	778	99	43	142
20	10,205	1,800	12,005	9,604	2,320	11,924	1,097	383	1,480	333	368	701
21	7,541	1,267	8,808	9,036	2,241	11,277	864	335	1,199	450	365	815
22	5,153	880	6,033	7,664	1,786	9,450	805	291	1,096	190	460	650
23	2,699	442	3,141	5,617	1,257	6,874	723	257	980	134	149	283
24	1,530	231	1,761	2,939	606	3,545	431	131	562	59	20	79
25	29,378	4,740	34,118	26,383	6,172	32,555	1,257	422	1,679	253	105	358
TOTAL	1,552,591	262,726	1,815,317	801,274	172,167	973,441	72,706	30,869	103,575	8,851	6,088	14,939

Table 3 (continued): Geo-coding Results

	HDV3			HDV4			HDV5			HDV6		
Age	**Matched**	**Unmatched**	**Total**	**Matched**	**Unmatched**	**Total**	**Matched**	**Unmatched**	**Total**	**Matched**	**Unmatched**	**Total**
1	767	397	1,164	471	347	818	251	170	421	961	663	1,624
2	550	300	850	573	281	854	165	70	235	843	311	1,154
3	405	165	570	304	187	491	231	57	288	497	306	803
4	619	282	901	376	251	627	295	144	439	425	344	769
5	588	796	1,384	198	147	345	126	94	220	242	200	442
6	501	242	743	169	94	263	133	66	199	272	175	447
7	460	130	590	140	79	219	108	42	150	263	134	397
8	332	123	455	184	82	266	133	91	224	243	184	427
9	831	994	1,825	195	48	243	164	52	216	219	113	332
10	586	167	753	157	92	249	150	999	1149	189	136	325
11	386	171	557	87	90	177	199	797	996	155	111	266
12	372	256	628	70	66	136	85	81	166	179	159	338
13	368	171	539	129	105	234	104	81	185	185	115	300
14	414	191	605	106	99	205	98	74	172	219	125	344
15	349	135	484	45	22	67	81	62	143	176	16	192
16	170	79	249	25	9	34	38	23	61	87	77	164
17	125	49	174	23	14	37	83	69	152	93	65	158
18	95	36	131	28	15	43	64	26	90	99	70	169
19	69	35	104	33	13	46	39	14	53	84	71	155
20	129	78	207	67	22	89	41	26	67	103	87	190
21	113	59	172	31	27	58	33	32	65	83	65	148
22	105	48	153	161	17	178	39	14	53	44	38	82
23	78	49	127	109	33	142	13	9	22	40	34	74
24	48	31	79	90	20	110	33	13	46	42	37	79
25	351	231	582	261	74	335	116	63	179	214	183	397
TOTAL	8,811	5,215	14,026	4,032	2,234	6,266	2,822	3,169	5991	5,957	3,819	9,776

