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September 1996

Final Report

Quick Response Freight Manual

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Prepared by

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1.0 Introduction

1.0 Introduction

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) requires that States and Metropolitan Planning Organizations (MPO's) consider urban freight in their long-range plans, transportation improvement programs, and annual work elements. There are, however, some issues that must be addressed before the States, MPO's and other planning agencies can be effective in freight planning:

- Most of these agencies have little experience with freight planning. Senior planners and managers have spent most of their professional careers dealing with the transportation of people, not freight;
- Current and historical data on freight, especially truck movements, are extremely limited; and
- Most of the models in the literature are highly complex, and require data that are not generally available to planning agencies.

1.1 Objectives of the Quick Response Freight Manual

The objectives of this manual are as follows:

- To provide background information on the freight transportation system and factors affecting freight demand to planners who may be relatively new to this area,
- To help planners locate available data and freight-related forecasts compiled by others, and to apply this information in developing forecasts for specific facilities,
- To provide simple techniques and transferable parameters that can be used to develop commercial vehicle trip tables which can then be merged with passenger vehicle trip tables developed through the conventional four-step planning process,
- To provide techniques and transferable parameters for site planning, that can be used by planners in anticipating local commercial vehicle traffic caused by new facilities such as regional warehouses, truck terminals, intermodal facilities, etc.

The manual addresses freight issues at different levels of analysis. On the more detailed site planning level, the methods include predicting the number and temporal distribution of truck trips to and from specific locations and identifying the routes used. On a more aggregate level such as corridor, metropolitan area, or regional level, the manual helps develop forecasts of trips generated by various traffic analysis zones and distribute these trips to the transportation network.

The analytical methods contained in the manual place special emphasis on inclusion of transferable parameters that can be used as default values for model inputs when data specific to the State or metropolitan area are not available.

This manual also identifies alternative analytical methodologies and data collection techniques in order to improve the accuracy of the freight analysis and planning processes.

1.2 Organization of the Manual

The manual is organized such that each chapter is independent of the others and the user can only read the chapter or chapters that serve his or her interests. The following describes the main chapters of the manual:

Chapter 2 - Factors Affecting Freight Demand identifies and describes a variety of factors that influence the demand for goods and commodities as well as the costs and service levels associated with freight transportation.

Chapter 3 - Simple Growth Factor Methods provides basic methods that can be used to forecast changes in freight demand due to changes in the level of economic activity and other factors affecting freight demand as described in Chapter 2. This chapter also describes ways in which the freight demand forecasts can be improved.

Chapter 4 - Incorporating Commercial Vehicles into the Travel Forecasting Process deals with the development of commercial vehicle trip tables for use as part of a conventional four-step travel forecasting process. The steps include Trip Generation, Trip Distribution, and Trip Assignment. The procedures are applied to a hypothetical study area. The chapter also provides information on time-of-day (or temporal) distribution of truck traffic.

Chapter 5 - Site Analysis describes and illustrates procedures for predicting the changes in commercial vehicle traffic and level of service characteristics on transportation networks due to specific planned facilities including major intermodal facilities and other special trip generators.

Chapter 6 - Data Collection to Support More Accurate Freight Analysis identifies primary and secondary data collection methodologies and data sources which can be used to improve the accuracy and reliability of the freight planning process.

Chapter 7 - Principles of Application provides additional guidance when applying the methods discussed in this manual in common planning problems.

Chapter 8 - Statewide Freight Forecasting in Support of Regionwide Forecasting explains the relationships between statewide and regional freight planning. Procedures adapted by Kansas and Wisconsin for freight analysis and planning in the state and regional levels are compared and contrasted. This chapter also discusses the advantages of Intermodal Management System (IMS) in freight planning and describes efforts by a number of States to develop an IMS.

Chapter 9 - Case Study Applications to Urban Areas presents real-world applications of the methods contained in the manual, as well as existing freight forecasting software models, to three urban settings namely: Lawrence, Kansas; Appleton, Wisconsin; and Green Bay, Wisconsin. An example of site analysis is also presented for a major trip generator in Green Bay, Wisconsin.

In addition to the main chapters, the manual contains an extensive compilation of data, data sources, data collection techniques and other literature pertaining to freight analysis. These are included in the appendix materials as follows:

Appendix A - Glossary of Terms defines some of the most common terms used in freight planning and analysis.

Appendix B - Selected References contains some of the bibliographical sources and materials used to develop the concepts and methodologies in the manual.

Appendix C - Standard Industrial Classification (SIC) Codes is a summary of descriptions and codes corresponding to the land use categories or classification of employers and establishments in any given location.

Appendix D - Trip Generation Summary Tables contains detailed truck trip generation rates for specific locations, land use types/SIC Codes, and commercial vehicle classifications. The rates are expressed in number of trips generated per employee, per 1,000 square feet of building space, and per acre of total land area. Appendix D also includes a table of trip generation regression formulae obtained from literature.

Appendix E - Internal Versus External Truck Trips compares the percentages of internal and external truck trips at a number of sites.

Appendix F - Time-of-Day Characteristics contains information on the hourly distribution of commercial vehicle traffic in selected areas.

Appendix G - Guide to State Data Centers lists for each State the name, address and telephone number of major organizations which collect, analyze and distribute economic data and statistical information which can be used for freight forecasting and analysis. The names of magazines, abstracts or journals that contain this information are also included.

Appendix H - Guide to State Trucking Associations lists for each State the name, address and telephone number of a major organization whose interests include (but are not necessarily limited to) truck transportation.

Appendix I - Bureau of Census Regional Offices identifies the cities, addresses and phone numbers of regional offices of the U.S. Census Bureau which can provide information on relevant freight and economic data collected by the Census such as the County Business Patterns.

Appendix J - National Trade Associations identifies the names, addresses, phone numbers and mission statements of national associations (mostly non-profit) that deal with a variety of freight issues.

Appendix K - Freight Transportation Data Sources lists and describes various sources of data (primarily Federal) and methods relevant to freight that are available to the public.

Appendix L - Commercial Data Sources lists and describes various sources of data and methods relevant to freight which can be purchased from private entities.

Appendix M - Recent Freight and Truck Surveys is a listing of freight and truck surveys recently conducted in various locations throughout the United States which are excellent sources of methods and techniques for data collection and analysis.

2.0 Factors Affecting Freight Demand

2.0 Factors Affecting Freight Demand

2.1 Introduction

This chapter identifies and describes a number of factors that affect the demand for freight. The factors may either directly influence the demand for goods and services, which in turn affect the demand for freight; or they may impact on the costs and/or levels of service of one or more freight transport modes, which influence whether or not (as well as how) the freight demands will be met.

The purpose of this chapter is to provide transportation planners and analysts meaningful insights on various determinants of freight demand. However, it is not the intent of this chapter to identify and discuss the universe of factors that bear directly or indirectly on freight demand. An adequate understanding of the mechanism and extent by which some of these factors influence the characteristics of the goods and commodities produced and consumed as well as the manner in which they are shipped is crucial to freight analysis and planning. These factors are generally used for forecasting future traffic (Chapter 3), estimating volumes of trips generated and attracted and distributing trips over the transportation network (Chapter 4), and predicting the impacts of new or planned facilities (Chapter 5).

