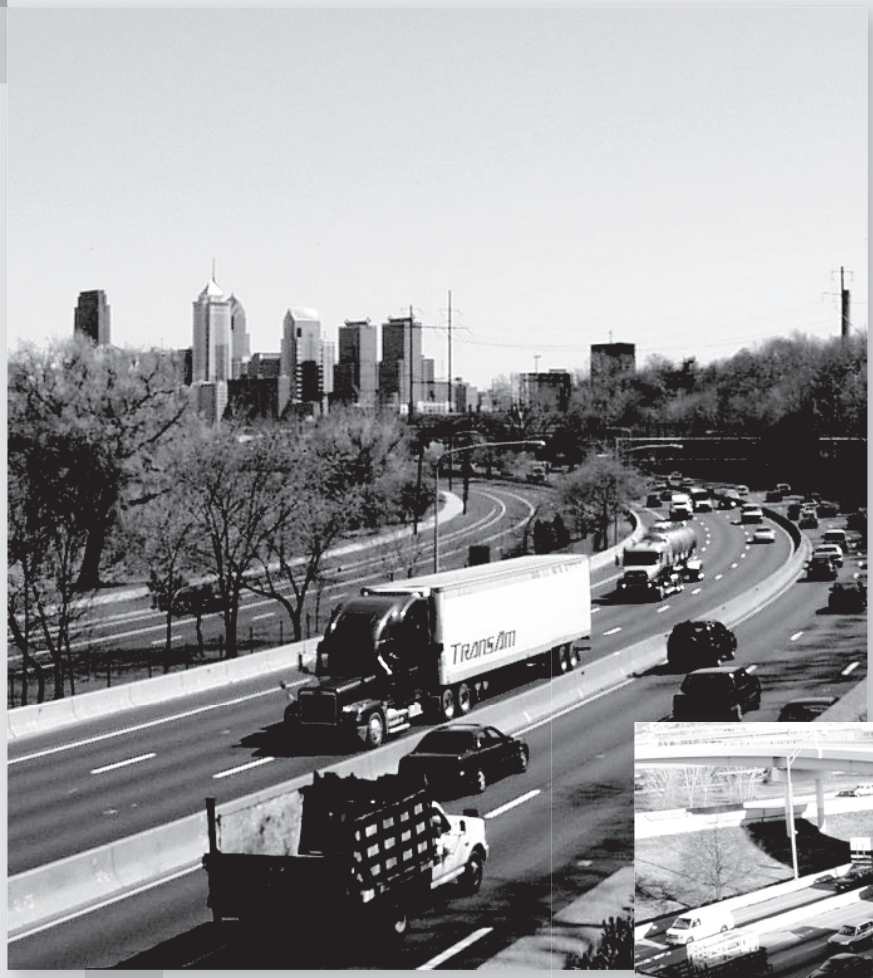
Delaware Valley
Regional Planning
Commission

FEBRUARY2005

TRUCKandBUS TRAVELinthe DELAWARE VALLEYREGION



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TRUCK and BUS TRAVEL in the DELAWARE VALLEY REGION

Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty, and intercity agency which provides continuing, comprehensive, and coordinated planning to shape a vision for the future growth of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties as well as the City of Philadelphia, in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer counties in New Jersey. DVRPC provides technical assistance and services, conducts high priority studies that respond to the request and demands of member state and local governments, fosters cooperation among various constituents to forge a consensus on diverse regional issues, determines and meets the needs of the private sector, and practices public outreach efforts to promote two-way communication and public awareness of regional issues and the commission.

Our logo is adapted from the official DVRPC seal, and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. This report was primarily funded by the Pennsylvania and New Jersey Departments of Transportation and the Federal Highway Administration (FHWA). The authors, however, are solely responsible for its findings and conclusions, which may not represent the official views or policies of the funding agencies.

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EXECUTIVE SUMMARY

Most goods and services used on a daily basis are transported by trucks via the highway system. Heavy trucks have different operating characteristics such as acceleration and deceleration rates, fuel consumption, noise levels, and pollutant emission rates than passenger cars. These characteristics can have disproportionate effects on highway capacities, levels of service, and pavement and bridge design requirements.

Trucks may be classified as either "heavy" or "light." Although definitions vary, heavy trucks are used almost exclusively for commercial purposes and can include everything from 2-axle, 6-tire single unit trucks to multi-trailer trucks. Light trucks, such as pickups, vans, and panel trucks, may be used for either personal or commercial purposes. Most light trucks have two axles and four tires and weigh less than 8,500 pounds.

Buses are designed to carry passengers and may have two axles and six tires or three or more axles. They include transit buses, intercity or charter buses, and school buses. Urban transit buses vary in size from small shuttle buses used to provide paratransit services to articulated buses that extend for 60 feet or more. Transit buses are generally not as powerful as intercity buses.

Trucks and buses are larger, heavier, and less maneuverable than passenger cars and make up an increasingly larger proportion of the traffic on the Delaware Valley's highways. Forecasts of future freight flows indicate that this trend will continue. Knowledge of truck travel is required to understand the importance of trucks to the economy and to evaluate the costs and benefits of potential changes in truck regulation, new freight facilities, or other truck travel trends. Although there are numerous sources of truck and bus travel data, it is difficult to get accurate data on their travel patterns at regional or local levels.

The primary sources of truck and bus travel data include the federal Highway Performance Monitoring System (HPMS), DVRPC's traffic classification count database, transit company operating data, vehicle registration data, and DVRPC’s Regional Highway Cordon and Truck Travel surveys.

This report compiles available data from numerous sources to estimate the number of trucks and buses in the region, their trip making patterns, and the magnitude of truck and bus travel in the region, expressed as vehicle-miles of travel (VMT). These estimates are necessary inputs to DVRPC’s travel simulation models and are also needed for mobile source emissions calculations and other planning purposes.

There are approximately 428,000 light trucks in the region. Of these, about 160,000, or 37 percent, are used commercially. Heavy trucks, which are used exclusively for commercial purposes, number about 51,000. These trucks make about 2.9 million trips per day, about 890,000 of which are made by heavy trucks. Interstate carriers based outside the region also contribute to regional truck travel. An additional 190,000 truck trips

enter the region each day. About 72 percent of these trips have a destination within the DVRPC region, while the other 28 percent, about 53,000 trips, continue though the region.

The region's bus fleet contains more than 14,000 vehicles. The vast majority of these, about 12,000, are school buses. About 1,500 buses are used to provide transit services in the region, serving over 620,000 passengers each day. Intercity bus carriers make about 500 trips across the region's boundary each, serving more than 11,000 passengers.

The region has a different distribution of VMT by vehicle type and highway classification than either the Pennsylvania or New Jersey statewide distributions. DVRPC developed a VMT distribution by vehicle type and highway functional class for the Delaware Valley region. The regional percentages of VMT from light trucks, heavy trucks, and buses are about 13.2 percent, 7.5 percent, and 1.1 percent, respectively. Heavy trucks travel approximately 7.8 million miles in the region on a typical day. Buses add another 1.1 million miles.

I. INTRODUCTION

Knowledge of truck travel is required to understand the importance of trucks to the economy and to evaluate the costs and benefits of potential changes in truck regulation, new freight facilities, or other truck travel trends. Estimates of both truck and bus travel on individual sections of road are needed to design pavements and bridges appropriate for the traffic volumes they will carry. Other metropolitan planning applications include the development of regional transportation plans, environmental impact studies, project evaluations, corridor studies, level-of-service calculations, congestion management programs, and air quality analyses. Most regional planning applications rely on travel demand models, which have been developed to include truck and bus trips. Accurate estimates of travel by vehicle class are needed to calibrate and validate these models.

Trucks and buses are larger, heavier, and less maneuverable than passenger cars and make up an increasingly larger proportion of the traffic on US highways. From 1970 to 2000, truck travel in the US, as measured in vehicle-miles of travel (VMT), has increased by 294 percent, while automobile travel has increased by 143 percent[1]. Forecasts of future freight flows indicate that this growth trend will continue. The volume of domestic freight is projected to increase by 87 percent between 1998 and 2020, while the volume of international freight is projected to increase by 107 percent during the same period[2].

In addition to occupying more roadway space than passenger cars, heavy vehicles have poorer operating capabilities with respect to acceleration, deceleration, and the ability to maintain speed on upgrades. Due to lower acceleration rates and greater length, heavy vehicles take longer than passenger cars to accelerate and clear specific conflict zones, such as intersections and railroad-highway grade crossings. Because heavy vehicles cannot keep pace with passenger cars in many situations, large gaps form in the traffic stream that can be difficult to fill by passing maneuvers. These gaps create inefficiencies in the use of roadway space that can not be completely overcome. This effect is most pronounced on sustained, steep grades and on two-lane roadways where passing must be accomplished using the opposing travel lane. Urban transit buses have additional impacts on traffic that result from the discharge and pickup of passengers, particularly if the stopped bus blocks a travel lane.

The effects of heavy vehicles on traffic operations are best quantified by the methods of the *Highway Capacity Manual (HCM)* [3]. The HCM calculates the effects of heavy vehicles in terms of passenger car equivalents (PCE). PCEs represent the relative effect of a heavy vehicle on highway capacity, compared to a passenger car. PCEs are a function of

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[1] *National Transportation Statistics 2002* BTS02-08, U.S. Department of Transportation, Bureau of Transportation Statistics, Washington DC, December 2002.

[2] *Freight Forecast Growth Rates – Preliminary Trends,* Federal Highway Administration, Office of Operations, Washington DC, July 2001 [Online]. Available http://www.ops.fhwa.dot.gov/freight/pp.

[3] *Highway Capacity Manual 2000,* Transportation Research Board, National Research Council, Washington, DC 2000.

highway type, grade, and the composition of the traffic stream. PCEs for heavy vehicles can vary from 1.0 to 7.5. The highest PCEs occur on long, sustained upgrades where there is a small percentage of heavy vehicles in the traffic stream. PCEs decrease as more heavy vehicles are present, because these vehicles tend to form platoons and have more uniform operating characteristics than do automobiles.

Heavy vehicles, by nature of their weight, have much higher fuel consumption rates than other types of vehicles. While passenger cars average about 21.4 mpg and vans, pickups and sport utility vehicles average about 17.1 mpg, heavy vehicles average only about 6 to 7 mpg. Single-unit trucks average 7.0 mpg, trucks with trailers average 6.1 mpg, and buses average about 6.7 mpg. It is estimated that single-unit trucks consume about 13 percent of the 72.4 billion gallons of fuel used annually by highway vehicles. Trailer-trucks consume a further 29 percent, and buses an additional 1.4 percent[4].

Truck traffic contributes disproportionately to highway noise levels. PCEs have also been developed for truck noise levels. Truck noise PCEs increase as average speeds decrease. They vary from 14.16 at 60 mph to as much as 84.85 at 20 mph[5]. Truck noise begins to dominate noise from other traffic once trucks account for more than about three percent of traffic.

Emission rates from heavy vehicles far exceed those of other types of highway vehicles. For example, heavy-duty diesel trucks with 1998 control technology average about 2.1 grams per mile of hydrocarbon emissions compared to 0.54 grams per mile for passenger cars. For oxides of nitrogen (NO_x) emissions, these rates are 6.5 grams/mile and 0.59 grams/mile, respectively[6]. These two pollutants are important because they can combine to form ozone in the presence of sunlight. New diesel engine standards beginning in model year 2004 and additional diesel fuel standards and test procedures beginning in 2007 are expected to significantly reduce heavy vehicle emissions rates in the future.

The axle loads of heavy vehicles contribute to various forms of pavement distress, and must be accounted for during the pavement design process. Of the various types of damage, fatigue (which leads to cracking) and permanent deformation (rutting) are of great importance. Damage done by a given vehicle increases roughly with the fourth power of its weight. If the weight of a vehicle is doubled, then the damage it does is 16 times as great. Spreading the weight over many wheels and many axles greatly reduces the damage caused per pound of vehicle weight. Also, axles spaced just a few feet apart do less damage than axles located individually when used on asphalt pavement. On concrete pavement, the damage is independent of the axle spacing. Cars do little or no pavement

[4]*National Transportation Statistics 2000*, Publ. BTS01-01, Bureau of Transportation Statistics, US Department of Transportation, Washington DC, April 2001.

[5]*Comprehensive Truck Size and Weight Study*, Publ. FHWA-PL-00-029, Federal Highway Administration, US Department of Transportation, Washington DC, August 2000.

[6]*Transportation Air Quality - Selected Facts and Figures*, Federal Highway Administration, US Department of Transportation, Washington DC, 2001.

damage in comparison to large trucks. It takes approximately 9,600 cars to do the same damage as a single 80,000 pound five-axle truck[7].

The number and type of heavy vehicles must also be accounted for in the design of bridges and other structures. The Federal Bridge Formula controls vehicle weight on bridges by limiting the weight on groups of axles, depending upon the distance between those axles. In addition, trucks and buses are a key consideration in the design of intersections. Intersection features that must consider the presence, frequency, and characteristics of heavy vehicles include curb return radii for right turns, stop bar placement, storage lengths for left-turn lanes, median widths on divided highways and the offset between opposing left-turn lanes. Heavy vehicles can also be a consideration when selecting the length of a yellow signal phase and assessing the need for an all-red clearance interval at signalized intersections.

Although there are numerous sources of truck and bus travel data, it is difficult to get comprehensive and accurate data on their travel patterns at regional or local levels. The long distance nature of freight transportation and intercity bus service causes much data to be collected at the state or national level. The U.S. Census Bureau tabulates commodity flows by metropolitan area; however, these data are primarily used for economic analyses and are reported by tonnage, not by number of trips. Light trucks, which can be used for either personal or commercial purposes, may or may not be included in tabulations of truck travel, depending upon the source of data and its intended application. For example, data collected for air quality calculations consider all pickups and vans to be light trucks, while surveys and other data collected for travel demand models group light trucks used for personal travel with automobiles and those used for commercial purposes with trucks.

This report compiles available data from numerous sources to estimate the number of trucks and buses in the region; their trip making patterns, which include the number of trips, trip rates, and trip length distributions; and the magnitude of truck and bus travel in the region, expressed as vehicle-miles of travel (VMT). The primary sources of truck and bus travel data include the federal Highway Performance Monitoring System, the Delaware Valley Regional Planning Commission's (DVRPC's) regional traffic classification count database, transit company operating data, vehicle registration data, and DVRPC's Regional Highway Cordon and Truck Travel surveys.