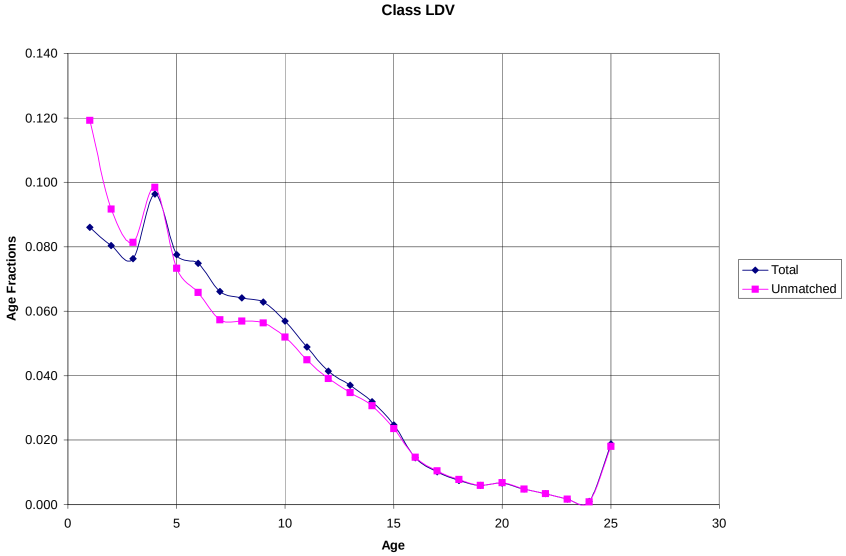
Table 3 (continued): Geo-coding Results

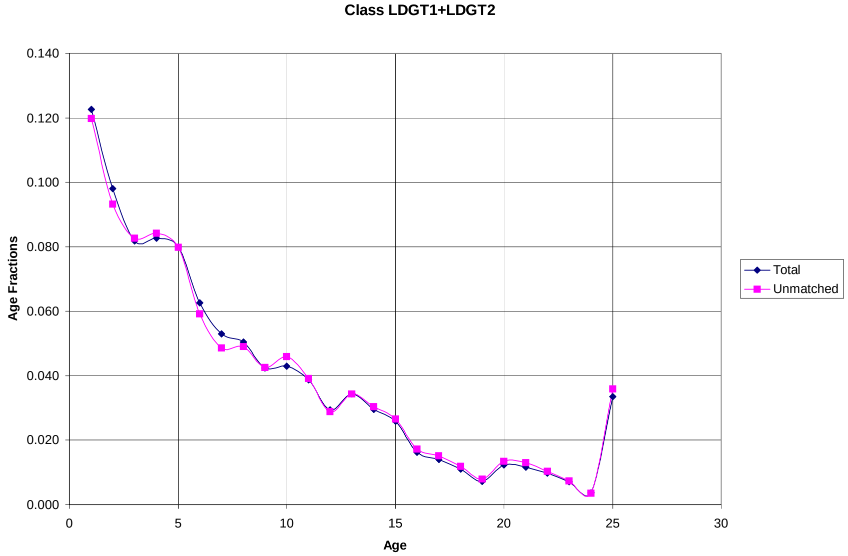
	HDV7			HDV8a			HDV8b		
Age	**Matched**	**Unmatched**	**Total**	**Matched**	**Unmatched**	**Total**	**Matched**	**Unmatched**	**Total**
1	556	387	943	1760	1,316	3,076	1,894	1,733	3,627
2	288	265	553	667	406	1,073	1,152	850	2,002
3	295	184	479	565	500	1,065	1,114	1,085	2,199
4	290	205	495	742	548	1,290	1,035	1,392	2,427
5	200	183	383	641	473	1,114	954	1,072	2,026
6	168	133	301	548	383	931	853	675	1,528
7	117	112	229	297	288	585	534	375	909
8	183	135	318	501	406	907	459	394	853
9	219	147	366	459	361	820	489	411	900
10	124	98	222	472	331	803	519	439	958
11	110	81	191	368	303	671	341	277	618
12	100	80	180	359	251	610	256	246	502
13	131	55	186	351	256	607	223	188	411
14	107	99	206	393	294	687	254	265	519
15	105	65	170	341	291	632	187	179	366
16	44	26	70	127	112	239	65	69	134
17	60	35	95	149	137	286	98	62	160
18	52	43	95	192	111	303	101	73	174
19	42	26	68	226	103	329	64	59	123
20	51	46	97	219	109	328	58	74	132
21	17	25	42	187	91	278	33	27	60
22	19	17	36	124	101	225	31	31	62
23	10	12	22	49	45	94	12	14	26
24	13	12	25	41	38	79	7	24	31
25	60	67	127	210	179	389	45	54	99
TOTAL	3,361	2,538	5,899	9,988	7,433	17,421	10,778	10,068	20,846