The factors influencing the demand for freight are more complex and interdependent than the factors influencing passenger demand because:[1]

- decisions by shippers, carriers and receivers affect whether or not a particular shipment is made and, if so, by what mode and route;
- there are many different types of commodities that make up the freight traffic, and these commodities have wide range of prices or values associated with them (also some are perishable while others are not);
- freight movements are measured in various units such as dollar value, quantity, weight, volume, container, carload, truckload etc.; and
- the cost of moving freight is much harder to determine compared with cost to move passengers because more specialized services are required for freight (i.e.

[1] See NCHRP 8-31 Final Report, *Multimodal Corridor and Capacity Analysis Manual*, Cambridge Systematics Inc. March 1996.

handling, loading, unloading, classifying, storing, packaging, warehousing, inventorying, etc.).

In this chapter, the discussions pertaining to the factors affecting freight demand are mostly adopted from the NCHRP 8-30 report, *Forecasting Freight Transportation Demand,* prepared by Cambridge Systematics Inc. The factors discussed in that report include:

1. The Economy
2. Industrial Location Patterns
3. Globalization of Business
4. International Trade Agreements
5. International Transportation Agreements
6. Just-in-Time Inventory Practices
7. Carrier-Shipper Alliances
8. Centralized Warehousing
9. Packaging Materials
10. Recycling
11. Economic Regulation and Deregulation
12. Intermodal Operating Agreements
13. Fuel Prices
14. Publicly Provided Infrastructure
15. User Charges and Other Taxes
16. Government Subsidization of Carriers
17. Environmental Policies and Restrictions
18. Safety Policies and Restrictions
19. Effects of Changes in Truck Size and Weight Limits
20. Congestion
21. Technological Advances

Additional explanations are provided to describe the characteristics of freight that are heavily influenced by each factor. A matrix of freight demand characteristics (i.e. commodity, shipment, mode and logistics cost) versus factors affecting freight demand is developed at the end of the chapter.

Since the degree by which each factor influences freight demand varies from case to case, it is not possible to make definitive assessments of their absolute and relative importance in determining freight demand. The planner should be able to make appropriate judgment based on his or her knowledge of the specific situation.

2.2 Factors that Affect Freight Demand[2]

1. The Economy

As a derived demand, freight demand is primarily influenced by the volume of goods produced and consumed. Expansion in the national economy, or the economy of any region, results in increases in overall demand (in terms of volume) for goods and services, while economic contractions result in demand reductions. Overall economic condition is also indicative of the buying/purchasing power of the population. The types and values of commodities produced and consumed usually reflect this economic condition.

At the national level, the size of the economy is most frequently measured in dollar terms as gross national product (GNP) or gross domestic product (GDP). However, freight demand is more closely related to the goods-production component of GNP or GDP. While real GDP of goods is a reasonable overall measure of the economy's influence on freight demand, it measures goods production in dollars rather than in weight or volume. Production of low value (dollars per ton) bulk commodities, such as agricultural products and coal, generate a larger share of freight demand than their total value would indicate.

2. Industrial Location Patterns

Industrial location patterns are critical to determining transport demand as measured in ton-miles, line-haul miles or other units which reflect length of haul. The influence of spatial distribution can best be measured through its actual effect on demand - as average length of haul by commodity or total ton-miles transported. The spatial distribution of economic activity also influences mode choice, with many commodities likely to be shipped by one mode when distances are short and by another when distances are longer. Travel time, reliability, shipping costs and other logistics costs are all a function of distance and vary from mode to mode. Another freight characteristic that is influenced by location (and hence distance) is the perishability of the product.

3. Globalization of Business

Many companies today manage worldwide production and distribution systems, and national economies are increasingly being integrated into a global economy. As production facilities are shifted to locations around the globe where products can be produced more economically, the demand for world trade will continue to increase. The patterns of domestic and foreign production and distribution vary significantly by industry and product type, and they affect transportation requirements in the United States. For example, increasing imports from Asia eventually may warrant containership

[2] For more detailed discussions, see NCHRP 8-30 Report - *Forecasting Freight Transportation Demand. A Guidebook for Planners and Policy Analysts.* Cambridge Systematics Inc., January 1996.

service directly from India, a service that would operate through the Suez Canal to the East Coast of the United States. These containers would then be transported inland from the East Coast, instead of from the West Coast as currently is the case.

The changing patterns of world trade influence both transport flows and mode choice. The costs of production and distribution of commodities will reflect much higher economies of scale compared to more localized businesses. The average length of haul for freight is also much higher for global businesses, and usually involves more than one line-haul or terminal facility. Most worldwide freight flows are intermodal, which highlights the need for standardization of packaging, equipment, handling, and safety procedures.

4. International Trade Agreements

Global production and distribution are also affected by international trade agreements, quotas, and tariff restrictions. The dynamics of the global marketplace have driven the formation of numerous large regional trading blocs including the European Union (EU), the ASEAN Free Trade Area (AFTA), and most important for the United States the North American Free Trade Agreement (NAFTA). The essence of the NAFTA is to lower total costs (i.e. distribution and logistics costs) for North American businesses exporting goods within the North American market. The tariff elimination schedule will allow all trade between Canada and the United States to be duty-free by 1998. For most U.S.-Mexico and Canada-Mexico trade, tariffs will be phased out by the year 2003.

The implications of the NAFTA have been significant for freight transportation interests, particularly in the border regions. NAFTA provisions radically change cross-border transportation systems (particularly between the United States and Mexico) which were complicated by regulations which increased costs. The passage of the NAFTA also spawned the implementation of the Customs Modernization and Informed Compliance Act (or MOD Act), which gave Customs the authority to expand its automated entry system. Over time, it allows Customs to eliminate old systems and adopt practices which will save both taxpayers and the trade community time and money. As tariff rates decline and cargo flows increase, improvements to the border infrastructure and the border crossing processes will continue to be made.

Further integration of economies of individual countries into regional economic and trading blocs is likely to occur.

5. International Transportation Agreements

Bilateral and multilateral international transportation agreements often involve complex negotiations as the nations involved seek to protect their interests and to create opportunities for trade and economic growth. Where carrier entry or participation is restricted in a particular market, rates tend to be higher. Each mode operates under a unique set of international arrangements. International air service agreements define the service routes, and they control the number of carriers from each country, as well as the type of aircraft, that can serve those routes. Although international water transport is largely free from route restrictions, carrier conferences influence rates and services in major markets, and cargo preferences may limit carrier participation in some trade. International motor carrier operations in North America are likely to become more efficient and competitive as a result of NAFTA, under which various prohibitions on U.S., Mexican, and Canadian carriers will be phased out and safety standards will be harmonized. In recent years, U.S. and Canadian rail carriers have become more integrated, affecting service, rates, and rail competition.

6. Just-in-Time (JIT) Inventory Practices

JIT systems focus on keeping inventories at minimum levels by coordinating input deliveries with production schedules. Adoption of a JIT system often results in increasing the frequency with which inbound shipments are scheduled, decreasing the lead times and sizes of these shipments, and increasing the importance of receiving these shipments on time. Firms which adopt JIT systems often reduce the number of suppliers and transport companies with which they deal and select suppliers which are close enough to be able to deliver shipments within short lead times.