Chapter II of this report discusses the various types of trucks and buses and the typical vehicle classification schemes for which data are collected. Chapter III summarizes the available information on the Delaware Valley's truck and bus fleet, including registration data, information on transit and school bus operations, traffic count tabulations, and survey data collected by DVRPC. Chapter IV discusses the trip making patterns of the region's light trucks, heavy trucks, and buses. Also included in the chapter is a tabulation of truck and bus trips that cross the region's boundary. Chapter V provides VMT estimates

[7] *Guide for the Design of Pavement Structures*, American Association of State Highway and Transportation Officials, Washington DC, 1986.

by vehicle type, and highway functional class in the region, along with comparisons to Pennsylvania and New Jersey statewide data from the states' highway performance monitoring system (HPMS) programs. Finally, conclusions drawn from the various data sources are presented in Chapter VI.

II. TYPES OF TRUCKS AND BUSES

At the most general level, vehicles are grouped into five categories: automobiles; pickups, vans, and SUVs; buses; single-unit trucks; and combination trucks. Pickups, vans, and SUVs may be used for personal travel or for commercial purposes and are usually classified as "light-trucks." Nationally, 2-axle, 4-tire light trucks account for approximately 26.4 percent of all vehicles and 2-axle, 6-tire trucks make up another 2.2 percent[8].

Figure 1 displays various types of heavy trucks. Single-unit trucks (SUT) are the most common. They are used extensively in urban areas for short hauls. Three-axle SUTs are used to carry heavy loads of materials and goods in lieu of the more common two-axle "panel truck," which is not usually considered a heavy vehicle. SUTs with four or more axles are used to carry the heaviest of the construction and building materials. They are also used for waste removal. A tractor-trailer combination without a trailer is also considered a single-unit truck.

The most common combination truck is the five-axle semi-trailer. It is used extensively for long and short hauls in urban and rural areas to carry and distribute all types of materials, commodities, and goods. Six or more axle semi-trailers are used to haul heavier loads and for hauls longer than those of the four-axle SUT. Although five-axle semi-trailers comprise only one-half percent of all vehicles nationwide, they account for 43 percent of all trucks and nearly two-thirds of all heavy truck VMT[9].

The most common multi-trailer combination is the "STAA" Double. The Surface Transportation Assistance Act (STAA) of 1982 required states to allow twin-trailer combinations with trailers 28 feet long to operate on a National Network of truck routes designated by the Secretary of Transportation. STAA Doubles have either five or six axles and are typically used to transport less-than-truckload freight between freight terminals. Both semi-trailers and STAA Doubles commonly have a maximum gross vehicle weight rating (GVWR) of 80,000 lbs.

In addition to STAA Doubles, several states allow one or more longer combination vehicles (LCV) to operate on designated routes. Massachusetts, New York, Ohio, Indiana, Florida, Iowa, Missouri, Arkansas, and every continental state west of the Mississippi River except Texas and California allow LCVs to operate. LCVs include seven-axle Rocky Mountain Doubles, eight-axle B-Train Doubles, nine-axle Turnpike Doubles, and seven-axle Triple trailer combinations. The LCV doubles have longer trailers and/or higher GVWRs than the STAA Doubles.

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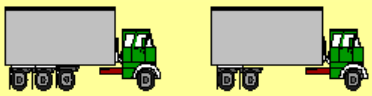
[8] *1997 Federal Highway Cost Allocation Study - Final Report*, Federal Highway Administration, US Department of Transportation, Washington DC, August 1997.

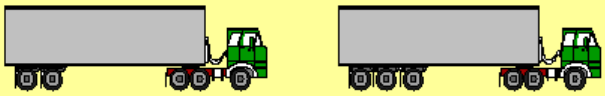
[9] Ibid.

Figure 1. Typical Truck Configurations

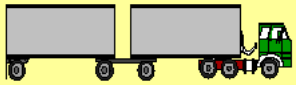
Single-Unit Trucks



Conventional Combination Vehicles

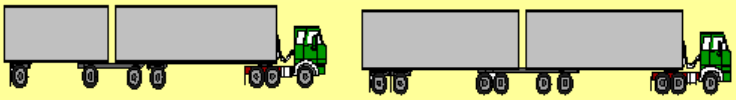


5-Axle Tractor Semi-Trailer 6-Axle Tractor Semi-Trailer

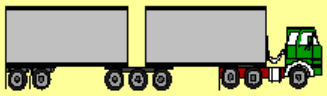


STAA Double

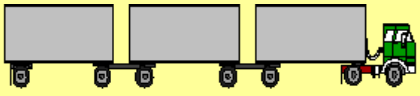
Longer Combination Vehicles (LCVs)



Rocky Mountain Double Trailer Turnpike Double Trailer



8-Axle B-Train Double Trailer



Triple Trailer

Although neither Pennsylvania nor New Jersey allow LCVs to operate within their borders, both states routinely allow overweight vehicles to operate with permits. Permit fees are intended to reflect the additional infrastructure costs and may require special equipment and routing.

The bus fleet is made up of three general types of vehicles: school buses, transit buses, and intercity buses. Nationally, these three types of buses account for about 0.3 percent of all vehicle registrations. About 71 percent of the bus fleet is comprised of school buses, 24 percent is transit buses, and the remaining 5 percent are intercity buses. Each type of bus has different operations that result in wide variations in average annual travel. School buses average about 11,000 miles of travel per year, transit buses average about 22,000 miles, and intercity buses travel about 66,000 miles per year[10].

Like trucks, buses come in several different configurations, which depend upon the type of service they provide. Examples of some of the more common configurations are shown in Figure 2.

A transit bus has front and center doors, normally with a rear-mounted engine, low-back seating, and without luggage compartments or restroom facilities. It may be powered by diesel, gasoline, or an alternative fuel source such as compressed natural gas. Transit buses are used for frequent-stop service and are typically low-floor vehicles that eliminate steps at the front entrance. The majority of these buses are 40 feet long, but 35-foot and 30-foot versions are also used in smaller cities and on lightly-traveled routes.

An articulated bus is an extra long transit bus with two connected passenger compartments. The rear body section is connected to the main body by a joint mechanism that allows the vehicle to bend when turning at an intersection, yet have a continuous interior. Articulated buses generally range in length from 54 to 66 feet.

A trolley bus (or trackless trolley) is another specialized form of transit bus. Trolley buses are rubber-tired, electrically powered buses that draw current from overhead wires via a connecting pole, from a central power source not onboard the vehicle. Philadelphia is one of only five metropolitan areas in the U.S. to offer trolley bus service[11].

An intercity bus, or motorcoach, has a front door only, separate luggage compartments, and usually restroom facilities and high-backed seats for use in high-speed, long-distance service. These buses are usually 40 to 45 feet in length, with a high-floor that requires riders to climb 2 or 3 steps from street level. They may also be equipped with a retractable lift to accommodate wheelchairs.

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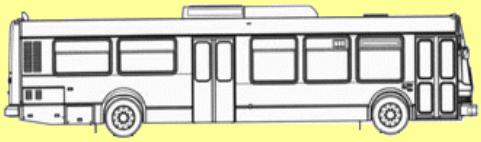
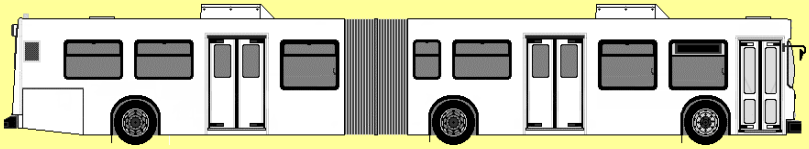
[10] *1997 Federal Highway Cost Allocation Study - Final Report*, Federal Highway Administration, US Department of Transportation, Washington DC, August 1997.

[11] *Bus and Trolleybus Definitions*, American Public Transportation Association [Online]: Available at http://www.apta.com/research/stats/bus/definitions.cfm.

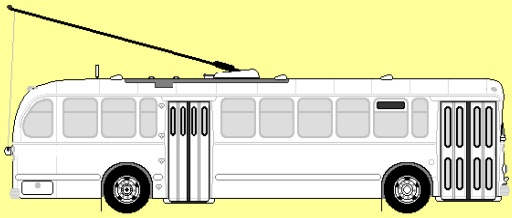
Figure 2. Typical Bus Configurations



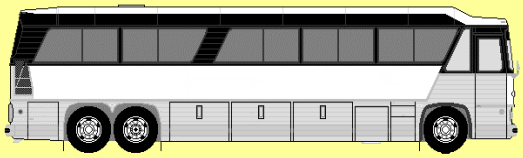
Transit Bus



Articulated Bus

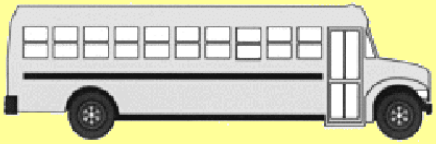


Trolley Bus



Intercity Bus

Paratransit Minibus



School Bus

Paratransit vehicles include vans and minibuses that provide transportation services for the disabled or other social services such as non-emergency medical. These buses do not usually operate on a fixed route and do not have nearly the passenger capacity of other transit buses.

A school bus is used to transport children to or from school. These buses are almost always painted yellow and equipped with flashing warning lights. They usually have a front-mounted engine and an emergency rear door, though students enter and exit via a single front door. The most common school bus sizes are 24 foot, 34 passenger; 32 foot, 52 passenger; and 35 foot, 64 passenger.

Other, less common bus configurations include the double decker bus, which has two levels of seating connected by stairways, and the trolley replica bus which has an exterior designed to look like a streetcar from the early 1900s.

Vehicles may be classified in several different ways. The classifications may represent differences in the vehicle's size, weight, number of axles, how the vehicle is registered or used, the highway user fees that vehicles pay, or the type of fuel or engine that the vehicle uses.

A. PA and NJ State Vehicle Registration Data

There is considerable variation in the ways individual states register vehicles, especially trucks. These vehicles may be registered by body type, use or purpose, or weight class. In addition, the weight class stratifications may also vary among states. For this report, only truck and bus registrations are of concern. Table 1 lists the various categories of trucks and buses that are included in the Pennsylvania and New Jersey registration files.

In Pennsylvania, trucks are registered by weight class. For both light and heavy trucks the vehicle's registration category is determined based on its gross vehicle weight. The vehicle weight categories are stratified into 25 separate weight bins, ranging from 5,000 pounds or less to 80,000 pounds. A truck's gross combination weight, which is the maximum loaded weight of the vehicle and its trailer(s) is also collected and included in Pennsylvania's registration data base. Bus registrations are stratified use, with separate classes for school buses, mass transit buses, and other buses.

New Jersey registers its trucks and buses by vehicle type, use, and engine fuel. Light truck categories include vans, pickups, and other light trucks. These categories are divided into gasoline and diesel powered subcategories. Vans and pickups are further divided into passenger and commercial uses. Heavy trucks are only divided into two categories: gas and diesel. However, New Jersey's registration data does include a gross vehicle weight code for truck registrations, which is calculated from the vehicle identification number (VIN). Unlike Pennsylvania, there are only four weight class codes in New Jersey, with the heaviest being 14,000 pounds and over. Bus registrations in New Jersey are divided into school and passenger bus categories, and further stratified by fuel type.

Table 1. PA and NJ State Registration Classification for Trucks and Buses

Vehicle Type	Pennsylvania	New Jersey
Light Trucks	5,000 lbs or less 5,001 to 7,000 lbs 7,001 to 9,000 lbs*	Passenger Van - Gas Passenger Van - Diesel Commercial Van - Gas Commercial Van - Diesel Passenger Pickup - Gas Passenger Pickup - Diesel Commercial Pickup - Gas Commercial Pickup - Diesel Other Light Truck - Gas Other Light Truck - Diesel
Heavy Trucks	9,001 to 11,000 lbs 11,001 to 14,000 lbs 14,001 to 17,000 lbs 17,001 to 21,000 lbs 21,001 to 26,000 lbs 26,001 to 30,000 lbs 30,001 to 33,000 lbs 33,001 to 36,000 lbs 36,001 to 40,000 lbs 40,001 to 44,000 lbs 44,001 to 48,000 lbs 48,001 to 52,000 lbs 52,001 to 56,000 lbs 56,001 to 60,000 lbs 60,001 to 64,000 lbs 64,001 to 68,000 lbs 68,001 to 73,280 lbs 73,281 to 76,000 lbs 76,001 to 78,000 lbs 78,001 to 78,500 lbs 78,501 to 79,000 lbs 79,001 to 80,000 lbs	Heavy Truck - Gas Heavy Truck - Diesel
Buses	School Bus Mass Transit Bus Other Bus	Passenger Bus - Gas Passenger Bus - Diesel School Bus - Gas School Bus - Diesel

*Trucks 8,501 lbs and over may be considered Heavy Vehicles

B. FHWA's Scheme F Vehicle Classification System

The most common classification stratification is the Federal Highway Administration's (FHWA's) "Scheme F," which is based on the number and spacing of a vehicle's axles. This scheme has the advantage of easily classifying vehicles through the use of common traffic counting machines.

The Scheme F classification scheme is separated into categories depending on whether the vehicle carries passengers or commodities. Non-passenger vehicles are further subdivided by number of axles and number of units. The addition of a light trailer to a passenger vehicle does not change the classification of that vehicle. Truck tractor units traveling without a trailer are considered single-units trucks. Vehicles are defined by the number of axles in contact with the road. Thus, "lift axles" are only counted when in the down position. Scheme F vehicle class definitions are as follows[12]:

1. **Motorcycles.** All two or three wheeled motorized vehicles. This category includes motorcycles, motor scooters, mopeds, and all three-wheel motorcycles.

2. **Passenger Cars.** 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.

3. **Other Two-Axle, Four-Tire, Single- Unit Vehicles.** Included in this classification are pickups, panels, vans, SUVs, and other vehicles such as campers, motor homes, ambulances, hearses, and minibuses. Other two-axle, four-tire single-unit vehicles pulling recreational or other light trailers are included in this classification.

4. **Buses.** All vehicles manufactured as traditional passenger carrying buses with two axles and six tires or three or more axles. This category includes transit, intercity, and school buses.

5. **Two-Axle, Six-Tire, Single-Unit Trucks.** All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., with two axles and dual rear wheels.

6. **Three-Axle, Single-Unit Trucks.** All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., with three axles.

7. **Four or More Axle Single-Unit Trucks.** All trucks on a single frame with four or more axles.

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[12] *Traffic Monitoring Guide*, Federal Highway Administration, US Department of Transportation, Washington DC, 2001.