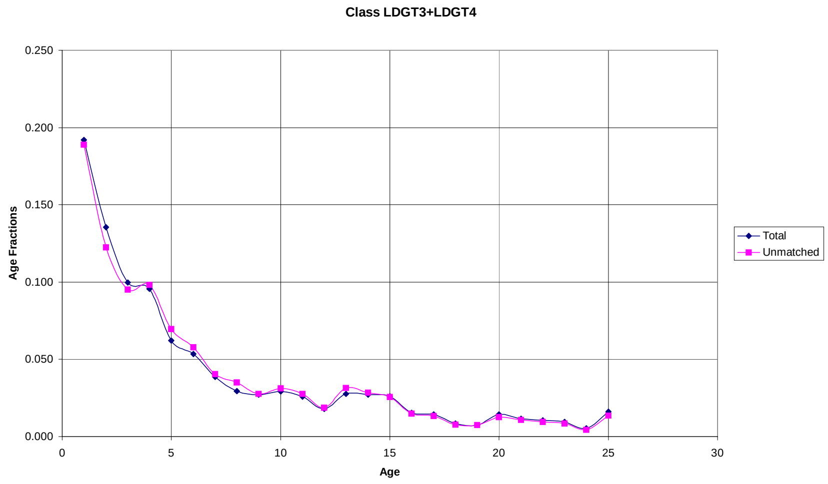
Table 3 (continued): Geo-coding Results

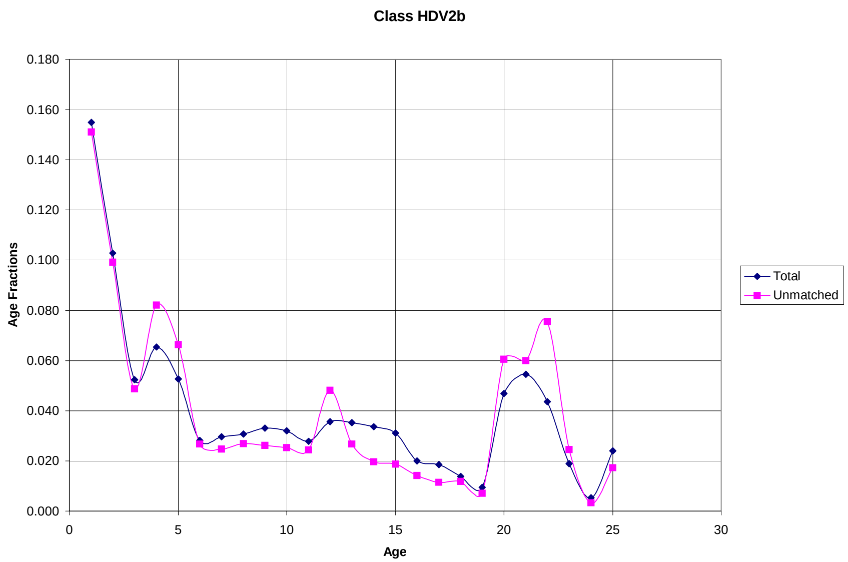
	HD Bus			MC		
Age	**Matched**	**Unmatched**	**Total**	**Matched**	**Unmatched**	**Total**
1	159	58	217	3072	645	3,717
2	100	35	135	2410	429	2,839
3	91	66	157	2328	403	2,731
4	80	51	131	1862	323	2,185
5	129	65	194	1627	268	1,895
6	77	30	107	1265	209	1,474
7	52	25	77	908	159	1,067
8	67	24	91	653	123	776
9	67	18	85	624	112	736
10	54	30	84	701	120	821
11	69	18	87	620	106	726
12	58	15	73	688	112	800
13	67	25	92	1073	195	1,268
14	79	38	117	1151	172	1,323
15	64	20	84	923	165	1,088
16	69	18	87	981	190	1,171
17	50	14	64	1415	269	1,684
18	67	21	88	921	162	1,083
19	56	17	73	896	169	1,065
20	40	15	55	599	115	714
21	30	28	58	495	86	581
22	25	11	36	312	79	391
23	11	6	17	278	57	335
24	25	10	35	241	45	286
25	96	26	122	1294	232	1,526
TOTAL	1,682	684	2,366	27,337	4,945	32,282

Graphs 1-4: Comparison of Aggregate Age Distributions of Total Fleet and Unmatched Segment