The effects on freight demand are to increase the number of individual shipments, decrease their length of haul and transport costs, and increase the reliability of on-time delivery. There may be some shifts to modes which are faster or better able to handle smaller shipment sizes. Within modes, the shift is likely to be to carriers capable of providing highly reliable service.

7. Carrier-Shipper Alliances

There have been dramatic changes in the institutional relationships among transportation providers and users. Shippers demand faster, reliable, "seamless" door-to-door transportation services, often without stating a mode preference. Such services can be made available through a single vendor who can arrange, manage, and monitor the movement. Increasingly, shippers are entering into partnerships with, and often providing in-plant space for, personnel of logistics companies which, in turn, often are subsidiaries of carriers.

The major impacts of carrier-shipper alliances on freight demand include lower logistics costs per unit of commodity, higher reliability of on-time delivery and lower probability of loss or damage claim.

8. Centralized Warehousing

As transportation systems have become more efficient and more reliable, there has been more consolidation of warehousing and distribution. This has resulted in part from the fact that manufacturing firms are increasing their use of third-party logistics providers who specialize in optimizing the distribution process. The results include increases in the demand for transportation (as reflected in ton-miles or line-haul miles) and in associated costs (i.e. line-haul, loading/unloading and in-transit logistics costs). However, centralized warehousing reduces the cost to keep and maintain an inventory which include storage space requirements, storage costs and shelf loss.

9. Packaging Materials

The use of lightweight materials as protective packaging for many manufactured products has resulted in a reduction in average weight and density (weight/volume) of shipments. This means that heavy fragile products such as appliances, glass products, computers and equipment are now more transportable than they used to be. The increase in low-density shipments has also created a demand for larger truck trailers and shipping containers (i.e. higher volume or cube limit).

10. Recycling

Increased use of recycled materials such as paper, aluminum, plastics and glass products affects freight origin and destination patterns, lengths of haul, and mode choice for several commodities. Recycling plants are frequently located near the markets they serve (i.e. residential or business communities that use recycled products), which also provide them with materials for recycling. The types of commodities, vehicles/carriers and routes associated with freight transportation depend upon the sizes and spatial distributions of the recycling plants and the markets they serve.

11. Economic Regulation and Deregulation

Deregulation within the transportation industry was driven by the desire to encourage greater price and service competition and to increase opportunities to develop multimodal and intermodal relationships among and within the various modes. The trend toward regulatory change began with the Transportation Act of 1940, but was most evident in the deregulatory actions taken in the 1970's and 1980's. These actions include the Airline Deregulation Act of 1978 (which was preceded by deregulation of the all-cargo air services industry in 1977), the Motor Carrier Act of 1980, the Staggers Rail Act of 1980, and the Shipping Act of 1984. All of these actions paved the way for the growth in intermodalism, the formation of multimodal transportation companies and alliances, and the evolution of logistics management -- all of which have substantial impacts on the costs and level of service of freight transportation.

12. Intermodal Operating Agreements

Transportation carriers have become increasingly multimodal, looking for the most effective ways to integrate and market their capacity and to combine the services of rail, truck, water, and air modes. Traditional competitors, both within and across modes, are recognizing the need to build cooperative relationships. As a result of intermodal operating agreements and joint ventures, carriers are able to offer a broader range of services and to tailor service packages for individual shippers, resulting in lower costs and higher levels of service for freight transportation.

13. Fuel Prices

For all modes of transportation, fuel is a large and volatile cost component. An increase in fuel prices is likely to result in transportation rate increases for faster modes (e.g., air) and for premium services provided by a given mode (e.g., high speed rail container and trailer carriage). Line-haul cost of various modes, which is a function of distance, will also be impacted by fuel price changes. Accordingly, some changes in demand for specific commodities or shift of mode may occur. When evaluating the effect of fuel price changes on choice of mode, it is necessary to consider fuel requirements for competing services rather than modal averages.

14. Publicly-Provided Infrastructure

Carriers (except for rail) rely heavily on publicly-financed and maintained infrastructure. The Federal Aviation Administration is responsible for airport runways and related airside infrastructure, as well as the air traffic control system. The U.S. Army Corps of Engineers is responsible for waterway and harbor maintenance and for the operation of locks and dams. The U.S. Coast Guard provides navigation aids and operates Vessel Traffic Services at selected ports. The Federal Highway Administration implements the federal aid highway program which funds the National Highway System and other highways on the basis of a matching formula; and most major highways are constructed and maintained by state highway agencies.

All infrastructure systems tend to be expanded somewhat more slowly than the freight carriers and shippers would like, resulting in higher travel times and operating costs, less reliable delivery times, limitations in type, size and weight of vehicles and shipments, constraints in delivery and pick-up time schedules and higher in-transit logistics costs. The quality of local infrastructure and the degree of congestion also affect shipper choices of mode, transfer facilities and ports.

15. User Charges and Other Taxes

User charges are the principal means of financing publicly-provided infrastructure. Government efforts to recover the costs of building and maintaining transportation infrastructure will continue to affect the competitive position of the modes involved. For the water mode, harbor maintenance fees fund approximately 40 percent of construction and maintenance costs for coastal harbors, and a variety of user charges (wharfage, dockage, equipment rental fees, gate fees, franchise fees) finance port operations. For the air mode, federal spending on airports and airways is supported by taxes on domestic and international airline passenger tickets, air cargo waybills, and fuel taxes (all of which are deposited in the Airport and Airway Trust Fund), with construction and operation of individual airports also financed through revenue bonds, facility leases, landing fees, and slot fees. Federal highway programs are supported by the Highway Trust Fund, which receives fuel taxes, an annual heavy vehicle use tax, and excise taxes. Most states also have highway or transportation trust funds, some with constitutional restrictions on how those funds are used.

In addition to user charges, transportation companies pay business, sales, and property taxes. Most of the revenue from these taxes is used for general operations of federal, state and local governments, though some is available for transportation applications. There continues to be considerable discussion and debate relating to the use of fuel taxes for non-transportation purposes.

All forms of user fees and taxes affect the total freight transportation cost, resulting in higher rates and prices for carriers, shippers and receivers of products. These fees and taxes can be imposed based upon the value, weight, volume or dimension of commodities, shipments and vehicles, thus affecting these characteristics of freight in the traffic stream.

16. Government Subsidization of Carriers

Government subsidization of carriers reduces transport costs and affects competition between classes of carriers, between modes, and between operators of carriers registered in different countries. Among domestic carriers, the rail industry has been concerned about subsidization of the motor carrier and barge industries. With the exception of public subsidies for operations on otherwise unprofitable branch lines, railroads currently do not receive any government subsidies (although they were the beneficiaries of historic subsidies, including granting of right-of-way and in some cases adjoining lands). Barges, on the other hand, provide service on waterways operated and maintained by the U.S. Army Corps of Engineers and pay a relatively small portion of the cost of constructing, operating, and maintaining the waterway infrastructure. Similarly, trucks operate on public roads, and the issue of whether heavy trucks pay their fair share of federal highway taxes continues to be controversial.

Operating subsidies to U.S.-flag vessel operators are likely to end in the near future. This could mean the demise of the U.S. merchant marine, as vessel operators reflag. Some argue that air carriers do not pay an appropriate share of costs associated with the air traffic control system, but the financial condition of the airline industry makes any substantial near-term increase in user charges unlikely.