8. **Four or Fewer Axle Single-Trailer Trucks.** All vehicles with four or fewer axles consisting of two units, one of which is a tractor or straight truck power unit.

9. **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 Trucks.** 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 Fewer Axle Multi-Trailer Trucks.** All vehicles with five or fewer axles consisting of three or more units, one of which is a tractor or straight truck power unit.

12. **Six Axle Multi-Trailer Trucks.** 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 Trucks.** All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit.

Table 2 lists the 13 Scheme F vehicle classes. As part of the Highway Performance Monitoring System (HPMS), statewide VMT is reported by highway functional class and vehicle class. FHWA recommends that states use the 13 Scheme F classes for their HPMS programs. Data from the HPMS are used to apportion Federal highway funds. The scheme F classification system is also used by the states to determine day-of-week and seasonal traffic variation patterns by vehicle type. Other uses include determining truck volumes for highway and pavement design purposes, highway cost allocation studies, accident rate analyses, noise analyses, and traffic engineering studies.

Table 2. FHWA Classification Scheme F Vehicle Types

Class Group	Example Vehicle(s)	Description	No. of Axles
1		Motorcycles	2
2		All Cars	2
		Cars with 1-Axle Trailer	3
		Cars with 2-Axle Trailer	4
3		Pickups and Vans (1 and 2-Axle Trailers)	2,3,or 4
4		Buses	2 or 3
5		2-Axle Single Unit	2
6		3-Axle Single Unit	3
7		4-Axle Single Unit	4
8		2-Axle Tractor, 1-Axle Trailer	3
		2-Axle Tractor, 2-Axle Trailer	4
		3-Axle Tractor, 1-Axle Trailer	4
9		3-Axle Tractor, 2-Axle Trailer	5
		3-Axle Truck 2-Axle Trailer	5
10		Tractor with Single Trailer	6 or more
11		5-Axle Multi-Trailer	5
12		6-Axle Multi-Trailer	6
13		7 or More Axle Multi-Trailer	7 or more

C. EPA's MOBILE Vehicle Classification System

The Environmental Protection Agency's (EPA's) mobile source air quality models, MOBILE5 and MOBILE6, use unique vehicle classification systems. These models classify vehicles according to the engine controls they are subject to, and the characteristic emission rates of each class. Gasoline and diesel powered vehicles are stratified into separate classes, as are heavy and light trucks, cars, and motorcycles. MOBILE5 uses eight vehicle classes while its successor model, MOBILE6, which is currently used for air quality analysis and conformity determinations, uses 28 vehicle classes. Table 3 lists the MOBILE5 and MOBILE6 vehicles classes.

The MOBILE models estimate pollution from highway vehicles. They calculate emissions of hydrocarbons (HC), oxides of nitrogen (NOx), and carbon monoxide (CO), particulate pollution, and other emissions from passenger cars, motorcycles, light- and heavy-duty trucks, and buses. These models account for the emission impacts of factors such as changes in vehicle emission standards, changes in vehicle populations and activity, and variation in local conditions such as temperature, humidity and fuel quality.

MOBILE6 is a major revision to the MOBILE5 model. The revision is based on new data, and also on new understanding of vehicle emission processes. It also includes the effects of regulations that have been issued since MOBILE5 was released.

As a result, vehicle data must be proportioned to many more classes under MOBILE6 compared to MOBILE5. To facilitate this apportionment, EPA has developed a method to convert from the MOBILE5 to the MOBILE6 vehicle classification system based on a series of vehicle class adjustment factors derived from national vehicle mix data[13]. For example, according to EPA, 32.46 percent of heavy duty vehicles are "Class 2b" trucks with gross weight ratings between 8,501 and 10,000 pounds. These vehicles are then divided between gasoline and diesel via a lookup table that varies by vehicle age.

[13] *User's Guide to MOIBLE6.0, Mobile Source Emissions Factor Model*, Publ. EPA420-R-02-001. US Environmental Protection Agency, Washington DC, January 2002.

Table 3. MOBILE5 and MOBILE6 Vehicle Classes

MOBILE5 Vehicle Types		MOBILE6 Vehicle Types	
LDGV	Gasoline fueled passenger cars	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
LDGT1	Gasoline fueled light-duty trucks <6000 lbs	LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs GVWR, 0-3,750 lbs LVW)
		LDGT2	Light-Duty Gasoline Trucks 2 (0-6,000 lbs GVWR, 3,750-5,570 lbs LVW)
LDGT2	Gasoline fueled light-duty trucks 6001 - 8500 lbs	LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs GVWR, 0-5,750 lbs ALVW)
		LDGT4	Light-Duty Gasoline Trucks 4 (6,001-8,500 lbs GVWR, >5,750 lbs ALVW)
HDGV	Gasoline fueled heavy-duty trucks and buses >8500 lbs	HDGV2b	Class 2b Heavy-Duty Gasoline Vehicles (8,501-10,000 lbs GVWR)
		HDGV3	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs GVWR)
		HDGV4	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs GVWR)
		HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs GVWR)
		HDGV6	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs GVWR)
		HDGV7	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs GVWR)
		HDGV8a	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs GVWR)
		HDGV8b	Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs GVWR)
		HDGB	Gasoline Buses (School, Transit, and Urban)
LDDV	Diesel fueled passenger cars	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)
LDDT	Diesel fueled light-duty trucks <8500 lbs	LDDT12	Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs GVWR)
		LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs GVWR)
HDDV	Diesel fueled heavy-duty trucks and buses >8500 lbs	HDDV2b	Class 2b Heavy-Duty Diesel Vehicles (8,501-10,000 lbs GVWR)
		HDDV3	Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs GVWR)
		HDDV4	Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs GVWR)
		HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs GVWR)
		HDDV6	Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs GVWR)
		HDDV7	Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs GVWR)
		HDDV8a	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVWR)
		HDDV8b	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs GVWR)
		HDDBT	Diesel Transit and Urban Buses
		HDDBS	Diesel School Buses
MC	Motorcycles	MC	Motorcycles

GVWR = Gross Vehicle Weight Rating, the maximum loaded weight for which the vehicle is designed, as specified by the manufacturer.
LVW = Loaded Vehicle Weight, the vehicle's curb weight plus 300 lbs.
ALVW = Adjusted Loaded Vehicle Weight, the average of a vehicle's curb weight and its GVWR.
Curb Weight = The manufacturer's estimated weight of the vehicle in operational status with all standard equipment and weight of fuel at normal tank capacity, and the weight of optional equipment.

III. TRUCK AND BUS DATA

It is important to have accurate information on the size and composition of the truck and bus fleet in the DVRPC region. It is also necessary to know about trips and trip rates and trip length distributions by vehicle type for planning purposes, including travel forecasting and air quality calculations. Registration data from state Department of Motor Vehicles (DMVs) can be used to estimate the size of the region's truck fleet. However, registration data do not provide enough information to separate personal vehicles from those used for commercial purposes. In addition, DMV registration files may not include some heavy trucks that are used for interstate travel. Finally, registration data do not provide information on the number or length of trips, and therefore can not be used to estimate VMT.

DVRPC supplements registration data with surveys to separate personal from commercial travel, which have much different trip making characteristics. Surveys are also used to determine trip rates, trip length distributions, trip purposes and the temporal distribution of truck and bus travel. The combination of registration and survey data provides a comprehensive view of region's truck and bus fleet. This information, combined with trip making characteristics from surveys and vehicle classification traffic counts, is used to estimate regional truck and bus trips and travel, calibrate and validate DVRPC's travel simulation models, and provide necessary inputs for mobile source emissions models, the HPMS program, highway design, traffic engineering, and level of service studies.

A. Registration Data

Trucks used to conduct business in the DVRPC region may either be registered in Pennsylvania or New Jersey or through the international registration plan (IRP). The IRP allows motor carriers to register their vehicles with the jurisdiction in which they are based, yet operate in all states and Canadian provinces that are IRP members. IRP registration fees are based upon the proportional mileage operated in each state and province. The IRP then provides credentials to operate in each jurisdiction. This program applies to commercial vehicles and combinations having a gross weight in excess of 26,000 pounds and vehicles having three or more axles, regardless of weight. Although not registered in either Pennsylvania or New Jersey, many of these vehicles may operate within the DVRPC region.

Because the DVRPC region is geographically located between major metropolitan areas, a high percentage of heavy vehicle activity is generated by external activity. The states' vehicle registration files may represent only a proportion of the overall truck activity, particularly for interstate truck traffic and traffic for larger heavy vehicles. The number of trucks registered in each county and the distribution between light and heavy trucks can provide useful insight into the magnitude of truck activity occurring in each county of the DVRPC region. These data can be compared to county-specific factors that influence freight demand including the type and location of industrial activities and the local

infrastructure system. Significant deviations from national registration patterns can indicate particularly intensive or sparse truck operations in that county.

Table 4 shows truck registrations by weight class for the five Pennsylvania counties in the region. The table includes both light and heavy trucks used for personal or commercial purposes. Motor homes, buses, trailers, taxis, limousines, and farm vehicles are not included in the truck registration table. Light trucks with gross weights of 5,000 pounds or less are typically used only as personal vehicles. Those between 5,000 and 9,000 lbs. may be used for either personal or commercial purposes. Those greater than 9,000 lbs. usually serve only commercial trips.

There are 293,545 trucks registered in the five Pennsylvania counties. Over half of these are light trucks with gross weight ratings of 5,000 pounds or less. Another 31.3 percent, or 91,934, weigh between 5,000 and 9,000 pounds. The heaviest trucks, those in classes 8a and 8b in the MOBILE6 vehicle classes, with gross vehicle weights of 33,000 lbs or greater, total 5,186 vehicles, or 1.8 percent of the total.

Of the five Pennsylvania counties, Montgomery County is home to the largest number of registered trucks. It also has the highest number of trucks in most of the individual weight classes. Delaware County has the lowest number of registered trucks. Despite its concentration of heavy industries, marine terminals, other freight facilities, and Interstate highways, Philadelphia has only the fourth highest number of registered trucks of the five Pennsylvania counties.

Table 4. Pennsylvania Truck Registrations by Gross Weight and County

Gross Weight (lbs)	Bucks		Chester		Delaware		Montgomery		Philadelphia		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
unknown	1,978	2.8%	2,154	4.2%	1,259	2.9%	5,142	6.2%	2,137	4.8%	**12,670**	**4.3%**
5000 or less	37,626	53.8%	26,688	51.8%	22,323	50.7%	38,105	45.7%	23,161	51.7%	**147,903**	**50.4%**
5001 to 7000	15,800	22.6%	10,740	20.8%	11,448	26.0%	18,112	21.7%	9,907	22.1%	**66,007**	**22.5%**
7001 to 9000	5,809	8.3%	4,607	8.9%	3,691	8.4%	8,466	10.2%	3,354	7.5%	**25,927**	**8.8%**
9001 to 11000	3,767	5.4%	3,044	5.9%	2,290	5.2%	4,988	6.0%	2,107	4.7%	**16,196**	**5.5%**
11001 to 14000	744	1.1%	468	0.9%	443	1.0%	837	1.0%	459	1.0%	**2,951**	**1.0%**
14001 to 17000	1,050	1.5%	917	1.8%	601	1.4%	1,707	2.0%	1,440	3.2%	**5,715**	**1.9%**
17001 to 21000	438	0.6%	401	0.8%	262	0.6%	696	0.8%	307	0.7%	**2,104**	**0.7%**
21001 to 26000	1,164	1.7%	950	1.8%	754	1.7%	1,936	2.3%	1,026	2.3%	**5,830**	**2.0%**
26001 to 30000	169	0.2%	175	0.3%	116	0.3%	594	0.7%	117	0.3%	**1,171**	**0.4%**
30001 to 33000	373	0.5%	424	0.8%	272	0.6%	589	0.7%	227	0.5%	**1,885**	**0.6%**
33001 to 36000	118	0.2%	134	0.3%	67	0.2%	144	0.2%	46	0.1%	**509**	**0.2%**
36001 to 40000	82	0.1%	45	0.1%	63	0.1%	87	0.1%	54	0.1%	**331**	**0.1%**
40001 to 44000	22	0.0%	21	0.0%	9	0.0%	34	0.0%	11	0.0%	**97**	**0.0%**
44001 to 48000	29	0.0%	45	0.1%	17	0.0%	41	0.0%	10	0.0%	**142**	**0.0%**
48001 to 52000	56	0.1%	51	0.1%	23	0.1%	96	0.1%	30	0.1%	**256**	**0.1%**
52001 to 56000	89	0.1%	113	0.2%	58	0.1%	211	0.3%	61	0.1%	**532**	**0.2%**
56001 to 60000	150	0.2%	136	0.3%	70	0.2%	295	0.4%	61	0.1%	**712**	**0.2%**
60001 to 64000	15	0.0%	23	0.0%	24	0.1%	80	0.1%	19	0.0%	**161**	**0.1%**
64001 to 68000	7	0.0%	11	0.0%	2	0.0%	28	0.0%	20	0.0%	**68**	**0.0%**
68001 to 73280	320	0.5%	241	0.5%	153	0.3%	991	1.2%	136	0.3%	**1,841**	**0.6%**
73281 to 76000	3	0.0%	5	0.0%	1	0.0%	5	0.0%	1	0.0%	**15**	**0.0%**
76001 to 78000	1	0.0%	8	0.0%	7	0.0%	1	0.0%	2	0.0%	**19**	**0.0%**
78001 to 78500	1	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	**1**	**0.0%**
78501 to 79000	1	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	**1**	**0.0%**
79001 to 80000	87	0.1%	114	0.2%	48	0.1%	164	0.2%	88	0.2%	**501**	**0.2%**
All Classes	**69,899**	**100.0%**	**51,515**	**100.0%**	**44,001**	**100.0%**	**83,349**	**100.0%**	**44,781**	**100.0%**	**293,545**	**100.0%**

Although New Jersey registers its trucks by vehicle type, use, and engine fuel, not all heavy trucks receive a gross vehicle weight rating. Table 5 provides New Jersey's privately-owned truck and bus registrations by vehicle type and county for the Delaware Valley Region. On the New Jersey side of the region, Burlington County has the most light trucks, heavy trucks, and buses. Mercer County has the highest ratio of heavy trucks to light trucks.