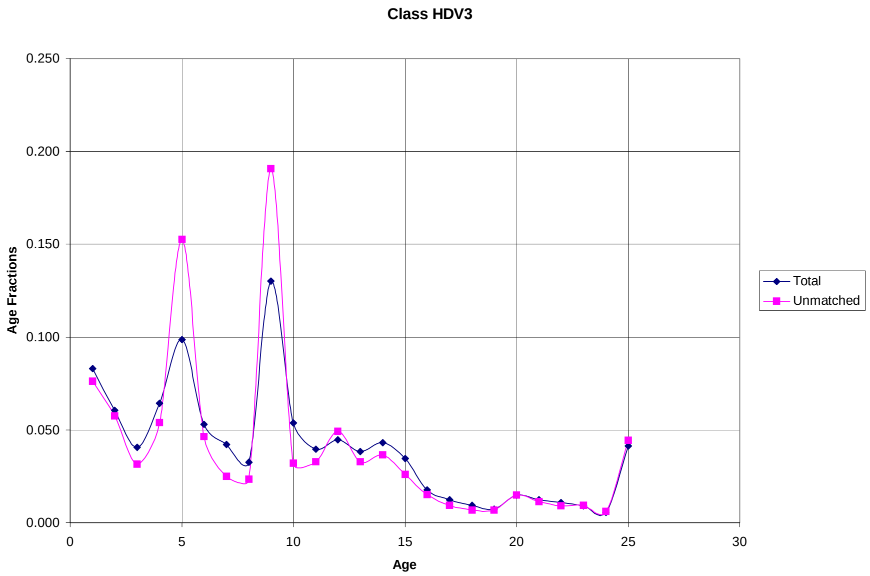


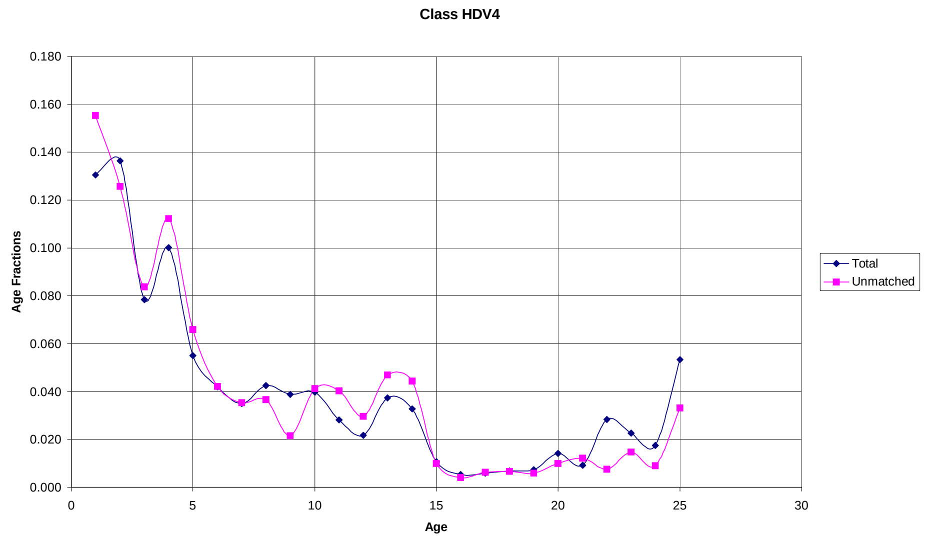


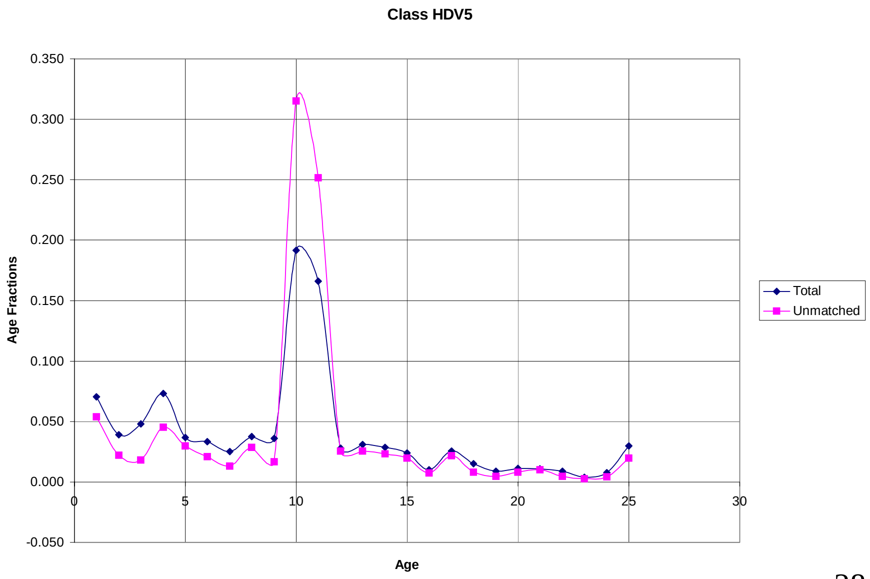