17. Environmental Policies and Restrictions

Environmental policies and restrictions affect all modes of transportation. The restrictions placed on the water mode and ports include the Clean Water Act, the Oil Pollution Act, dredge disposal controls, and speed and draft restrictions. Motor carriers are most affected by emissions controls and clean fuel requirements. Air carriers, particularly the all-cargo carriers that operate older aircraft and that operate primarily at night, are most affected by noise restrictions. These environmental policies and restrictions significantly add to the cost of freight transportation. In addition to the impacts of environmental policies on modal costs, freight demand also is affected by environmental policies which affect decisions on the locations of industrial sites and the locations at which raw materials are produced.

18. Safety Policies and Restrictions

Safety regulations increase carrier capital and operating costs while reducing all accident-related costs (insurance, liability payments, loss and damage, and delay). These regulations also create some small costs for safety inspections and record-keeping. One example of a regulatory action that resulted in demonstrable accident cost savings is the Federal 55 mph speed limit.

The regulation of hazardous materials (*hazmat*) transport increases transport costs. Although we are aware of no data on the costs of hazmat regulation, we believe these costs do represent a significant proportion of carrier operating costs for hazmat shipments. Route restrictions for hazmat truck operations are the responsibility of state and local governments. The amount of such route restrictions is probably increasing, and may become a significant factor in choice of mode in the future

Although changes in safety regulations may have some effect on carrier costs and on modal competition, aside from the effects on the cost of hazmat carriage, these effects are likely to be small relative to those of most of the other factors discussed in this chapter.

19. Effects of Changes in Truck Size and Weight Limits

Changes in truck size and weight limits can have a significant impact on the cost of goods movement by truck. Truck size and weight limits control the amount of payload that can be carried on a truck. For high-density freight, the maximum payload usually is controlled by weight limits; for low-density freight, the maximum payload usually is controlled by the cubic capacity of the truck (i.e., length, width, and height limits). Because increases in truck size and weight limits increase the payload per trip, fewer truck trips are required to carry the same amount of freight. Longer and heavier trucks generally cost more to operate on a per-vehicle-mile basis; however, these increases only partially offset any cost savings associated with making fewer trips.

Changes in truck size and weight limits may result in shifts of freight to or from other modes, particularly rail. Without the diversion of additional freight from rail, increases in truck size and weight limits would be expected to reduce truck traffic volumes. The extent to which volume reductions would be offset by the diversion of freight to trucks is an important issue in the debate over the effects of changes in limits.

20. Congestion

In many urban areas, increasing highway congestion is affecting the cost and efficiency of truck transport, and the reliability required by just-in-time shipping. Highway congestion affects trucking costs primarily by increasing the number of driver hours and vehicles required to haul a given amount of freight and by reducing truck fuel economies.

Recent studies of congestion have distinguished recurring congestion from the effects of incidents such as disabled vehicles, accidents, and construction or maintenance activities. To meet delivery schedules in congested areas, allowances must be made for the possibility of incident-related delays. Such allowances are costly to truckers, since they increase the time that a driver and vehicle are idle.

Increasing congestion in large metropolitan areas has led to proposals for truck bans during peak periods in some metropolitan areas. In 1988, Los Angeles Mayor Thomas Bradley proposed a plan for reducing congestion which included a truck-permitting program that would drastically reduce the number of large trucks allowed to operate on the streets of Los Angeles during the morning and evening peak periods.

Congestion also exists in air, water and rail freight transportation resulting in increased operating cost and lower level of service.

21. Technological Advances

A number of significant technological advances in equipment and information systems over the past three decades have had a profound impact on freight transportation involving all modes. The most notable equipment advances include containerization, double-stack technology, automation and robotics, handling and interchange systems, automated terminals, and conveyance design. Advances in information systems include electronic data interchange (EDI), automated equipment identification (AEI), applications of Intelligent Transportation Systems (ITS) to commercial vehicle operations, global positioning systems, and cargo/container routing and tracking systems. Many of the technologies which enable significant increases in productivity are readily available, while others require significant financial investment before achieving wide application. It should be noted that there are regulatory, market, and institutional obstacles to be overcome before some of these advances can be implemented.

Technology will continue to evolve and improve, affecting all facets of freight transportation including the type, size and weight of commodities, the means by which they are produced and distributed, and the associated costs.

■ 2.3 Summary

Table 2.1 shows a list of freight demand characteristics pertaining to the commodity, shipment, mode and logistics costs, and whether or not these characteristics are influenced by the factors discussed above.

Some of the factors described have an influence on the type, weight, volume and value (prices) of commodities shipped. For example, a healthy economy characterized by high GDP, high average income and raised consumer confidence will most likely exhibit heavy consumer spending on many different types of commodities in addition to the basic ones such as food and general necessities. The consumers can afford to buy more expensive items in bigger quantities, and extra income will be available for purchasing products that they can normally live without including some appliances, electronics and all forms of equipment/tools. Other commodity attributes that may be influenced by the factors are the perishability of the products, their storage space requirements and degree of hazard. For example, technological advances in refrigeration may allow some perishable commodities to last longer than they would under normal circumstances. High volume packaged product (e.g. using Styrofoam etc.) would require a lot more storage space than the same item unpacked. Finally, stricter safety and environmental policies on hazardous waste transport would significantly reduce the quantity of such hazardous materials (i.e. chemical wasters, radioactive substances) being moved from one place to another.

The second category of freight characteristics, shipment, refers to the length or distance and the number of transfer points involved in the shipment of the commodities. International trade agreements such as NAFTA would eliminate barriers to free trade between the United States and other countries thereby increasing not only the volume of commodities shipped but the average line-haul distance (e.g. vehicle-miles traveled) and number of transfer points (stops) for these commodities.

The impacts of the factors on logistics costs, modal attributes and level of service characteristics including volume/weight limits, travel costs, reliability, travel time and probability of loss or damage are dependent on the specific type of mode and route the carrier or shipper uses. Some of the factors identified may impact all modes available for freight transport. For example, the overall economy and fuel prices usually have the same impact on all modes. However, other factors identified may affect some modes or routes more heavily than the others, which not only changes their logistics costs and modal level of service characteristics but also their relative attractiveness compared to other modes. Economic regulation/deregulation on air freight transportation may change the modal choices of regular air freight shippers and carriers. Truck size and weight limits will hurt the trucking industry by increasing the cost to move commodities by truck.

Note further that the impacts of the factors on freight demand characteristics can vary in magnitude and extent, which are not reflected in the table.