Just over eight percent of New Jersey's registered trucks are classed as heavy vehicles (more than 8,500 lbs). This is a significantly smaller percentage than observed in Pennsylvania. It appears likely that many, if not most, of the New Jersey's "unclassified" trucks are, in fact, heavy trucks. New Jersey calculates gross weight from the vehicle identification number (VIN). Heavy vehicle VIN coding is not uniform, and each manufacturer can have unique coding conventions. As a result, incorrect interpretations of gross weight may have occurred during data entry.

The values in Table 5 do not include vehicles registered to governments or other public agencies, such as school districts. Privately-owned buses account for about 2.1 percent of the total trucks and buses registered in the New Jersey counties. Although some school districts own and operate their own bus fleets, most are owned and operated by private businesses that contract to provide service. Statewide, about 22 percent of New Jersey school buses are district-owned[14]. Applying this percentage to the values in Table 5 would result in an additional 1,057 buses in the New Jersey portion of the region, and would bring the total to 4,805. This value is more consistent with an independent estimate of school buses operating in the New Jersey portion of the region, 4,650, discussed in Section F of this chapter. Using this value, the share of buses in the New Jersey counties would represent about 2.7 percent of the total registered trucks and buses. Bus registrations are not available at the county level for the Pennsylvania portion of the region. However, Pennsylvania statewide data show that buses account for about 2.5 percent of all trucks and buses combined.

The combined registration files provided by Pennsylvania and New Jersey states contain 473,098 records for the DVRPC nine-county region. There are 293,545 light and heavy trucks registered in the Pennsylvania portion of the region and 179,553 trucks and buses registered in the New Jersey counties. Over 80 percent of these, or 363,648, are light trucks. The Pennsylvania registration data includes 239,837 trucks with GVWR of 9,000 pounds or less and the New Jersey file contains 153,811 vans, pickups, and other light trucks.

[14] *State-by State Transportation Statistics, 1998-99 School Year*, School Bus Fleet [Online]: Available at http://www.schoolbusfleet.com/stats.cfm.

Table 5. New Jersey Truck Registrations by Vehicle Type and County

Type of Truck	Burlington		Camden		Gloucester		Mercer		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Van	11,884	21.2%	11,960	24.8%	7,047	16.9%	8,226	24.5%	**39,117**	**21.8%**
Pick Up Truck	30,173	53.9%	24,423	50.7%	25,704	61.5%	15,958	47.5%	**96,258**	**53.6%**
Other Light Truck	5,723	10.2%	4,625	9.6%	4,188	10.0%	3,900	11.6%	**18,436**	**10.3%**
Bus	1,190	2.1%	1,047	2.2%	803	1.9%	708	2.1%	**3,748**	**2.1%**
Heavy Truck	4,832	8.6%	4,177	8.7%	2,654	6.3%	3,328	9.9%	**14,991**	**8.3%**
Unclassified	2,208	3.9%	1,934	4.0%	1,410	3.4%	1,451	4.3%	**7,003**	**3.9%**
Total	**56,010**	**100.0%**	**48,166**	**100.0%**	**41,806**	**100.0%**	**33,571**	**100.0%**	**179,553**	**100.0%**

B. DVRPC's Cordon Line Highway Traffic Data

DVRPC has identified 155 highway stations along the region's boundary, or cordon, that are significant for travel simulation and other transportation planning activities. These stations are grouped according to their functional class: freeways and other expressways, arterials, and local roads. The travel patterns of these facilities are especially critical, as major new development has occurred in many areas near the cordon line in recent years.

For each cordon station, a daily traffic count was collected. A total of 1,455,717 trips cross the region's boundary at these stations each day. About 13.6 percent, or 198,421 of these trips, are made by light trucks. Another 131,563, or 9.0 percent, are made by heavy trucks.

In order to determine the origin-destination travel patterns, travel activity, and travel mode of vehicles crossing the nine-county DVRPC boundary, a Cordon Line Highway Traffic Survey was conducted[15]. The survey, conducted in the spring and summer of 2001, consisted of roadside interviews at 12 locations around the region. Questions were asked about trip origin, destination, and purpose; highway use and vehicle type; and vehicle occupancy. The survey form is shown in Figure 3. The survey was designed with special emphasis on trucks. Commercial vehicles accounted for 3,101 of the 18,577 vehicles surveyed. For trucks, additional questions were asked about truck type, garaging and commodity information.

Light trucks accounted for 15.9 percent of the surveyed vehicles. Of these, more than half were pickups (at 8.8 percent of surveyed vehicles), followed by single-units (4.0 percent), panels (1.8 percent), and others (1.4 percent). Just under 10 percent (175 out of 1,597) of the pickups surveyed were used for commercial purposes; only 3.2 percent of surveyed vans (67 out of 2,102) were commercial vehicles.

Heavy trucks made up 9.2 percent of the vehicles stopped at the cordons. Most of these were tractor-trailers at 7.9 percent of all traffic, followed by double-trailers (0.8 percent) and others (0.5 percent). Figure 4 shows the distribution of surveyed truck traffic, including both light and heavy trucks, by vehicle type.

The cordon survey, along with supplemental survey data from the Pennsylvania and New Jersey Turnpike Commissions and other historical data, was used to determine the external and through trip patterns of all cordon stations, which are discussed in Chapter IV. Data from the cordon survey were also used to help separate light trucks into personal and commercial uses, proportion the unclassified vehicles from the DMV registration files to light and heavy trucks, and to develop trip length distributions for external and through trips.

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[15] *Regional Cordon Line Stations for the Delaware Valley Region,* Delaware Valley Regional Planning Commission, Publication No. 02044, September 2002.

Figure 3. Cordon Line Highway Survey Questionnaire

Delaware Valley Regional Planning Commission **Nº 10000**
EXTERNAL AND THROUGH TRIP SURVEY **Time : :** 1[ ] AM 2[ ] PM

1. Where did you start this trip? (Origin) **2. Is this home?** 1[ ] Yes 2[ ] No

_____
Street address or nearest intersection

_____
Town or City County State Zip Code

3. Where will this trip end? (Destination) **4. Is this home?** 1[ ] Yes 2[ ] No

_____
Street address or nearest intersection

_____
Town or City County State Zip Code

5. Will you stop before arriving at your destination? **6. Is this home?** 1[ ] Yes 2[ ] No

1[ ] No 2[ ] Yes, If yes, where?

_____
Street address or nearest intersection

_____
Town or City County State Zip Code

7. Why do you use this road? (check one or more)
1[ ] Saves Time 3[ ] Less Congestion 5[ ] No Traffic Lights
2[ ] Saves Money 4[ ] Better Road Condition 6[ ] Other_____

8. What is/are the major road(s) that you will take to reach the destination after this road?

1st Highway_____ 2nd Highway _____

9. What type of vehicle is used for the trip?

Passenger Vehicles	**Light Trucks**	**Heavy Trucks (3 axles or more)**
1[ ] Auto	5[ ] Pickup	9[ ] Tractor-Trailer
2[ ] Van, Sta. Wagon	6[ ] Panel	10[ ] Double Trailer
3[ ] SUV	7[ ] Single Unit	11[ ] Other _____
4[ ] Other _____	8[ ] Other _____	

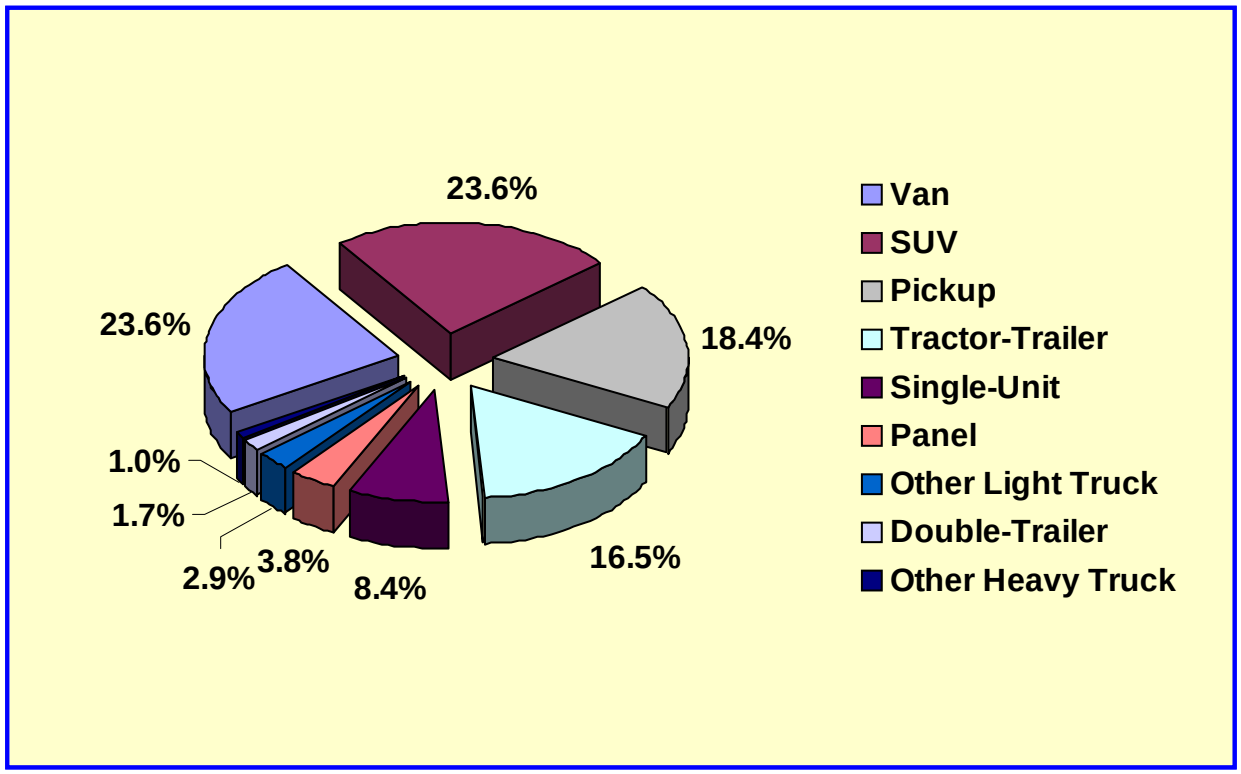
10. What is the purpose of this trip? (Passenger Vehicles Only)
1[ ] Work 3[ ] Eat Meal 5[ ] Social/Recreation 7[ ] Visitor/Tourist
2[ ] School 4[ ] Shopping 6[ ] Medical 8[ ] Other _____

11. How many people are in the vehicle? (Passenger Vehicles Only)
1[ ] One 2[ ] Two 3[ ] Three 4[ ] Four 5[ ] Five 6[ ] More than Five

12. Where is this truck garaged or parked when not in service? (Trucks Only)
1[ ] Bucks County 4[ ] Montgomery County 7[ ] Burlington County 10[ ] Mercer County
2[ ] Chester County 5[ ] Philadelphia County 8[ ] Camden County 11[ ] Other NJ County
3[ ] Delaware County 6[ ] Other PA County 9[ ] Gloucester County 12[ ] Other State

13. What type of commodities are you carrying? (Trucks Only)
1[ ] Empty 4[ ] Agricultural Products 7[ ] Retail Store Merchandise
2[ ] Manufactured Products 5[ ] Building Materials 8[ ] Parcels
3[ ] Petroleum Products 6[ ] Refrigerated Products 9[ ] Other _____

Figure 4. Type of Vehicle Used for Truck Trips Crossing the Region's Boundary



C. DVRPC's Truck Travel Survey

A small Truck Travel Survey was conducted to collect current information on truck travel activity, origin and destination patterns, trip length frequency, and commodity data in the Delaware Valley region. The survey was conducted in late 2000 and 2001. Weekday Truck Travel Diary survey forms were sent to almost 500 trucking and freight handling establishments, including both shippers and truck owners and drivers. Detailed information was collected on up to 12 trips per day per truck. Questions were asked about number of daily trips; trip origin, destination, and purpose; truck type, garaging, and commodity information; land use at each stop location; time of day; and the odometer reading at the beginning and end of each trip. A sample survey questionnaire is provided in Figure 5. Although a very large number of survey forms were mailed out, and extensive efforts were made to follow up with each trucking and shipping firm, only 155 completed survey forms were returned.

Figure 5. Truck Travel Survey Questionnaire

A PERSONAL MESSAGE TO THE TRUCK DRIVER

Before you complete this **Weekday Truck Travel Diary**, please read the attached example which illustrates the weekday trips made by a hypothetical tractor-trailer in a 24 hour period. For any weekday, please answer all questions in the diary and record each trip in the order you make it from the starting address of the first trip to the address of the last trip.

1. What type of truck is used for your trips today ? *(check one)*

[ ] Pickup [ ] Panel [ ] Single Unit [ ] Dump Truck [ ] Flatbed [ ] Tractor-Trailer [ ] Double Trailer [ ] Other

2. Where is this truck garaged or parked when not in service? *(check one)*

[ ] Bucks Co. [ ] Chester Co. [ ] Delaware Co. [ ] Montgomery Co. [ ] Philadelphia [ ] Other Pennsylvania county

[ ] Burlington Co. [ ] Camden Co. [ ] Gloucester Co. [ ] Mercer Co. [ ] Other New Jersey county [ ] Other State

3. What is the starting address of your first truck trip today? 4. Is this your home? [ ] Yes [ ] No

_____

Street address or nearest intersection

_____

City or Town County State Zip Code

5. Start Odometer Reading _____ 6. Date : ____ (Month) ____ (Day) , 2000

WEEKDAY TRUCK TRAVEL DIARY

TRIP #	Start Time *(check AM or PM)*	Stop Time *(check AM or PM)*	Stop Odometer Reading	Location of Stop	Stop Purpose *(check one)*	Commodity Carried to Location of Stop *(check one)*	Land Use at Stop *(check one)*
TRIP 1	: [ ] AM [ ] PM	: [ ] AM [ ] PM	_____ (Mileage)	_____ Street address or nearest intersection _____ City or Town County _____ State Zip Code	[ ] Pickup, Load [ ] Dropoff, Unload [ ] Unload & Load [ ] Fuel Service [ ] Eat, Personal	[ ] Empty [ ] Parcels [ ] Manufact. Products [ ] Retail Store Merchandise [ ] Petroleum Products [ ] Refrigerated Products [ ] Agriculture Products [ ] Hazardous Materials [ ] Building Materials [ ] Other	[ ] Residential [ ] Service [ ] Retail, Commercial [ ] Government [ ] Manufact. - ing [ ] Transportation [ ] Ware - housing [ ] Utilities [ ] Office [ ] Other
•							
•							
•							
TRIP 12	: [ ] AM [ ] PM	: [ ] AM [ ] PM	_____	_____ Street address or nearest intersection _____ City or Town County _____ State Zip Code	[ ] Pickup, Load [ ] Dropoff, Unload [ ] Unload & Load [ ] Fuel Service [ ] Eat, Personal	[ ] Empty [ ] Parcels [ ] Manufact. Products [ ] Retail Store Merchandise [ ] Petroleum Products [ ] Refrigerated Products [ ] Agriculture Products [ ] Hazardous Materials [ ] Building Materials [ ] Other	[ ] Residential [ ] Service [ ] Retail, Commercial [ ] Government [ ] Manufact. - ing [ ] Transportation [ ] Ware - housing [ ] Utilities [ ] Office [ ] Other

7. If your truck makes more than 12 trips on the survey day, write the total number here _____

8. Comments : _____

_____

Tractor-trailers comprise 97, or 63 percent, of the trucks surveyed. Single-unit trucks account for 32, or about 20 percent. Also included in the survey were one pickup truck, four dump trucks, five flatbeds, and no double-trailer trucks. Ninety-nine of the surveyed trucks (64 percent) are garaged in the Pennsylvania portion of the region when not in service, 49 are garaged in the New Jersey counties, and only seven are garaged outside the region.