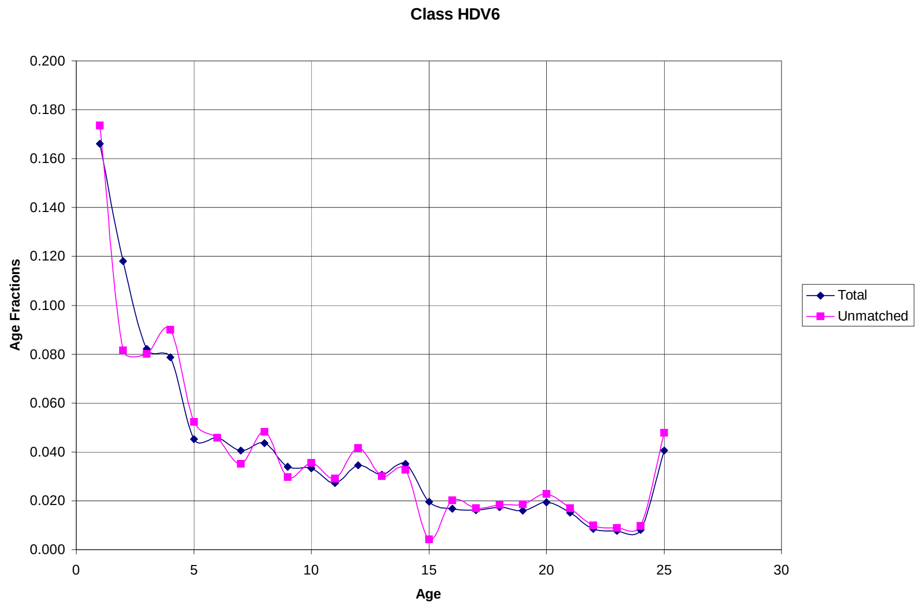


Graphs 5-8: Comparison of Aggregate Age Distributions of Total Fleet and Unmatched Segment (continued)