Table 2.1 - Demand Factors vs. Freight Characteristics

FREIGHT CHARACTERISTICS / FACTORS	1 The Economy	2 Industrial Location Patterns	3 Globalization of Business	4 International Trade Agreements	5 International Transportation Agreements	6 Just-in-Time Inventory Practices	7 Carrier-Shipper Alliances	8 Centralized Warehousing	9 Packaging Materials	10 Recycling	11 Economic Regulation/Deregulation	12 Intermodal Operating Agreements	13 Fuel Prices	14 Publicly-Provided Infrastructure	15 User Charges and Other Taxes	16 Government Subsidization of Carriers	17 Environmental Policies and Restrictions	18 Safety Policies and Restrictions	19 Changes in Truck Size and Weight Limits	20 Congestion	21 Technological Advances
Commodity																					
Commodity Type (e.g. SIC Code)	X	X	X	X					X	X	X			X			X	X	X		X
Weight	X		X	X		X			X		X			X	X				X		X
Volume	X		X	X		X		X	X		X		X		X				X		X
Value	X		X	X						X	X				X						X
Perishability (shelf-life)		X	X	X		X														X	X
Storage space requirements	X		X	X		X		X	X			X									X
Degree of Hazard				X							X			X	X		X	X			X
Shipment																					
Line haul miles	X	X	X	X	X			X		X	X	X	X	X	X						X
Miles per number of stops	X	X	X	X	X			X		X	X	X		X							X
Mode																					
Cube limit			X	X	X				X		X	X		X	X				X		X
Weight limit			X	X	X				X		X	X		X	X				X		X
Suitability for hazardous materials			X	X	X						X			X	X		X	X			X
Line-haul costs (per shipment or per mile)		X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X
Pickup costs (per shipment or per mile)		X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X
Delivery costs (per shipment or per mile)		X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X
Wait time		X	X	X	X	X	X	X			X	X		X						X	X
Travel time		X	X	X	X	X	X	X			X	X		X			X	X		X	X
Reliability		X	X	X	X	X	X	X			X	X		X						X	X
Probability of loss and damage claim			X	X	X	X	X	X	X		X	X		X			X	X			X
Load ratio			X	X	X	X			X		X	X		X					X		X
Logistics Costs																					
Order costs			X	X	X		X	X			X	X			X	X	X		X	X	X
Loading and unloading costs		X	X	X	X		X	X			X	X			X	X	X	X	X	X	X
In-transit capital carrying cost		X	X	X	X		X				X	X			X	X	X	X	X	X	X
In-storage capital carrying costs			X	X	X	X	X	X			X	X			X	X		X			X
Storage cost			X	X	X	X	X	X			X	X		X	X	X					X
Shelf loss in transit		X	X	X	X		X				X	X			X	X					X
Cost of filing loss and damage claims			X	X	X		X	X			X	X			X	X	X	X			X
Capital carrying cost on loss and damage			X	X	X		X				X	X			X	X	X	X		X	X
Carrying cost for safety stock			X	X	X		X				X	X			X	X	X	X		X	X
Emergency shipment cost		X	X	X	X		X				X	X	X	X	X	X		X		X	X

3.0 Simple Growth Factor Methods

3.0 Simple Growth Factor Methods

■ 3.1 Introduction

This chapter provides simple methods that can be used to forecast the changes in freight demand due to changes in the level of economic activity or other related factors. The procedure involves applying growth factors to baseline freight traffic data or economic variables in order to project the future freight travel demands. The growth factor approach is classified into two types -- (1) *based on historical traffic trends*, and (2) *based on forecasts of economic activity*. The first approach involves the direct application of a growth factor, calculated based upon historical traffic information, to the baseline traffic data. The second approach recognizes that demand for freight transportation is derived from underlying economic activities (e.g. employment, population, income, etc.). In this approach, forecasts of changes in economic variables are used to estimate the corresponding changes in freight traffic. A hypothetical example is provided at the end of the chapter to illustrate and differentiate the two approaches.

Growth factor methods can be used by State DOT's, MPO's and other planning agencies to establish rough estimates of statewide (or regional) growth in freight traffic for the freight component of a transportation plan. They might also be used to forecast truck travel for pavement design and management. At the local level, these methods might be used to project growth in freight traffic in a given corridor or the level of activity at an intermodal facility.

This chapter also briefly describes a more elaborate alternative approach for freight transportation demand forecasting using statistical techniques.

■ 3.2 Growth Factors Based on Historical Traffic Trends

This section presents a very simple procedure for using historical data for projecting future freight demand. It assumes the availability of at least two years of historical data for the freight demand variable being forecast.

Using two years of historical data, an annual growth factor (AGF) is calculated as follows:

$$AGF = (T2/T1)^{1/(Y2-Y1)}$$

where T1 is freight demand in year Y1 and T2 is freight demand in year Y2.

The annual growth factor can then be applied to predict future demand (T3) for some future year (Y3) as follows:

$$T3 = T2\ AGF^{Y3-Y2}$$

For example, assume that the number of truck trips at a given location on an average weekday was 8,000 in 1990 and 10,000 in 1995. Using this simple procedure, the forecast number of truck trips for the year 2005 is 15,625; i.e.,

$$AGF = (10{,}000/8{,}000)^{1/5} = 1.04564$$

$$15{,}625 = (10{,}000)\ (1.04564)^{10}$$

If more than two years of historical data are available for the variable to be forecast, we suggest that these data be plotted and examined to insure that they exhibit a relatively steady growth rate over time. If the year-to-year changes appear erratic, then the assumption underlying the simple procedure – relatively constant growth rate over time – is called into question.

Particularly for long-range forecasts, using growth factors based solely on historical trends is dangerous because it does not consider the underlying mechanisms or factors that bring about changes in demand for freight. Since freight transportation demand is "derived" from the more basic demands for goods and services, forecasts of various economic factors that affect the demand for goods should be used to predict the corresponding growth (or changes) in freight demand. This procedure is described below.

■ 3.3 Growth Factors Based on Economic Projections

This section presents a simple procedure for forecasting freight using projections of future demand or output for the goods being transported. It also describes various sources of economic forecasts which a freight analyst can use in applying this procedure as well as ways to improve its accuracy. A brief discussion of sensitivity analysis and alternative futures is also included. Most of these discussions were excerpted from the NCHRP 8-30, *Forecasting Freight Transportation Demand*.[1]

3.3.1 Analysis Steps Explained

To simplify the approach for deriving forecasts of future freight traffic from economic forecasts, it can be assumed that the demand for transport of a specific commodity is directly proportional to an economic indicator variable that measures output or demand

[1] NCHRP 8-30 Report - *Forecasting Freight Transportation Demand. A Guidebook for Planners and Policy Analysts*, Cambridge Systematics Inc., January 1996.

for the commodity. With this assumption, growth factors for economic indicator variables, which represent the ratios of their forecast-year values to base-year values, can be used as the growth factors for freight traffic.

This procedure requires data or estimates of freight traffic by commodity type for a reasonably "normal" base year, as well as base year and forecast year values for the corresponding economic indicator variables. The basic steps involved in the process are as follows:

1. Select the commodity or industry groups that will be used in the analysis. This choice is usually dictated by the availability of forecasts of economic indicator variables. As discussed in the next section, much of the available forecasts are by Standard Industrial Classification (SIC) code.

2. Obtain or estimate the distribution of base-year freight traffic by commodity or industry group. If actual data on the distribution are not available, state or national sources may be used to estimate this distribution. For example, the Census Bureau's Truck Inventory and Use Survey (TIUS) provides information on the distribution of truck VMT by commodity carried and industry group. A sample application of TIUS data for this purpose is presented in the example at the end of this section.