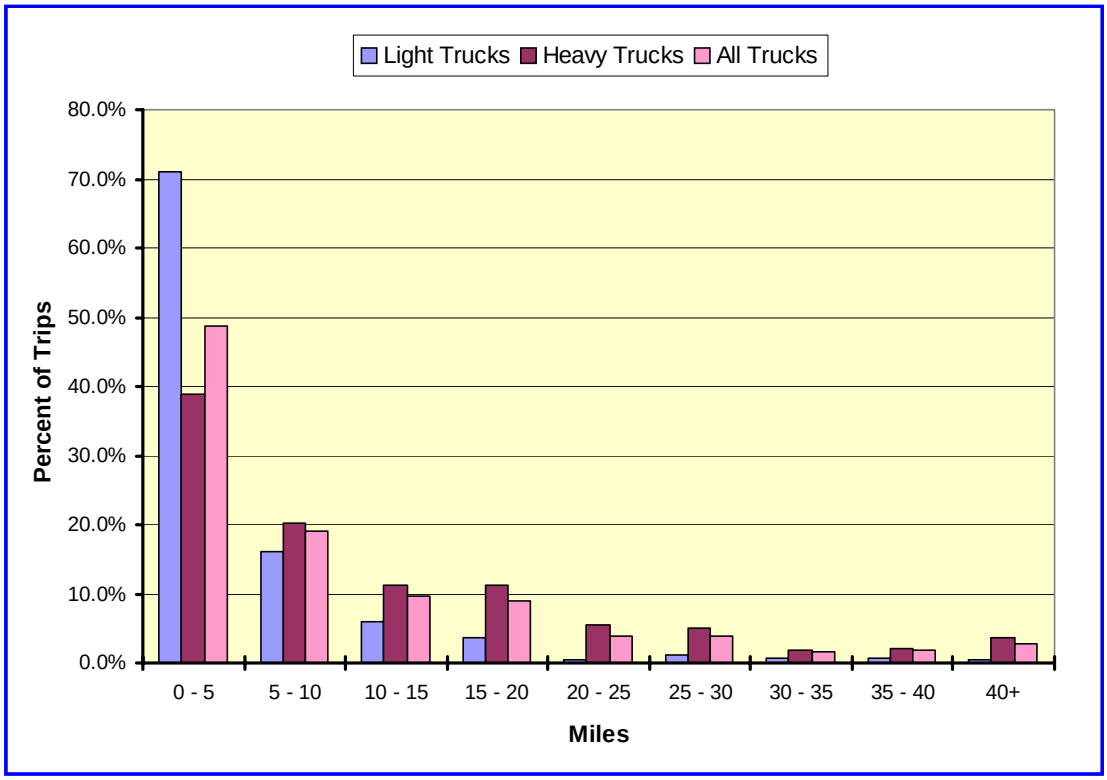
A total of 2,825 one-way trips were made by the surveyed trucks. Although only 12 of 155 trucks surveyed are panel trucks, they account for over half of all trips. All of the panel trucks included in this survey were used to drop off and pick up parcels, and thus tend to make large numbers of short trips. Tractor-trailers account for the next highest number of trips at 760 (27 percent), followed by single-unit trucks with 340 trips, or 12 percent of the total. The average number of truck trips per day made by all trucks surveyed is 18.23. The average for non-parcel trucks is 8.59.

For travel simulation purposes, pickups, and panel trucks are considered light trucks and dump trucks, flat beds, and tractor-trailers are considered heavy trucks. Because single-unit trucks can be either light or heavy trucks for the purposes of travel simulation, they were split between these two categories to determine trip length distributions. Two-axle, four-tire single-units are considered light and two-axle, six-tire single-units and those with three or more axles are classified as heavy trucks. Figure 6 provides trip length frequency distributions for light and heavy trucks. The distributions in the figure are for internal trips only, i.e. those trips that both begin and end within the DVRPC region. These distributions are needed to calibrate and validate DVRPC's travel simulation models. Separate trip length distributions for trucks entering or exiting the region are developed from DVRPC’s Cordon Survey.

There were a total of 922 internal trips for which distance could be determined, 280 light truck trips and 642 heavy truck trips. The light trucks had an average trip length of 4.70 miles. Only nine trips (3.2 percent) were greater than 20 miles; 199, or 71.1 percent were five miles or less. Heavy trucks tend to make longer trips compared to light trucks. Their average internal trip length was 11.78 miles. While trips of 5 miles or less are still the most prevalent, they account for 250 out of 642, or 38.9 percent, of heavy truck trips, compared to 71.1 percent for light trucks. In addition, 117 heavy truck trips (18.2 percent) were 20 miles or greater in length. When light trucks and heavy trucks are combined, their average internal trip length is 9.63 miles, with 449 (48.7 percent) trips of five miles or less.

If one were to consider all surveyed trips, including those that extend beyond the region's boundaries, the average truck trip length would be 20.86 miles; light trucks would average 7.98 miles and heavy trucks 25.58 miles. Additionally, 32 percent of heavy truck trips would be greater than 20 miles and 14 percent would be greater than 50 miles.

Figure 6. Truck Trip Length Distribution



The Truck Travel survey asked three questions about each trip stop: stop purpose, commodity carried to stop, and land use at stop location. The results from these questions are tabulated for the 1,183 trips for which this information is available. "Drop off, Unload" is by far the most prevalent trip purpose, accounting for 737, or 62.3 percent of the surveyed trips with purpose information. This purpose also accounts for 136 of the 137 panel truck trips, due to all surveyed panel trucks being in the parcel delivery business. The next most frequent trip purpose was "Pickup, Load" with 242, or 20.5 percent of surveyed trips, followed by "Load & Unload" with 102 (8.6 percent). "Fuel Service" and "Eat, Personal" together accounted for only 7.8 percent of surveyed trip purposes.

Manufactured Products were the most commonly carried commodity of the surveyed trips, accounting for 264 trips, or 22.3 percent. Other common commodities include Retail Store Merchandise at 169 trips (14.3 percent) and Parcels at 149 trips, or 12.6 percent of all surveyed trips. About 13.9 percent of surveyed trips were empty.

The most common land use at the stop location of the surveyed truck trips was Retail, Commercial, which accounted for 293, or 24.8 percent of all surveyed trips, followed by Manufacturing at 202 trips (17.1 percent). Other common land uses include Transportation (14.9 percent), Warehousing (13.9 percent), and Residential (7.9 percent).

D. DVRPC's Vehicle Classification Traffic Counts

DVRPC regularly collects and analyzes traffic data to determine the utilization of the region's highway network. The traffic counting program supports VMT forecasting, the congestion management system (CMS), travel simulation models, individual project level analyses, and traffic monitoring and trend analysis. Many of the agency's counts are set to collect traffic volumes by vehicle classification, using the Scheme F classes.

Table 6 indicates the truck traffic recorded by DVRPC's traffic counters in each county. Light trucks in the table include pickups and vans (Scheme F class 3 vehicles from Table 1) and heavy trucks include both single-units and combination vehicles (Scheme F classes 5 thru 13). Light trucks account for just over 13 percent of all counted traffic, and heavy trucks make up an additional 7.5 percent. The New Jersey counties tend to have a higher percentage of truck traffic than the Pennsylvania counties. DVRPC's vehicle classification traffic counts are discussed in further detail in Chapter V.

Table 6. Truck Traffic from DVRPC's Vehicle Classification Traffic Counts

County	Percent of Total Traffic		
	Light Trucks	Heavy Trucks	All Trucks
Bucks	13.4%	6.8%	20.2%
Chester	14.2%	6.9%	21.1%
Delaware	12.5%	7.0%	19.5%
Montgomery	13.0%	7.0%	20.0%
Philadelphia	12.4%	6.9%	19.3%
PA Counties	**13.1%**	**6.9%**	**20.0%**
Burlington	13.6%	8.7%	22.3%
Camden	12.0%	7.9%	19.9%
Gloucester	14.3%	8.8%	23.1%
Mercer	13.2%	9.0%	22.2%
NJ Counties	**13.4%**	**8.7%**	**22.1%**
Region Total	**13.2%**	**7.5%**	**20.7%**

E. Size and Composition of the Region's Truck Fleet

The information available from the Pennsylvania and New Jersey truck registration files, DVRPC's Cordon Line Highway Traffic and Truck surveys, and classification counts was used to develop estimates of the size and composition of the truck fleet in the DVRPC region. These estimates are necessary inputs to DVRPC's travel simulation models and are also needed for mobile source emissions calculations and other planning purposes. Three general classes of trucks were estimated for each county: private work trucks, light commercial trucks, and heavy commercial trucks. An additional estimate was made for heavy trucks that could not be assigned to an individual county due to registration through the IRP, incomplete address data, or some other reason.

Private work trucks include those pickups, vans, and other light trucks that are garaged at home may be used for both work and household trip purposes. Pickups, vans, and SUVs that are registered to a company and used strictly for commercial purposes (e.g. by locksmiths, florists, etc), are included with panel trucks and single-unit trucks as light commercial trucks. Tractor-trailers, double-trailers, flatbeds, and dump trucks, and similar vehicles are classed as heavy commercial trucks. Table 7 provides the number and type of truck by county. The values in the table were developed by DVRPC based on the states' registration data and other secondary sources. Just under 56 percent of the region's truck fleet are personal trucks. Light trucks make up the majority of the commercial trucks at 76 percent and account for about one third of all trucks in the region.

Table 7. Delaware Valley Region Truck Fleet by County

Registration Location	Private Work Trucks	Commercial Trucks Light	Commercial Trucks Heavy	Total Trucks
Bucks	45,526	20,259	4,114	69,899
Chester	32,058	15,483	3,974	51,515
Delaware	28,047	13,379	2,576	44,002
Montgomery	47,161	27,625	8,563	83,349
Philadelphia	28,115	13,382	3,285	44,782
Not Specified			5,144	5,144
PA Counties	**180,907**	**90,128**	**27,656**	**298,691**
Burlington	26,971	21,914	5,936	54,821
Camden	24,172	17,804	5,144	47,120
Gloucester	19,899	17,745	3,359	41,003
Mercer	16,205	12,605	4,054	32,864
Not Specified			5,054	5,054
NJ Counties	**87,247**	**70,068**	**23,547**	**180,862**
Region Total	**268,154**	**160,196**	**51,203**	**479,553**

F. Bus Data in the Region

The DVRPC region is served by a dense and complex network of public transportation services, including more than 150 bus routes. Consequently, buses have a significant presence on the region's highways. Although buses have a greater impact on highways than passenger cars, they significantly increase the person-carrying capacity of urban highways. SEPTA and NJTransit handle almost all of the region's transit bus trips. Other carriers providing local bus service include Pottstown Urban Transit, Krapf's Coaches, and several services operated by Transportation Management Associations (TMAs). Transit buses are only one component of overall bus travel. Other forms include intercity carriers, such as Greyhound and Trailways, school, charter, paratransit, and shuttle buses.

Although the Federal Transit Administration (FTA) maintains operating and other statistics for the larger transit providers, it is difficult to gather complete information on bus travel at the regional level, for several reasons. First, transit service is only one component of bus travel and FTA does not compile statistics on intercity, charter, or school bus travel. Second, some transit provides, such as NJTransit and Pottstown Urban Transit have service areas that cross the region's boundary. Third, the available statistics may only include revenue-miles, rather than total travel, or may include only weekday data.

Table 8 shows the components of the regional bus fleet and bus miles of travel for which data are available. Bus miles of travel for SEPTA represent average daily values. Mileage for NJTransit and the intercity bus routes are average weekday values. For the Pennsylvania and New Jersey school districts, the mileage values are for an average school day. The data for transit providers include both revenue and non-revenue miles for fixed-route service. They do not include paratransit travel. The school district values are route-miles only. School bus fleet and mileage for Pennsylvania was provided by the Pennsylvania Department of Education. The New Jersey Department of Motor Vehicles provided New Jersey school district bus fleet data. New Jersey school district bus mileage was estimated from the average Pennsylvania school bus mileage.

The region's bus fleet contains over 14,000 vehicles. Together they travel about 943,000 miles each day school day. When school is not in session, regional bus mileage drops to just over 200,000 miles per day. NJTransit buses average about 220 miles per day. SEPTA buses, with service concentrated in the densely developed City of Philadelphia, average less than half the mileage of a NJTransit bus. School buses average about 62 miles per school day.

There are a combined 8,671 SEPTA and school buses operating in the five Pennsylvania counties of the DVRPC region. On the New Jersey side, school buses and NJTransit buses total 4,910.

Table 8. Bus Data in the Delaware Valley Region

Provider	Number of Buses	Average Daily Miles of Travel
SEPTA	1,300 [1]	125,450 [6]
NJTransit	260 [2]	56,934 [7]
PA School Districts	7,371 [3]	453,397 [8]
NJ School Districts	4,650 [4]	286,026 [9]
Intercity	548 [5]	20,862 [10]
Total	**14,129**	**942,669**

[1] Total number of buses. 1,148 are active at any given time.
[2] Active peak period buses in DVRPC portion of service area.
[3] Source: Pennsylvania Department of Education. 4,570 have capacities of 24 or more pupils.
[4] Source: New Jersey Department of Motor Vehicles.
[5] Number of weekday intercity trips entering and exiting region.
[6] Average daily miles of travel. About 11% are non-revenue.
[7] Average weekday miles of travel. About 20% of miles are non-revenue.
[8] Average school day route-miles of travel. Estimated from mileage of 24+ buses.
[9] Average school day route-miles of travel. Estimated from PA school bus mileage.
[10] Average weekday miles of travel within the DVRPC region.