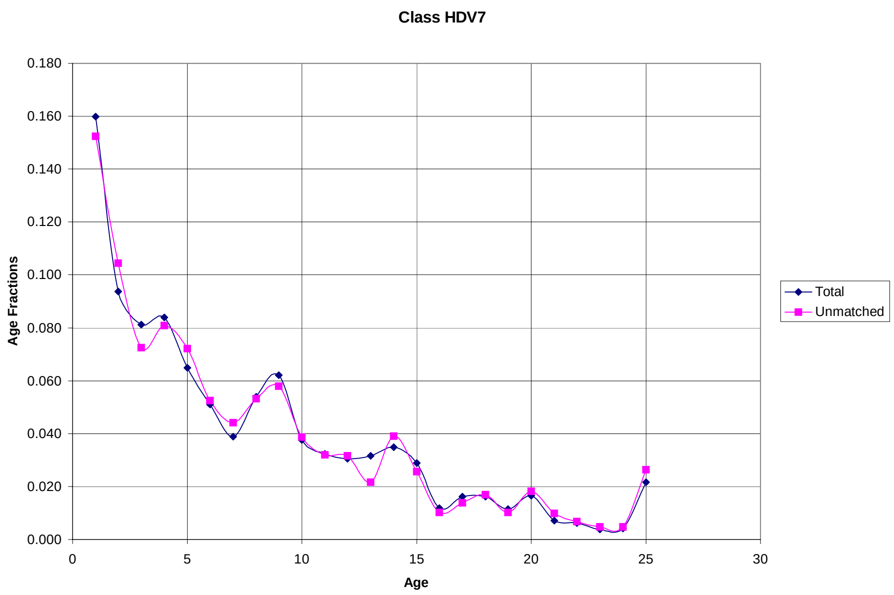


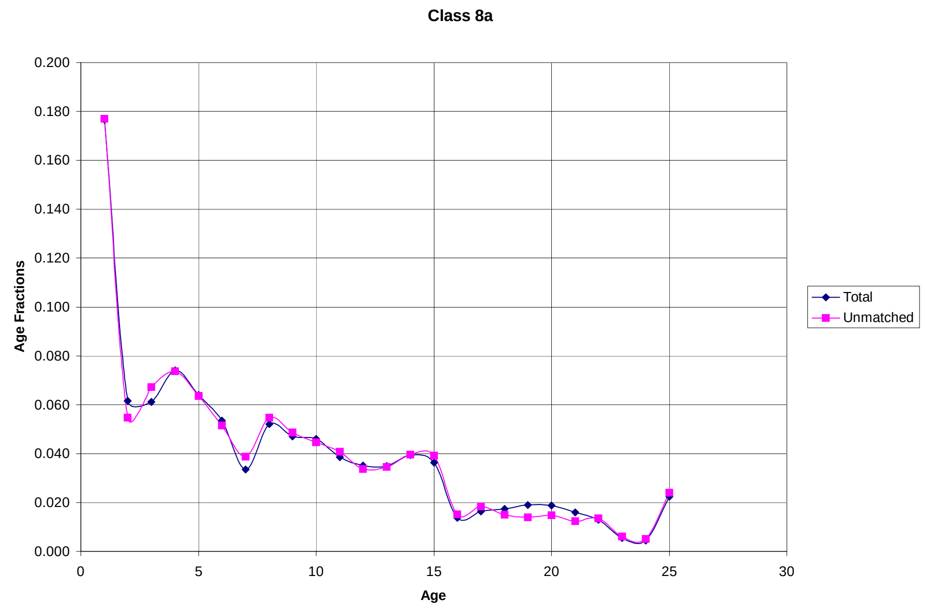


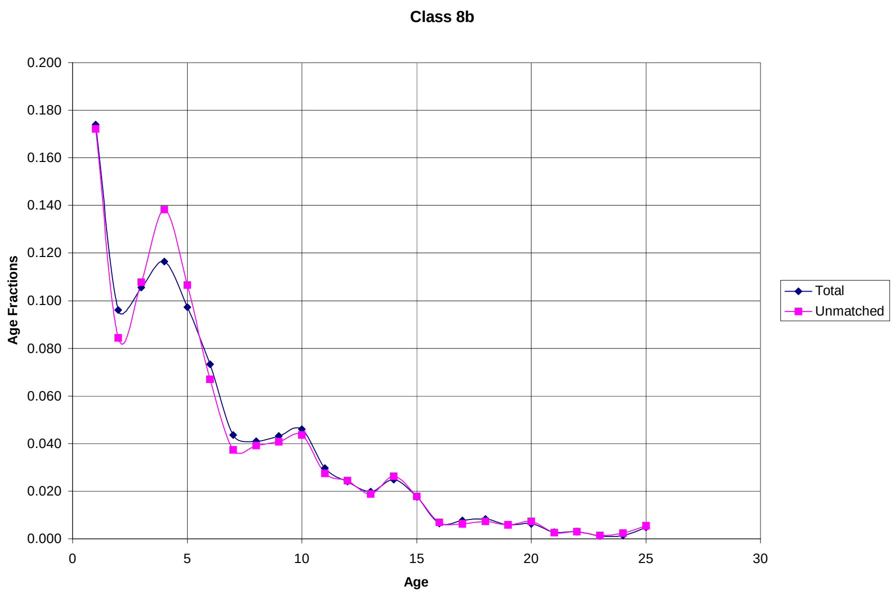