3. Determine the annual growth factor (AGF) for each commodity or industry group as follows:

$$AGF = (I_2/I_1)^{1/(Y2-Y1)}$$

   where I_1 is the value of the economic indicator in year Y1 and I_2 is the value of the economic indicator in year Y2.

4. Using the annual growth factor and base-year traffic, calculate forecast-year traffic for each commodity or industry groups as follows:

$$T_f = T_b \, AGF^n$$

   where n is the number of years in the forecast period.

5. Aggregate the forecasts across commodity or industry groups to produce the forecast of total freight demand.

The most desirable indicator variables are those that measure goods output or demand in physical units (tons, cubic feet, etc.). However, forecasts of such variables frequently are not available. More commonly available indicator variables are constant-dollar measures of output or demand, employment, or, for certain commodity groups, population or real personal income. The following subsection describes the data sources for forecasts of some of these economic indicator variables.

3.3.2 Sources of Economic Forecasts

There are several sources which can be used by analysts at State DOT's, MPO's and other planning agencies to obtain estimates of growth in economic activity (by geographic area and industry or commodity type). In general, large urban areas tend to have a smaller growth rate than smaller suburban and rural areas.

Many states fund research groups that monitor the state's economy and produce forecasts of changes in the economy. For example, the Center for the Continuing Study of the California Economy develops 20-year forecasts of the *value* of California products by the two-digit Standard Industrial Classification (SIC) code. Similarly, the Texas Comptroller of Public Accounts develops 20-year forecasts of *population* for ten sub-state regions and 20-year forecasts of *output* and *employment* by one-digit SIC code and sub-state region; and a private firm produces 20-year forecasts of output and employment in Texas by three-digit SIC code. Appendix G lists the data centers in each state.

Long-term economic forecasts also are available from two federal agencies. At 2½-year intervals, the Bureau of Labor Statistics (BLS) publishes low, medium and high 12 to 15-year forecasts of several economic variables, including *real domestic output*, *real exports and imports*, and *employment*, for each of 226 sectors (generally corresponding to groups of three-digit SIC industries).[2] Also, at five-year intervals, the Bureau of Economic Analysis (BEA) develops 50-year regional projections of *population* and *personal income* as well as *employment* and *earnings* by industry sector.[3] The BEA forecasts are published by state for 57 industries, and by metropolitan statistical area and BEA economic area for 14 industry groups (see Appendix K, Part 1).

In addition to the state and federal agencies, short and long-term economic forecasts are also available from several private sources (see Appendix L). The private firms use government and industry data to develop their own models and analyses. Two of the better known private sources are DRI/McGraw Hill and the WEFA Group.

DRI provides national, regional, state, Metropolitan Statistical Area (MSA), and county-level macroeconomic forecasts on a contract or subscription basis. Variables forecast include *gross domestic product*, *employment*, *imports, exports*, and *interest rates*. DRI also produces short-term (2½- to 3-year) and long-term (20- to 25-year) *industrial input* and *output* forecasts for 250 industries (2, 3, or 4-digit SIC code). Industrial inputs include *employment*, *energy*, and *materials* used in production. These input/output forecasts are updated semiannually. *Price* and *wage indices* are also forecast for 650 different industries.

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[2] The most recent BLS forecasts are contained in U.S. Department of Labor, Bureau of Labor Statistics, *American Work Force 1992-2005*, Bulletin 2452, April 1994.

[3] See U.S. Department of Commerce, Bureau of Economic Analysis, *BEA Regional Projections to 2040*, Three Volumes, U.S. Government Printing Office, October 1990.

WEFA produces quarterly short (2½ to 3½ year) and long-term (10- and 25-year) and annual long-term (25-year) U.S. macroeconomic forecasts. Variables forecast include *gross domestic product*, *employment, price indices*, *financial indicators*, and *foreign exchange rates*. WEFA also produces short-term (3 year) *output* forecasts for 537 industries (at the 4-digit SIC level) on a quarterly basis, and long-term (10-year) *input* and *output* forecasts for 480 industries semi-annually.

3.3.3 Improving the Demand Forecasts

The basic procedure presented above makes the simplifying assumption that, for any transport facility, the percentage change in demand for transport (i.e. freight traffic) of each commodity group will be identical to the percentage change in the corresponding indicator variable. However, for various reasons, the two percentage changes are likely to be somewhat different from each other. These reasons include changes over time in:

1. value of output per ton;
2. output per employee;
3. transportation requirements per ton; and
4. competition from other facilities and modes.

To the extent that the likely effects of these changes are understood and can be estimated at reasonable cost, the basic procedure should be modified to reflect these effects. These effects are discussed below.

For most commodity groups, the relationship between *value of output* (measured in constant dollars) and volume shipped (measured in pounds, tons, cubic feet, etc.) may change over time. These changes may be due to a change in the mix of commodities being produced within a given commodity group (e.g., more aluminum and less steel) or a change in the average real value per ton of major products within the group. These changes may result in changing value per ton in either direction. For example, the shift to personal computers from mainframes provides an important example of a product category, computers, in which the value per ton, or per pound, has decreased appreciably. When transport demand is being forecast for several different commodity groups, adjustments for expected changes in value per ton for all commodity groups will be relatively expensive to make and may not have a very significant effect on the overall forecast of transport demand. However, when there are one or two commodity groups that are of particular interest, some consideration should be given, at least in an informal way, to determining how real value per ton for these groups has been changing and how it is likely to change over the forecast period.

Employment is related to transport demand less closely than is real output. Hence, employment is a less desirable indicator variable. However, long-term forecasts of employment are more available than forecasts of output, so that, for some purposes, employment forecasts must be used. As a result of improvements in labor productivity, real dollar-valued *output per employee* increases over time, and physical output (in tons or cubic feet) tends to increase as well. Forecasts of the overall increase in real dollar-valued output per employee for goods-producing industries (agriculture, mining, construction, and manufacturing) can be obtained from DRI/McGraw-Hill. In order to avoid a downward bias in the forecasts of transport demand, forecasts of percentage change in employment should be converted to forecasts of percentage change in (real dollar-valued) output by multiplying by estimated compound growth in labor productivity over the forecast period.

Decreases in the *real cost of transportation* that have occurred over time have resulted in a general tendency for industry to increase its consumption of transport services in order to economize on other factors of production. This tendency has resulted in trends toward decreased shipment sizes and increases in both lengths of haul and standards of service, with the last effect resulting both in a demand for premium quality services (e.g., Just-In-Time Delivery, see Chapter 2) provided by traditional modes and in diversion to more expensive modes that offer faster, more reliable service. Statistical analyses, using procedures such as those presented in Section 3.4 below, should provide useful data for forecasting the extent to which these trends are likely to increase the overall demand for freight transport. However, similar analyses of the secular shift toward higher quality modes are unlikely to produce reliable results because of the difficulty in controlling for temporal changes in modal service quality.

Finally, whenever relevant, forecasts of demand for a facility or mode should be adjusted to reflect expected changes in *degree of competition* from other facilities or modes. These changes may result from:

- expected changes in relative costs;
- the elimination of base-year supply constraints at the facility in question or at competing facilities; or
- the development of future supply constraints at the facility in question or at competing facilities; or
- the development of new competing facilities.