IV. TRUCK AND BUS TRIPS

The trip making patterns of trucks and buses have profound impacts on the region's transportation system. These patterns include the number of trips made by vehicle type each day; the distances involved, expressed as a trip length distribution; and their geographic distribution, expressed in terms of origins and destinations at the traffic analysis zone (TAZ) level. For travel simulation and other transportation planning purposes, trips are divided into three general categories:

1. Internal-Internal trips which have both origins and destinations within the DVRPC region.

2. Internal-External and External-Internal trips which have either origins or destinations within the region, and

3. External-External trips or Through trips which have both origins and destinations outside the region.

Internal-External, External-Internal, and External-External truck trip data are derived from DVRPC's cordon survey, discussed in Chapter III. Intercity bus trips crossing the cordon were also discussed in Chapter III. This chapter presents the estimation of Internal-Internal light and heavy truck trips, and all three categories of bus passenger trips.

A. Internal Truck Trip Rates

For travel modeling purposes, internal-internal truck trips are generated based on the number of households, manufacturing jobs, retail employment jobs, and other types of employment. Commercial trucks are divided in the simulation models as light and heavy which are consistent with the FHWA vehicle classification system. Pickup, panel, and small single unit (two-axle) are classified as light trucks, while large single unit, dump, flatbed, tractor-trailer, and double-trailer trucks are classified as heavy. Light and heavy truck trip rates per household or per job are estimated and then multiplied by the number of households or jobs in each TAZ to obtain the numbers of truck trip origins or destinations.

DVRPC's Truck Travel Survey, discussed in Chapter IV, was used to update the commission's truck trip rates. This survey provided information on the average number of daily trips per truck, trip length distributions, origins and destinations, trip ends, trip purposes, commodities carried, peak and off-peak trips, and land use at the stop locations. In addition to this survey, DVRPC reviewed a truck survey prepared for the Greater Buffalo Regional Transportation Council to compare results.[16] The Buffalo survey is also small,

[16] *Greater Buffalo-Niagra Regional Transportation Council Goods Movement Study*, Jack Faucett Associates, Walnut Creek, California, April 1999.

but larger than DVRPC's (322 trucks). The two surveys have produced trip rates for parcel and non-parcel trucks as shown in Table 9.

Table 9. Average Daily Truck Trip Rates from Buffalo and DVRPC Surveys

Truck Type	Buffalo Survey	DVRPC Survey
Trip Rate for All Trucks	19.7 trips	18.2 trips
Trip Rate for Non-Parcel Trucks	10.4 trips	8.7 trips
Trip Rate for Parcel Trucks	109.6 trips	133.0 trips

As can be seen from the table, the results of the two surveys are similar, and there is a large variation in the trip rates between parcel and non-parcel trucks (8.7 vs. 133.0). If corrected for bias due to over-sampling of parcel trucks, the average daily trip rate would be 13.1 for light trucks and 8.2 for heavy trucks.

The estimates of truck trip rates from this survey, along with class counts, DVRPC's estimate of the region's truck fleet size, and the truck trip length frequency distribution from the Truck Survey, were used to update DVRPC's truck trip rates for the Trip Generation component of the Travel Simulation Model. These updated rates are a function of TAZ-level socio-economic variables and area type. They are shown in Table 10. These rates are for internal-internal truck trips only. External-internal, internal-external, and through trip rates are generated separately based on the results of the Cordon Survey.

Table 10. Truck Trip Rates for Generating Vehicle Origins or Destinations

	Truck Trip Rates by Area Type					
	CBD	CBD Fringe	Urban	Suburban	Rural	Open Rural
Trip Rates for Light Trucks						
Per Household	0.10	0.17	0.29	0.43	0.51	0.59
Per Retail Employment Job	0.30	0.44	0.29	1.04	1.15	1.15
Per Other Employment Job	0.16	0.17	0.32	0.38	0.48	0.60
Trip Rates for Heavy Trucks						
Per Household	0.07	0.07	0.08	0.10	0.12	0.13
Per Manufacturing / Wholesale Job	0.08	0.10	0.13	0.14	0.15	0.16
Per Retail Employment Job	0.12	0.16	0.35	0.36	0.52	0.56
Per Other Employment Job	0.06	0.12	0.21	0.27	0.36	0.36

Using the trip rates from Table 10 along with DVRPC's estimation of households and employment by sector at the TAZ level results in 1,067,000 light truck trip per day and 840,000 heavy truck trips, for a total of 2,808,000 truck trips per day in the region. Combining the internal-internal truck trip making estimates with external and through travel from survey and count data taken along the cordon line, results in a comprehensive picture of truck travel pattens in the DVRPC region. A summary of regional truck trips is provided in Table 11.

Table 11. Summary of Regional Truck Trips

Type of Trip	Truck Trips per Day		
	Light Trucks	Heavy Trucks	Total
Internal - Internal	1,967,383	840,354	2,807,737
Internal - External and External - Internal	184,187	92,619	276,806
External - External	14,234	38,944	53,178
All Truck Trips	**2,165,804**	**971,917**	**3,137,721**

B. Bus Passenger Trips

For travel simulation modeling purposes, it is also necessary to gather data on bus passenger trips in terms of internal-internal, external-internal, and external-external travel. For these purposes, only urban mass transit and intercity bus passengers are considered. School bus riders are not included.

Because almost all bus transit routes in the DVRPC region are entirely internal, these trips can be tabulated from the ridership reports of the various transit service providers operating within the region.

There are two types of bus services that cross the DVRPC cordon line: intercity bus service such as Greyhound and Trailways and some long distance New Jersey Transit routes. The number of and frequency of intercity bus routes crossing the cordon was obtained from *Russell's Official National Motor Coach Guide*[17]. Additional information was obtained form published schedules for New York and Atlantic City service. Ridership information for these routes is proprietary, but the service providers supplied average

[17] *Russell's Official National Motor Coach Guide for United States and Canada*, Russell's Guides, Inc., Cedar Rapids, Iowa, 2001.

passenger loads crossing the cordon line. For the NJ Transit routes that cross the cordon, service frequency information was gleaned from published schedules, while ridership across the cordon was provided by NJ Transit staff.

External-internal trips were separated from through trips at the cordon stations manually by DVRPC staff based on the service patterns of each route and whether or not service was provided to a major bus terminal. Catchment areas were established around each stop location and divided into distance based rings, centered on the bus stop. Trips were allocated to TAZs in the rings based distance and accessibility.

Table 12 provides a summary of the region's bus passenger trips. About 633,000 bus rides are provided in the DVRPC region each day. The vast majority of these, about 621,000, occur entirely within the region's boundaries. About 11,400 people cross the region's cordon line each day on a bus. Only about 11 percent of these are people who travel through the region on a bus.

Table 12. Bus Passengers Trips in the DVRPC Region

Type of Trip	Bus Passenger Trips per Day
Internal - Internal	621,124
Internal - External and External - Internal	10,154
External - External	1,286
All Bus Passenger Trips	**632,564**

V. TRUCK AND BUS VEHICLE MILES OF TRAVEL

The area-wide impacts of energy consumption, exhaust emissions, and noise all vary with vehicle-miles of travel (VMT). Because heavy vehicles disproportionately contribute to all these factors, it is desirable to have accurate estimates of VMT by vehicle class. Estimates of truck volumes on individual sections of road are also necessary for design purposes and to analyze traffic operations. Regional estimates of truck and bus VMT generally must be developed from traffic counts. However, limited resources make it impractical to conduct classification counts on all highway sections of interest. Therefore, analytical methods must be created to produce reliable estimates from relatively limited data. These methods involve classifying vehicles by characteristics that can be readily discerned by available traffic counting devices, analyzing the differences in traffic patterns among different vehicle types and highway facilities, and developing factoring procedures to determine the distribution of traffic among vehicle types.

A. HPMS VMT Data by Vehicle Type and Functional Class

Both Pennsylvania and New Jersey tabulate and report statewide VMT values by vehicle class and functional class. Both states follow Scheme F classifications, except that in Pennsylvania's tabulations motorcycles are included with passenger cars and buses are included with single-unit trucks.

The statewide HPMS VMT tabulations by vehicle type and functional class are from the state's continuous counting stations. These permanent counting locations continuously monitor traffic. They are used to determine how traffic volumes from the various vehicle types vary by hour-of-day, day-of-week, month-of-year, and with highway functional class. Monitoring and recording these traffic variations is important because heavy vehicles have significantly different spatial and temporal distributions than passenger cars and other personal vehicles[18]. On most roads truck traffic drops on weekends, and outside of urban areas automobile traffic generally rises.

There are, however, some disadvantages from deriving regional truck and bus VMT estimates solely from the states' continuous counting stations. First, there are only a limited number of stations statewide. Second, average statewide values may not correlate well with Delaware Valley traffic patterns. For example, the rural portions of the region are in close proximity to the large population and employment center of the Philadelphia metropolitan region. Many of Pennsylvania's rural highway facilities are located in areas that are far away from any significant urban activity. Even if they are near an urban area, it is likely to be much smaller than Philadelphia. Similarly, New Jersey's statewide urban VMT distributions are heavily influenced by the New York City metropolitan region.

[18]Weinblatt, Herbert, "Using Seasonal and Day-of-Week Factoring to Improve Estimates of Truck Vehicle Miles Traveled," in *Transportation Research Record 1522*, Transportation Research Board, National Academy of Sciences, Washington DC, 1995.

Nevertheless, the statewide VMT distributions provide excellent comparison data sets for regional VMT data. Tables 13 and 14 provide Pennsylvania and New Jersey statewide VMT distributions by vehicle type and highway functional class.

1. Pennsylvania's HPMS VMT Distribution

In Pennsylvania, heavy vehicles (classes 4 thru 13) account for 10.4 percent of the statewide VMT, and combination trucks (tractors and single or multi-trailers, i.e. classes 8 thru 13) account for 5.41 percent of VMT. Class 9 vehicles (five-axle, single-trailer trucks) are responsible for more than three-fourths of the combination truck VMT, and 4.09 percent of all VMT. Approximately 19.49 percent of Pennsylvania's VMT is attributable to pickups, vans, and other light trucks (class 3). According to Pennsylvania's HPMS data, VMT from class 10 (six or more axle, single-trailer trucks) and class 13 (seven or more axle, multi-trailer trucks) is negligible.

Truck traffic accounts for a substantially higher percentage of VMT on rural facilities compared to urban facilities – 13.79 percent of all rural VMT is from heavy trucks versus 7.66 percent for urban VMT. Combination vehicles account for 7.94 percent of all rural VMT compared to 3.36 percent of all urban VMT in Pennsylvania. In addition, higher functional classes of highways generally have higher percentages of truck traffic.

This is most pronounced on rural interstates where 27.91 percent of VMT is due to heavy vehicle traffic. Over 84 percent of this traffic is from combination vehicles, accounting for 23.50 percent of all rural interstate VMT in Pennsylvania. In contrast, only 14.17 percent of the VMT on urban Interstates in Pennsylvania is from heavy vehicles, and only 70 percent of that is from combination trucks (9.97 percent of total urban interstate VMT). On other urban freeways and expressways, heavy trucks and combination vehicles account for 8.25 percent and 3.94 percent of VMT, respectively.

On rural arterials and collectors, heavy truck traffic varies from 7.91 percent to 11.52 percent and combination vehicle traffic from 1.00 to 6.24 percent. On rural local roads, heavy trucks and combination vehicles account for 9.02 percent and 1.00 percent, respectively.

On Pennsylvania's urban arterials and collectors, heavy truck traffic varies from 5.30 percent to 6.15 percent and combination vehicle traffic from 0.84 to 3.94 percent. On urban local roads, heavy trucks and combination vehicles account for 5.53 percent and 0.80 percent, respectively.

Table 13. Pennsylvania's HPMS VMT Distribution by Vehicle Type and Functional Class

Highway Functional Class	"Scheme F" Vehicle Classifications														Heavy Trucks	Comb. Trucks
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total		
Rural																
Interstate	0.00%	60.10%	12.00%	0.00%	3.37%	0.76%	0.28%	3.98%	18.00%	0.00%	1.02%	0.50%	0.00%	100.00%	27.91%	23.50%
Other Principal Arterial	0.00%	70.47%	18.00%	0.00%	3.98%	0.95%	0.36%	1.18%	4.75%	0.00%	0.12%	0.18%	0.00%	100.00%	11.52%	6.24%
Minor Arterial	0.00%	64.67%	27.00%	0.00%	4.28%	0.95%	0.35%	0.71%	1.97%	0.00%	0.01%	0.06%	0.00%	100.00%	8.33%	2.75%
Major Collector	0.00%	65.09%	27.00%	0.00%	5.11%	0.99%	0.28%	0.45%	1.04%	0.00%	0.01%	0.03%	0.00%	100.00%	7.91%	1.53%
Minor Collector	0.00%	61.69%	30.00%	0.00%	6.12%	0.93%	0.26%	0.33%	0.65%	0.00%	0.00%	0.01%	0.00%	100.00%	8.30%	1.00%
Local	0.00%	60.98%	30.00%	0.00%	6.81%	0.96%	0.25%	0.33%	0.66%	0.00%	0.00%	0.01%	0.00%	100.00%	9.02%	1.00%
All Rural Facilities	**0.00%**	**64.03%**	**22.18%**	**0.00%**	**4.63%**	**0.91%**	**0.30%**	**1.48%**	**6.01%**	**0.00%**	**0.28%**	**0.18%**	**0.00%**	**100.00%**	**13.79%**	**7.94%**
Urban																
Interstate	0.00%	73.83%	12.00%	0.00%	3.20%	0.73%	0.27%	1.48%	8.01%	0.00%	0.29%	0.19%	0.00%	100.00%	14.17%	9.97%
Other Freeway	0.00%	74.75%	17.00%	0.00%	3.34%	0.71%	0.26%	0.82%	2.93%	0.00%	0.07%	0.12%	0.00%	100.00%	8.25%	3.94%
Other Principal Arterial	0.00%	75.85%	18.00%	0.00%	3.30%	0.62%	0.19%	0.57%	1.39%	0.00%	0.01%	0.07%	0.00%	100.00%	6.15%	2.04%
Minor Arterial	0.00%	74.20%	20.50%	0.00%	3.47%	0.58%	0.14%	0.40%	0.66%	0.00%	0.01%	0.03%	0.00%	100.00%	5.30%	1.10%
Collector	0.00%	76.08%	18.50%	0.00%	3.81%	0.64%	0.12%	0.34%	0.49%	0.00%	0.00%	0.01%	0.00%	100.00%	5.42%	0.84%
Local	0.00%	75.97%	18.50%	0.00%	4.03%	0.59%	0.11%	0.30%	0.49%	0.00%	0.00%	0.01%	0.00%	100.00%	5.53%	0.80%
All Urban Facilities	**0.00%**	**75.03%**	**17.32%**	**0.00%**	**3.46%**	**0.64%**	**0.19%**	**0.69%**	**2.53%**	**0.00%**	**0.07%**	**0.08%**	**0.00%**	**100.00%**	**7.66%**	**3.36%**
All Facilities	**0.00%**	**70.10%**	**19.49%**	**0.00%**	**3.99%**	**0.76%**	**0.24%**	**1.04%**	**4.09%**	**0.00%**	**0.16%**	**0.12%**	**0.00%**	**100.00%**	**10.40%**	**5.41%**