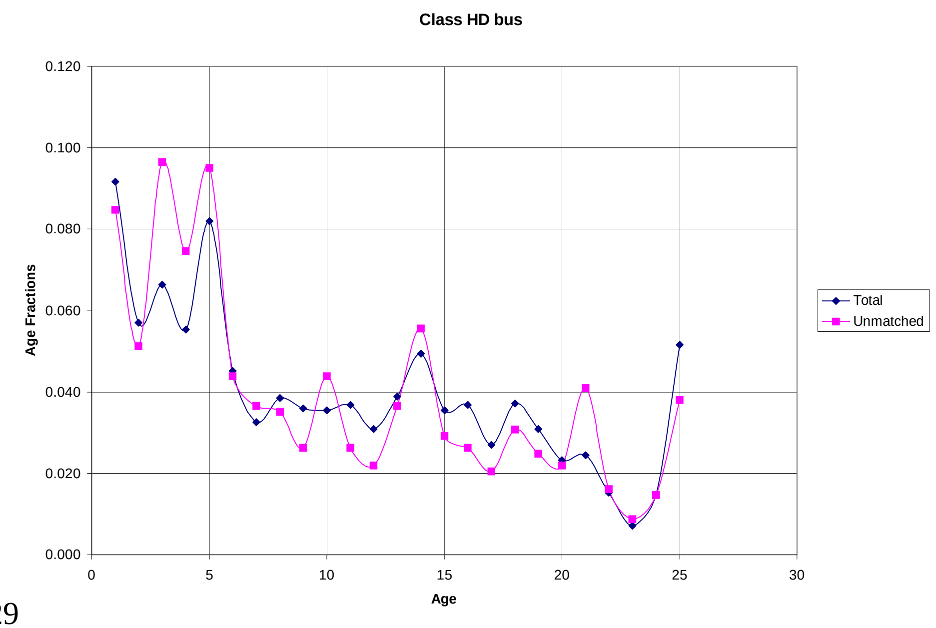


Graphs 9-12: Comparison of Aggregate Age Distributions of Total Fleet and Unmatched Segment (continued)