The forecasting problems posed by base-year supply constraints frequently can be avoided by choosing a base year when no significant supply constraints existed. When this is not practical, a combination of historic data and judgment may be used to adjust the estimates of base-year facility usage to eliminate the effects of the supply constraints, thus producing estimates of base-year demand in the absence of supply constraints; annual growth rates or growth factors can then be applied to these estimates of base-year demand to produce the forecast demand.

3.3.4 Sensitivity Analysis

The growth factor methods presented above produce just a single forecast of freight demand. Planning decisions can then be made on the basis of this forecast. However, planners are cautioned that the forecast is likely not to be completely accurate – either because some of the assumptions (e.g., those relating to economic growth) prove to be inaccurate, or because of deficiencies in the procedure itself. Because no forecast can be guaranteed to be perfectly accurate, effective planning requires that planning decisions be reasonably tolerant of inaccuracies in the forecast. The conventional approach to analyzing the effects of alternative futures is to subject a forecast to some form of *sensitivity analysis*.

The development of any forecast requires a number of assumptions to be made, either explicitly or implicitly. Some of the types of assumptions that may be incorporated into forecasts of demand for a transportation facility relate to:

- Economic growth – both nationally and locally;
- Growth in the economic sectors that generate significant volumes of freight handled by the facility;
- Transport requirements of these sectors (which may be affected by increased imports or exports, or by changes in production processes);
- Modal choice (which may be affected by changing transport requirements or changing cost and service characteristics of competing modes);
- Facility usage per unit of freight volume (which may be affected by changes in shipment size or container size);
- The availability and competitiveness of alternative facilities;
- Value per ton of output; and
- Output per employee (if employment is used as an indicator variable).

Sensitivity analysis consists of varying one or more of these assumptions in order to produce alternative forecasts. The most common alternative assumptions to be considered are those related to economic growth; and, indeed, economic forecasters (including BLS) frequently provide high and low forecasts of growth in addition to a medium (or most likely) forecast. These alternative forecasts of economic growth can be used to generate alternative forecasts of transport demand, and additional alternative forecasts of exogenous variables (e.g., trade) can be used to produce an even larger set of forecasts of transport demand (e.g., high growth, high trade; high growth, low trade; etc.) However, simply varying these exogenous forecasts generally will not produce a set of transport-demand forecasts that represents the full range of demand that might exist in future years of interest. To produce a better understanding of the range of demand that might exist in the future, a more thorough sensitivity analysis should be conducted.

One approach to conducting a thorough sensitivity analysis consists of reviewing each of the assumptions explicit or implicit in the analysis and, for each assumption, generating a pair of reasonably likely alternative assumptions, one that would increase the forecast of demand and one that would decrease it. A high forecast of demand can then be generated by using all the alternative assumptions that would tend to increase the forecast (or at least all those that are logically compatible with each other); and a low forecast can be generated by using all the alternative assumptions that would tend to decrease the forecast. These high and low forecasts should provide planners with appropriate information about the range of transport demand that could exist in the future. Planning decisions can then be made that are designed to produce acceptable results for any changes in transport demand within the forecast range.

A somewhat more systematic type of sensitivity analysis consists of making small changes in the analytic assumption, one at a time, and determining the effect of each change on forecast demand. The results of this effort are a set of estimates of the *sensitivity* of the forecast to each of the assumptions. This type of sensitivity analysis can provide more insight into the relationships between the various analytic assumptions and the forecasts produced. However, this approach requires a greater expenditure of resources. Furthermore, the most important sensitivity results – high and low forecasts of demand – can be generated using either approach, though these forecasts will be affected by the alternative analytic assumptions used to generate them and the care with which the high and low forecasts are then generated.

■ 3.4 Alternative Forecasting Methods

One alternative to the use of growth factor methods for forecasting freight travel demand is regression analysis. Regression analysis involves identifying one or more independent variables (the explanatory variables) which are believed to influence or determine the value of the dependent variable (the variable to be explained), and then calculating a set of parameters which characterize the relationship between the independent and dependent variables. For freight planning purposes, the dependent variable normally would be some measure of freight activity and the independent variables usually would include one or more measures of economic activity (e.g. employment, population, income). For forecasting purposes, forecasts must be available for all independent variables. These forecasts may be obtained from exogenous sources or from other regression equations (provided that the system of equations is not circular), or they may be developed by the forecaster using other appropriate techniques.

For forecasting purposes, regressions normally use historic *time-series* data (an alternative is *cross-section* data) obtained for both the dependent and independent variables over the course of several time periods (e.g., years). Regression techniques are applied to the historic data to estimate a relationship between the independent variables and the dependent variable; and this relationship is applied to forecasts of the independent variables for one or more future time periods to produce forecasts of the dependent variable for the corresponding time periods.

The reader is referred to Appendix E of the NCHRP Project 8-30 Report, *Forecasting Freight Transportation Demand*, for a more detailed discussion of regression and other statistical techniques for forecasting freight traffic.

■ 3.5 Illustrative Example

The hypothetical example provided below demonstrates the two approaches for freight demand forecasting using simple growth factors and shows how a freight demand forecast can be refined using information on changes in freight characteristics.

Suppose that a 4-lane highway segment in Kentucky serves both passenger and commercial vehicles. The current (e.g. 1995) average daily truck traffic is approximately 8,000 vehicles, or an average of 2,000 vehicles per lane per day. Historical data on truck traffic reveals the following information:

Year	Daily Truck Traffic
1985	3,450
1986	5,270
1987	6,550
1988	6,880
1989	7,130
1990	7,240
1991	7,330
1992	7,500
1993	7,590
1994	7,820
1995	8,000

The Bureau of Census' 1992 Truck Inventory User Survey (TIUS) contains the following information on vehicle miles traveled by all 6-tire trucks and combination vehicles in the United States:

1992 Percentage Distribution of Truck VMT

Source: Truck Inventory and Use Survey, Bureau of Census, 1992.

Major Use	VMT (Millions)	%
Agriculture (Farming)	7,454.9	6.6%
Forestry and Lumbering	2,611.5	2.3%
Mining and Quarrying	1,480.6	1.3%
Construction	13,453.5	12.0%
Manufacturing	8,446.7	7.5%
Wholesale Trade	12,397.4	11.0%
Retail Trade	8,552.3	7.6%
Transportation and Public Utilities	51,180.3	45.6%
Services	6,782.1	6.0%
TOTAL	112,359.3	100.0%

For this hypothetical example, it will be assumed that the national distribution of truck VMT shown above is applicable to the State of Kentucky and the highway segment being analyzed. In practice, a more localized or site-specific VMT distribution is preferred to national average since the latter may not fully represent the actual area being analyzed.

The Bureau of Economic Analysis' (BEA) forecasts of Gross State Product (GSP) for each of these industries in Kentucky are shown in the table below:

Gross State Product by Place of Work in Kentucky

Source: Bureau of Economic Analysis Regional Projections Through 2045.