Table 14. New Jersey's HPMS VMT Distribution by Vehicle Type and Functional Class

Highway Functional Class	"Scheme F" Vehicle Classifications 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Heavy Trucks	Comb. Trucks
Rural																
Interstate	0.13%	71.35%	12.20%	0.65%	2.66%	1.02%	0.71%	1.82%	7.82%	0.64%	0.45%	0.22%	0.33%	100.00%	15.67%	11.28%
Other Principal Arterial	0.21%	73.54%	16.58%	0.48%	3.58%	0.95%	0.30%	0.85%	3.21%	0.17%	0.08%	0.03%	0.02%	100.00%	9.19%	4.36%
Minor Arterial	0.08%	73.59%	22.21%	0.27%	2.41%	0.38%	0.07%	0.36%	0.61%	0.02%	0.00%	0.00%	0.00%	100.00%	3.85%	0.99%
Major Collector	0.22%	78.57%	15.19%	0.60%	2.99%	0.66%	0.29%	0.73%	0.70%	0.02%	0.00%	0.03%	0.00%	100.00%	5.42%	1.48%
Minor Collector	0.15%	83.96%	10.13%	0.33%	2.48%	1.76%	0.13%	0.54%	0.32%	0.11%	0.01%	0.00%	0.08%	100.00%	5.43%	1.06%
Local	0.34%	86.23%	10.68%	0.41%	1.51%	0.32%	0.02%	0.30%	0.12%	0.00%	0.00%	0.07%	0.00%	100.00%	2.34%	0.49%
All Rural Facilities	**0.20%**	**76.55%**	**14.94%**	**0.49%**	**2.78%**	**0.78%**	**0.29%**	**0.84%**	**2.69%**	**0.18%**	**0.11%**	**0.07%**	**0.07%**	**100.00%**	**7.82%**	**3.96%**
Urban																
Interstate	0.03%	76.86%	10.79%	0.93%	3.10%	0.86%	0.36%	1.14%	4.70%	0.98%	0.22%	0.03%	0.00%	100.00%	11.39%	7.07%
Other Freeway	0.08%	77.64%	11.20%	1.02%	2.72%	1.43%	0.51%	1.78%	2.27%	0.77%	0.30%	0.27%	0.01%	100.00%	10.06%	5.40%
Other Principal Arterial	0.14%	77.60%	12.78%	0.91%	3.22%	0.77%	0.40%	1.06%	1.94%	1.03%	0.06%	0.05%	0.04%	100.00%	8.57%	4.18%
Minor Arterial	0.29%	83.10%	11.23%	0.55%	2.46%	0.81%	0.14%	0.81%	0.44%	0.05%	0.06%	0.01%	0.05%	100.00%	4.83%	1.42%
Collector	0.48%	85.92%	9.32%	0.91%	1.01%	1.04%	0.10%	0.49%	0.10%	0.20%	0.00%	0.16%	0.27%	100.00%	3.37%	1.22%
Local	0.46%	77.80%	12.15%	1.25%	2.40%	1.88%	0.28%	1.60%	0.24%	0.21%	1.31%	0.10%	0.32%	100.00%	8.34%	3.78%
All Urban Facilities	**0.20%**	**79.02%**	**11.54%**	**0.92%**	**2.71%**	**1.08%**	**0.33%**	**1.19%**	**1.89%**	**0.63%**	**0.31%**	**0.09%**	**0.09%**	**100.00%**	**8.32%**	**4.20%**
All Facilities	**0.20%**	**78.52%**	**12.23%**	**0.83%**	**2.73%**	**1.02%**	**0.32%**	**1.12%**	**2.05%**	**0.54%**	**0.27%**	**0.09%**	**0.08%**	**100.00%**	**8.22%**	**4.15%**

2. New Jersey's HPMS VMT Distribution

New Jersey's statewide VMT distribution shows similar patterns to Pennsylvania's, except that New Jersey's truck VMT percentages on rural facilities are generally lower than Pennsylvania's. Like Pennsylvania, both heavy trucks and combination vehicles comprise a higher percentage of VMT on rural facilities than urban facilities, and the proportion of truck traffic is highest on the higher functional classes, such as principal arterials and Interstates. However, the differences in heavy truck and combination vehicle VMT between rural and urban areas in less pronounced in New Jersey than Pennsylvania.

In New Jersey, buses (class 4) account for 0.83 percent of statewide VMT, heavy trucks (classes 5 thru 13) account for 8.22 percent, and combination trucks (classes 8 thru 13) account for 4.15 percent of VMT. Buses and heavy truck VMT numbers may be added together for comparisons with Pennsylvania's heavy vehicle VMT percentages. In New Jersey, the percentage of VMT from buses, heavy trucks, and combination vehicles on urban facilities is 0.92 percent, 8.32 percent, and 4.20 percent, respectively. On rural facilities these values are 0.49 percent, 7.82 percent, and 3.96 percent. Unlike Pennsylvania, New Jersey's HPMS VMT distribution shows a non-negligible percentage of VMT from class 10 and 13 vehicles.

According to New Jersey's HPMS data, light trucks (class 3) account for only 12.23 percent of the state's VMT. This is significantly lower than the 19.49 percent reported for Pennsylvania. Pennsylvania's class 3 VMT shares were adjusted to account for difficulties some traffic counters have distinguishing light trucks from passenger cars, especially smaller SUVs and compact pickup trucks. The sum of VMT from classes 2 (passenger cars) and 3 (light trucks) in Pennsylvania and New Jersey are very similar: 89.59 percent and 90.75 percent, respectively.

On rural interstates in New Jersey, 15.67 percent of VMT is due to heavy truck traffic. Nearly 72 percent of this traffic is from combination vehicles, which account for 11.28 percent of all rural interstate VMT in New Jersey. An additional 0.65 percent of rural Interstate VMT is from buses. In contrast, on urban Interstates in New Jersey, heavy trucks account for only 11.39 percent of the VMT, and only 62 percent of that is from combination trucks (7.07 percent of total urban interstate VMT). Buses account for 0.93 percent of urban Interstate VMT. On other urban freeways and expressways, heavy trucks, combination vehicles, and buses account for 10.06 percent, 5.40 percent, and 1.02 percent of VMT, respectively.

On rural arterials and collectors, heavy truck traffic varies from 3.85 percent to 9.19 percent and combination vehicle traffic from 0.99 to 4.36 percent. Bus traffic varies from 0.33 to 0.48 percent. On rural local roads, heavy trucks, combination vehicles, and buses account for 2.34 percent, 0.49 percent, and 0.41 percent, respectively.

On New Jersey's urban arterials and collectors, heavy truck traffic varies from 3.37 percent to 8.57 percent; combination vehicle traffic varies from 1.22 to 4.18 percent; and bus traffic

varies from 0.55 to 0.91 percent. On urban local roads, heavy trucks, combination vehicles, and buses account for 8.34 percent, 3.78 percent, and 1.25 percent, respectively.

B. DVRPC's VMT Data by Vehicle Type and Functional Class

DVRPC developed a VMT distribution by vehicle type and functional class for the Delaware Valley region based on its regional classification traffic count database. This distribution is shown in Table 15.

DVRPC's class counts show that the regional percentages of VMT from both light and heavy trucks fall between the statewide Pennsylvania and New Jersey values. Like New Jersey, the differences in heavy truck and combination vehicle VMT proportions between rural and urban facilities are not as pronounced as Pennsylvania. Most rural areas in the DVRPC region are in close proximity to a large urban area, unlike much of rural Pennsylvania.

In the DVRPC region, buses account for 1.10 percent of total VMT, heavy trucks account for 7.52 percent, and combination trucks account for 3.92 percent of VMT. Buses and heavy truck VMT numbers may be added together for comparisons with Pennsylvania's heavy vehicle VMT percentages.

On urban facilities in the region, the percentage of VMT from buses, heavy trucks, and combination vehicles is 1.12 percent, 7.33 percent, and 3.84 percent, respectively. On rural facilities these values are 1.01 percent, 9.50 percent, and 4.32 percent. The share of regional VMT from light trucks is 13.20 percent. For rural and urban facilities in the region, these shares are 16.68 percent and 12.53 percent, respectively.

Table 15. VMT Distribution by Vehicle Type and Functional Class for the Delaware Valley Region

Highway Functional Class	"Scheme F" Vehicle Classifications 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Heavy Trucks	Comb. Trucks
Rural																
Interstate	0.33%	69.83%	15.90%	1.07%	4.09%	1.07%	0.25%	2.71%	3.85%	0.19%	0.23%	0.34%	0.14%	100.00%	12.87%	7.46%
Other Principal Arterial	0.66%	71.81%	16.50%	0.85%	3.41%	1.01%	0.38%	1.59%	3.46%	0.16%	0.06%	0.02%	0.09%	100.00%	10.18%	5.38%
Minor Arterial	0.73%	72.36%	17.86%	1.42%	2.52%	0.63%	0.43%	1.57%	1.65%	0.15%	0.05%	0.07%	0.56%	100.00%	7.63%	4.05%
Major Collector	0.87%	72.07%	19.27%	1.24%	2.91%	0.57%	0.56%	0.81%	1.03%	0.25%	0.03%	0.06%	0.33%	100.00%	6.55%	2.51%
Minor Collector	0.15%	78.54%	15.71%	1.27%	2.85%	0.34%	0.09%	0.38%	0.60%	0.02%	0.00%	0.02%	0.03%	100.00%	4.33%	1.05%
Local	1.97%	79.36%	15.04%	0.74%	1.19%	0.37%	0.36%	0.32%	0.56%	0.07%	0.00%	0.01%	0.01%	100.00%	2.89%	0.97%
All Rural Facilities	**0.80%**	**73.02%**	**16.68%**	**1.01%**	**3.01%**	**0.79%**	**0.37%**	**1.42%**	**2.43%**	**0.15%**	**0.07%**	**0.08%**	**0.17%**	**100.00%**	**8.49%**	**4.32%**
Urban																
Interstate	0.61%	74.37%	13.37%	1.47%	3.20%	0.90%	0.16%	2.62%	1.37%	0.47%	0.44%	0.55%	0.47%	100.00%	10.18%	5.92%
Other Freeway	1.06%	74.59%	13.84%	1.21%	3.25%	1.13%	0.53%	1.09%	2.87%	0.22%	0.03%	0.03%	0.15%	100.00%	9.30%	4.39%
Other Principal Arterial	1.64%	77.97%	11.33%	1.12%	2.27%	0.81%	0.72%	1.23%	1.95%	0.67%	0.04%	0.08%	0.17%	100.00%	7.94%	4.14%
Minor Arterial	0.49%	80.63%	12.54%	0.74%	1.97%	0.72%	0.46%	1.28%	0.44%	0.25%	0.03%	0.13%	0.32%	100.00%	5.60%	2.45%
Collector	0.48%	81.16%	12.68%	1.32%	1.05%	0.68%	0.30%	1.08%	0.68%	0.24%	0.03%	0.07%	0.23%	100.00%	4.36%	2.33%
Local	2.08%	80.40%	12.55%	0.88%	0.99%	0.46%	0.38%	1.06%	0.73%	0.22%	0.04%	0.10%	0.11%	100.00%	4.09%	2.26%
All Urban Facilities	**1.07%**	**77.94%**	**12.53%**	**1.12%**	**2.25%**	**0.79%**	**0.45%**	**1.50%**	**1.36%**	**0.41%**	**0.12%**	**0.19%**	**0.26%**	**100.00%**	**7.33%**	**3.84%**
All Facilities	**1.03%**	**77.15%**	**13.20%**	**1.10%**	**2.37%**	**0.79%**	**0.44%**	**1.49%**	**1.53%**	**0.37%**	**0.12%**	**0.17%**	**0.25%**	**100.00%**	**7.52%**	**3.92%**

On rural interstates, 12.87 percent of VMT is due to heavy truck traffic. Only 58 percent of this traffic is from combination vehicles, which account for 7.46 percent of all rural interstate VMT in the region. An additional 1.07 percent of rural Interstate VMT is from buses. On urban Interstates in the DVRPC region, heavy trucks account for 10.18 percent of the VMT, and 58 percent of that is from combination trucks (5.92 percent of total urban interstate VMT). Buses account for 1.47 percent of urban Interstate VMT. On other urban freeways and expressways, heavy trucks, combination vehicles, and buses account for 9.30 percent, 4.39 percent, and 1.21 percent of VMT, respectively.

Although Interstate facilities have the highest percentage of heavy truck travel in both rural and urban areas, that percentage is lower than the Pennsylvania or New Jersey statewide HPMS values because most of the region's Interstate facilities are oriented towards the region's core employment centers and serve very high volumes of commuter traffic. The percentage of truck traffic on these facilities, however, does increase as one moves outward, toward the region's boundary.

On rural arterials and collectors, heavy truck traffic varies from 4.33 percent to 10.80 percent and combination vehicle traffic from 1.05 to 5.38 percent. Bus traffic varies from 0.85 to 1.42 percent. On rural local roads, heavy trucks, combination vehicles, and buses account for 2.89 percent, 0.97 percent, and 0.74 percent respectively.

On the region's urban arterials and collectors, heavy truck traffic varies from 4.36 percent to 7.94 percent; combination vehicle traffic varies from 2.33 to 4.14 percent; and bus traffic varies from 0.74 to 1.32 percent. On urban local roads, heavy trucks, combination vehicles, and buses account for 4.09 percent, 2.26 percent, and 0.88 percent, respectively.