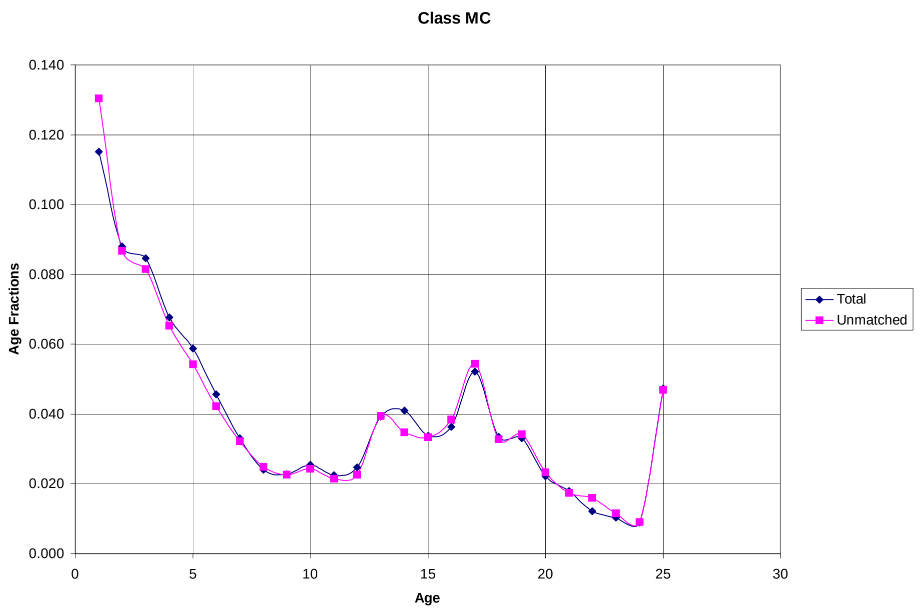




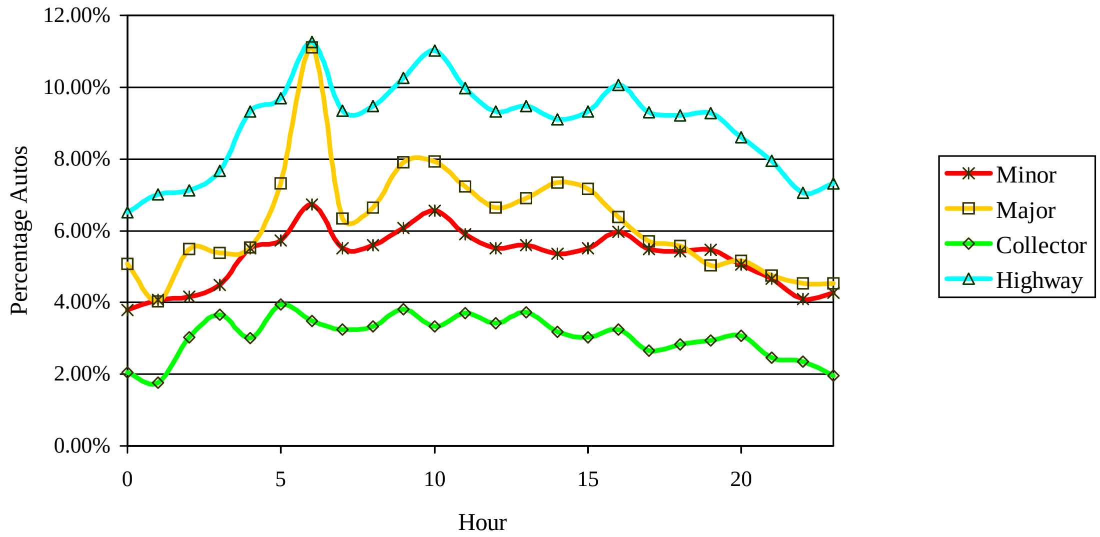




Graph 13: Comparison of Aggregate Age Distributions of Total Fleet and Unmatched Segment (continued)

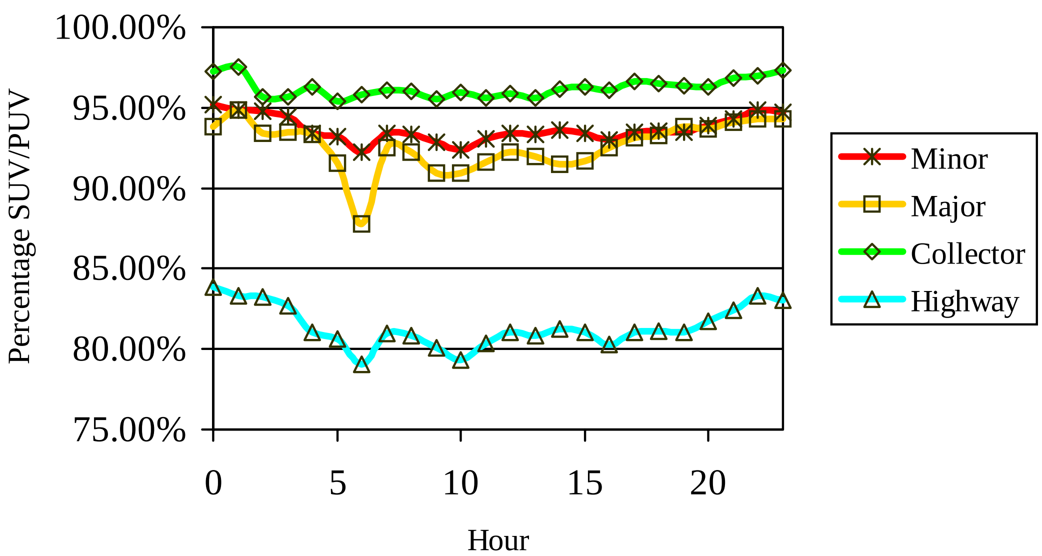


Graph 14: Auto Mix by Hour



Note: Hour 0 is 12AM-1AM

Graph 15: SUV/PUV Mix by Hour



The links chosen at random are as follows:
Minor Arterial: Centerville Road, Dallas County
Major Arterial: US 67, Johnson County
Collector: Town Center Drive, Dallas County
Highway: I-35 NB, Tarrant County