Table 16 summarizes and compares the VMT distributions by functional class from the Pennsylvania and New Jersey statewide HPMS data and DVRPC's regional class counts. The table combines the bus and heavy truck categories into a single heavy vehicle total. This facilitates a more direct comparison with the Pennsylvania statewide data, because they do not report separate VMT totals for buses. Values for both heavy vehicles and combination trucks in rural areas fall between the Pennsylvania and New Jersey percentages in both rural and urban areas. For example, in urban areas, the share of VMT from heavy vehicles from the Pennsylvania statewide HPMS is 7.66 percent; this share from the New Jersey statewide HPMS is 9.24 percent, and the value from DVRPC's traffic counts is 8.45 percent.

Table 16. Pennsylvania and New Jersey Statewide and DVRPC Regional Heavy Vehicle VMT Distributions

Highway Functional Class	Pennsylvania Heavy Vehicles	Pennsylvania Comb. Trucks	New Jersey Heavy Vehicles	New Jersey Comb. Trucks	DVRPC Heavy Vehicles	DVRPC Comb. Trucks
Rural						
Interstate	27.91%	23.50%	16.32%	11.28%	13.94%	7.46%
Other Principal Arterial	11.52%	6.24%	9.67%	4.36%	11.03%	5.38%
Minor Arterial	8.33%	2.75%	4.12%	0.99%	9.05%	4.05%
Major Collector	7.91%	1.53%	6.02%	1.48%	7.79%	2.51%
Minor Collector	8.30%	1.00%	5.76%	1.06%	5.60%	1.05%
Local	9.02%	1.00%	2.75%	0.49%	3.63%	0.97%
All Rural Facilities	**13.79%**	**7.94%**	**8.30%**	**3.96%**	**9.50%**	**4.32%**
Urban						
Interstate	14.17%	9.97%	12.32%	7.07%	11.65%	5.92%
Other Freeway	8.25%	3.94%	11.08%	5.40%	10.51%	4.39%
Other Principal Arterial	6.15%	2.04%	9.48%	4.18%	9.06%	4.14%
Minor Arterial	5.30%	1.10%	5.38%	1.42%	6.34%	2.45%
Collector	5.42%	0.84%	4.28%	1.22%	5.68%	2.33%
Local	5.53%	0.80%	9.59%	3.78%	4.97%	2.26%
All Urban Facilities	**7.66%**	**3.36%**	**9.24%**	**4.20%**	**8.45%**	**3.84%**
All Facilities	**10.40%**	**5.41%**	**9.05%**	**4.15%**	**8.62%**	**3.92%**

Applying the VMT percentages shown in Table 15 to the region's 2000 VMT distribution[19] results in the actual average daily vehicle-miles of travel by vehicle type and functional class in the Delaware Valley region. These values, in thousands of miles per day, are shown in Table 17. Approximately 104 million miles of vehicular traffic occurs in the region each day. Just over 7.8 million of these vehicle-miles are from heavy trucks, 4.1 million of which is due to combination vehicles. Buses account for another 1.1 million vehicle-miles each day. Of this total, about 11 percent is from SEPTA buses[20]. Another five percent is from New Jersey Transit buses. Light trucks are responsible for about 13.7 million miles of travel each day.

Because nearly 84 percent of the region's VMT occurs on urban areas, the VMT distribution by vehicle type on these facilities is most important. Here, heavy trucks account for nearly 6.4 million miles of vehicular travel each day. Just over half of this of this VMT is from combination vehicles. Urban bus VMT averages nearly 980,000 miles per day.

C. Regional VMT Distribution by MOBILE Vehicle Type and County

Using all available data sources, DVRPC has developed estimates of highway travel by county and vehicle type for the Delaware Valley region. These estimates are presented in the eight MOBILE5 vehicle classes for two reasons. First, due to the limited number of class counts available, relative to the region's highway mileage, there is greater confidence in presenting these values in the eight MOBILE5 classes, rather than the 13 Scheme F classes. Second, air quality analyses and conformity determinations require that VMT distributions be provided by county in the 28 MOBILE6 vehicle classes (shown in Table 3). The MOBILE6 users' guide provides a methodology to expand the eight MOBILE5 classes into 28 MOBILE6 classes[21]. DVRPC's VMT distributions by county and vehicle type are shown in Table 18.

[19] *Technical Memorandum: 1999 and 2000 Vehicle Miles of Travel in the Delaware Valley Region,* Delaware Valley Regional Planning Commission, Philadelphia, PA, May 2002.

[20] *Ridership and Statistics Report, Fiscal Year 2001,* Southeastern Pennsylvania Transportation Authority, Philadelphia, PA.

[21] *User's Guide to MOIBLE6.0, Mobile Source Emissions Factor Model*, Publ. EPA420-R-02-001. US Environmental Protection Agency, Washington DC, January 2002.

Table 17. Average Daily Vehicle-Miles of Travel by Vehicle Type and Functional Class in the Delaware Valley Region (000s)

Highway Functional Class	"Scheme F" Vehicle Classifications 1	2	3	4	5	6	7	8	9	10	11	12	13	Total	Heavy Trucks	Comb. Trucks
Rural																
Interstate	8.7	1,845.5	420.2	28.3	108.1	28.3	6.6	71.6	101.7	5.0	6.1	9.0	3.7	2,642.8	340.1	197.2
Other Principal Arterial	43.7	4,755.6	1,092.7	56.3	225.8	66.9	25.2	105.3	229.1	10.6	4.0	1.3	6.0	6,622.5	674.2	356.3
Minor Arterial	14.5	1,433.9	353.9	28.1	49.9	12.5	8.5	31.1	32.7	3.0	1.0	1.4	11.1	1,981.6	151.2	80.3
Major Collector	18.9	1,565.1	418.5	26.9	63.2	12.4	12.2	17.6	22.4	5.4	0.7	1.3	7.2	2,171.6	142.2	54.5
Minor Collector	1.4	737.2	147.5	11.9	26.8	3.2	0.8	3.6	5.6	0.2	0.0	0.2	0.3	938.7	40.6	9.9
Local	45.5	1,831.1	347.0	17.1	27.5	8.5	8.3	7.4	12.9	1.6	0.0	0.2	0.2	2,307.3	66.7	22.4
All Rural Facilities	**132.7**	**12,168.5**	**2,779.6**	**168.6**	**501.3**	**131.8**	**61.6**	**236.6**	**404.5**	**25.8**	**11.7**	**13.4**	**28.4**	**16,664.4**	**1,415.1**	**720.4**
Urban																
Interstate	117.0	14,264.7	2,564.5	282.0	613.8	172.6	30.7	502.5	262.8	90.1	84.4	105.5	90.1	19,180.7	1,952.6	1,135.5
Other Freeway	91.8	6,460.1	1,198.7	104.8	281.5	97.9	45.9	94.4	248.6	19.1	2.6	2.6	13.0	8,660.9	805.5	380.2
Other Principal Arterial	396.5	18,851.1	2,739.3	270.8	548.8	195.8	174.1	297.4	471.5	162.0	9.7	19.3	41.1	24,177.3	1,919.7	1,000.9
Minor Arterial	83.4	13,720.4	2,133.9	125.9	335.2	122.5	78.3	217.8	74.9	42.5	5.1	22.1	54.5	17,016.5	952.9	416.9
Collector	39.1	6,613.2	1,033.2	107.6	85.6	55.4	24.4	88.0	55.4	19.6	2.4	5.7	18.7	8,148.4	355.3	189.9
Local	209.7	8,106.3	1,265.4	88.7	99.8	46.4	38.3	106.9	73.6	22.2	4.0	10.1	11.1	10,082.5	412.4	227.9
All Urban Facilities	**937.5**	**68,015.3**	**10,934.5**	**979.7**	**1,964.7**	**690.6**	**391.7**	**1,307.0**	**1,186.7**	**355.5**	**108.2**	**165.3**	**228.5**	**87,265.4**	**6,398.3**	**3,351.3**
All Facilities	**1,070.2**	**80,182.6**	**13,718.9**	**1,148.4**	**2,465.9**	**822.4**	**453.3**	**1,543.6**	**1,591.2**	**381.3**	**119.9**	**178.8**	**257.0**	**103,933.4**	**7,813.4**	**4,071.7**

Table 18. VMT Distribution by County and MOBILE5 Vehicle Type in the Delaware Valley Region

MOBILE Vehicle Type		VMT Mix Data for New Jersey					VMT Mix Data for Pennsylvania					
Code	Description	Burl.	Camden	Glouc.	Mercer	Average	Bucks	Chester	Delaw.	Montgo.	Phila.	Average
LDGV	Gasoline passenger cars	53.22%	54.46%	53.21%	54.89%	**53.95%**	55.76%	56.17%	56.41%	56.44%	56.54%	**56.26%**
LDGT1	Gasoline light trucks <6000 lbs	23.78%	23.67%	23.80%	23.74%	**23.75%**	23.84%	23.00%	23.85%	23.76%	23.54%	**23.60%**
LDGT2	Gasoline light trucks >6000 lbs	11.77%	11.69%	11.79%	11.53%	**11.69%**	11.59%	11.75%	11.62%	11.73%	11.83%	**11.70%**
HDGV	Gasoline heavy trucks & buses	3.35%	2.92%	3.15%	2.85%	**3.07%**	2.34%	2.60%	2.36%	2.32%	2.41%	**2.41%**
LDDV	Diesel passenger cars	0.04%	0.03%	0.03%	0.04%	**0.03%**	0.04%	0.04%	0.03%	0.04%	0.04%	**0.04%**
LDDT	Diesel light trucks	0.24%	0.23%	0.22%	0.25%	**0.23%**	0.24%	0.24%	0.24%	0.22%	0.25%	**0.24%**
HDDV	Diesel heavy trucks & buses	6.90%	6.20%	6.70%	6.10%	**6.48%**	5.19%	5.30%	4.79%	4.69%	4.89%	**4.97%**
MC	Motorcycles	0.70%	0.80%	1.10%	0.60%	**0.80%**	1.00%	0.90%	0.70%	0.80%	0.50%	**0.78%**
	All Vehicles:	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
	Passenger Cars:	**53.26%**	**54.49%**	**53.24%**	**54.93%**	**53.98%**	**55.80%**	**56.21%**	**56.44%**	**56.48%**	**56.58%**	**56.30%**
	Light Trucks:	**35.79%**	**35.59%**	**35.81%**	**35.52%**	**35.67%**	**35.67%**	**34.99%**	**35.71%**	**35.71%**	**35.62%**	**35.54%**
	Heavy Vehicles:	**10.25%**	**9.12%**	**9.85%**	**8.95%**	**9.55%**	**7.53%**	**7.90%**	**7.15%**	**7.01%**	**7.30%**	**7.38%**

VI. FINDINGS AND CONCLUSIONS

Because trucks and buses have disproportionate effects on the transportation system, it is necessary to have accurate estimates of heavy vehicle travel patterns. Heavy vehicles include some single-unit trucks, single-trailer trucks, multi-trailer trucks, and school, transit, and intercity buses. Single-unit trucks are the most common of the heavy trucks. Five-axle single-trailer trucks are the most common of the combination vehicles.

The region is home to nearly 480,000 trucks. The majority of these, however, are light trucks such as pickups and vans that are used primarily for private travel. There are just over 210,000 commercial trucks in the region, of which 51,000 are classified as heavy trucks. Montgomery County is home to more light and heavy commercial vehicles than any other county. Next highest is Burlington County. Despite its concentration of heavy industries, marine terminals, and other freight facilities, Philadelphia is home to less commercial vehicles than all counties except Delaware and Mercer.

The region's truck fleet makes about 3.1 million trips per day. About two-thirds of these trips are made by light trucks and one-third by heavy trucks. The vast majority of these trips, about 89 percent, occur entirely within the region. However, 330,000 trucks cross the region's boundary each day, 53,000 of which do not have a stop within the region.

The region is also home to about 14,000 buses. About 85 percent of these are school buses. The remainder are urban transit and intercity buses. These buses serve about 633,000 passengers each day. Only about eight percent of the passengers cross the region's cordon line.

The DVRPC region has a different distribution of VMT by vehicle type and highway classification than either the Pennsylvania or New Jersey statewide distributions. Both statewide distributions have the highest percentages of heavy vehicles on Interstates in both rural and urban areas. In the Delaware Valley region, the highest percentage of heavy vehicles occur on Interstate facilities in bot rural and urban areas.

The heavy truck VMT in the region is approximately evenly divided between single-unit trucks and combination vehicles, in both rural and urban regions. Two-axle single-unit trucks travel three times the mileage of three-axle single-unit trucks, which in turn travel nearly twice as much as four-axle single-units. Five-axle single-trailer trucks account for the greatest proportion of combination vehicle VMT in rural areas, while four-axle single trailers have a slightly higher share in urban areas.

Heavy trucks travel approximately 7.8 million miles in the region on a typical day. About 2.5 million of these miles are attributable to two-axle single-unit trucks, about 822,000 are attributable to three-axle single-unit trucks, and about 453,000 to four-axle single-units. Combination trucks account for approximately 4.1 million of these miles, with five-axle single-trailer trucks accounting for about 1.6 million miles per day. Buses add about

another 1.1 million miles of travel to the region's daily VMT. Only about 16 percent of this bus travel can be attributed to SEPTA and NJ Transit buses.

Using EPA's MOBILE5 vehicle classification system, passenger cars account for 55.1 percent of the DVRPC region's highway travel. Light trucks, which include pickups, minivans, and SUV's, account for another 35.6 percent of daily travel. Heavy-duty vehicles, including buses, comprise 8.5 percent of regional travel. Over two-thirds of the heavy vehicle travel is diesel fueled. Motorcycles make up just under one percent of the highway volume.

Truck and Bus Travel in the Delaware Valley Region

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ABSTRACT

This report compiles available data from numerous sources to estimate the number of trucks and buses in the region, their trip making patterns, and the magnitude of truck and bus travel in the region, expressed as vehicle-miles of travel (VMT). These estimates are necessary inputs to DVRPC's travel simulation models and are also needed for mobile source emissions calculations and other planning purposes. The primary sources of truck and bus travel data include the federal Highway Performance Monitoring System, DVRPC's regional traffic classification count database, transit company operating data, vehicle registration data, and DVRPC's Regional Highway Cordon and Truck Travel surveys.

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