Major Use	Gross State Product (Million 1987 $)	
	1992	2000
Agriculture (Farming)	2,075	2,357
Forestry and Lumbering	309	456
Mining and Quarrying	3,125	3,888
Construction	2,508	2,838
Manufacturing	15,719	19,671
Wholesale Trade	3,404	4,225
Retail Trade	6,159	7,767
Transportation and Utilities	6,290	7,781
Services	16,255	19,675
TOTAL	55,844	68,658

Gross State Product (GSP) is the gross market value of the goods and services attributable to labor and property located in a State. It is the State counterpart of the nation's Gross Domestic Product (GDP). Again, for this hypothetical example, it will be assumed that the statewide trends in GSP as presented above are applicable to the highway segment being analyzed. In practice, more localized forecasts should be used.

Determine the total daily truck traffic in the corridor in the year 2000 using both historical traffic growth rate and economic projections. Assume that commodity demand for an industry is directly proportional to the Gross State Product for that industry. In reality, the average price per ton of each commodity may change with time making the above assumption implausible. Furthermore, Gross State Product alone may not be an adequate economic indicator (see Chapter 2 and earlier sections of this Chapter).

A. Historical Trends

Plotting and review of the historical data on truck traffic indicates very large percentage increases from 1985 to 1986 and from 1986 to 1987. In subsequent years, the year-to-year growth is much less. It appears that some occurrence in 1985 or 1986 – perhaps a significant change in the highway network or changes in traffic counting procedures – caused a sharp increase in counted volume on the segment in question. Such an unusual pattern would indicate the need for further investigation. Unless this investigation provides an indication to the contrary, it would seem reasonable to use the 1987 to 1995 growth as the basis for an annual growth factor, since growth during this period was fairly stable.

Forecast of the total truck traffic in the year 2000 is then calculated as follows:

$$AGF = (8{,}000/6{,}550)^{1/(1995-1987)}$$

$$= 1.0253$$

$$T_{2000} = T_{1995}\ AGF^{2000-1995}$$

$$= (8{,}000)\ (1.0253)^{5}$$

$$= 9{,}065$$

B. Economic Projections

Following the step-by-step procedures discussed earlier in Section 3.3, the current total daily truck traffic (8,000) is first divided into the various commodity group categories using the truck VMT distribution. As stated above, it is assumed that production of each commodity group, and therefore the freight demand, is directly proportional to the Gross State Product for each commodity category. The results of these two steps are shown in the table below:

Industrial Category	**% VMT**	**Daily Truck Traffic (1995)**
Agriculture (Farming)	6.6%	531
Forestry and Lumbering	2.3%	186
Mining and Quarrying	1.3%	105
Construction	12.0%	958
Manufacturing	7.5%	601
Wholesale Trade	11.0%	883
Retail Trade	7.6%	609
Transportation and Public Utilities	45.6%	3,644
Services	6.0%	483
TOTAL	100.0%	8,000

Using the BEA forecasts, the average annual growth factor in GSP (and thus the demand for commodities associated with GSP) for the various categories are calculated as shown below (*Step 3*):

Industrial Category	Gross State Product (Million 1987 $)		Annual
	1992	2000	Growth Factor
Agriculture (Farming)	2,075	2,357	1.0170
Forestry and Lumbering	309	456	1.0593
Mining and Quarrying	3,125	3,888	1.0305
Construction	2,508	2,838	1.0164
Manufacturing	15,719	19,671	1.0314
Wholesale Trade	3,404	4,225	1.0302
Retail Trade	6,159	7,767	1.0326
Transportation and Utilities	6,290	7,781	1.0296
Services	16,255	19,675	1.0263
TOTAL	55,844	68,658	

For each industrial category, the annual growth factor in GSP is used to forecast the year 2000 truck traffic volume (*Step 4*). For example, the forecast of truck traffic for agriculture/farming is calculated as follows:

Agriculture/Farming:

$$T_{2000} = T_{1995} * (AGF)^{(2000-1995)}$$

$$= 531 * (1.0170)^5$$

$$\cong 577 \text{ trucks per day}$$

Finally, the individual forecasts are aggregated to calculate the total future truck traffic estimated, as shown in the table below (*Step 5*):

Industrial Category	Daily Truck Traffic (1995)	Annual Growth	Daily Truck Traffic (2000)
Agriculture (Farming)	531	1.0170	577
Forestry and Lumbering	186	1.0593	248
Mining and Quarrying	105	1.0305	123
Construction	958	1.0164	1,039
Manufacturing	601	1.0314	702
Wholesale Trade	883	1.0302	1,024
Retail Trade	609	1.0326	715
Transportation and Public Utilities	3,644	1.0296	4,217
Services	483	1.0263	550
TOTAL	8,000		9,195

Truck traffic forecasts based on historical trends do not provide as much underlying basis as the forecasts shown above. One is therefore more inclined to use forecasts based on economic projections rather than those based on historical traffic projections.

Again, the above forecasts assume that the unit prices of the commodities, or values of output per ton, remain unchanged over time. As explained earlier, this is a very restrictive assumption because unit prices do change with time. In order to improve these forecasts, adjustments must be made based on the historical price variations.

To illustrate the adjustment procedure for coal mining, the following data derived from the 1994 U.S. Statistical Abstract will be used:

Price of Bituminous Coal

Source: 1994 U.S. Statistical Abstract

	Price per Short Ton (1987 $)	% Change
Year		
1987	23.00	
1988	21.13	-8.1%
1989	19.93	-5.6%
1990	18.87	-5.3%
1991	17.89	-5.2%
1992	17.14	-4.2%
Average:		-5.7%

The price of coal is dropping but at a decreasing rate. Continuing this trend, we forecast the following prices through the year 2000:

	Price per Short Ton (1987 $)	% Change
Year		
1993	16.59	-3.2%
1994	16.11	-2.9%
1995	15.73	-2.4%
1996	15.41	-2.0%
1997	15.16	-1.6%
1998	14.96	-1.3%
1999	14.79	-1.1%
2000	14.66	-0.9%

Forecasts for coal mining as part of the general mining and quarrying industrial classification in the State of Kentucky are shown in the following table:

Gross State Product for Mining/Quarrying in Kentucky
Source: Bureau of Economic Analysis Regional Projections Through 2045.

Industrial Category	Gross State Product (Million 1987 $)		Annual
	1992	2000	Growth Rate
Mining and Quarrying			
• Metal Mining	0	0	0.00%
• Coal Mining	2,911	3,649	3.17%
• Oil and Gas Extraction	74	72	-0.24%
• Non-metallic minerals, except fuels	141	167	2.30%
TOTAL	3,125	3,888	3.05%

The equivalent tonnage for coal mining can be calculated as follows:

1992 Tonnage = $2,911,000/ ($17.14/ton)
≅ 169,837 short tons

2000 Tonnage = $3,649,000/ ($14.66/ton)
≅ 248,909 short tons

Therefore the more accurate annual growth rate for coal mining truck traffic is:

$= 100\% * ((248{,}909/169{,}837)^{1/8} - 1)$

$\cong 4.9\%$

which is higher than the growth factor of 3.17% used in the earlier calculation.

4.0 Incorporating Commercial Vehicles Into The Travel Forecasting Process

4.0 Incorporating Commercial Vehicles into the Travel Forecasting Process

■ 4.1 Introduction

This chapter describes a simplified quick-response procedure for incorporating commercial vehicles into the travel forecasting processes used by Metropolitan Planning Organizations, State Departments of Transportation, and other planning agencies. This chapter also provides alternative approaches that might be used if more data are available (or can be collected) and more accuracy is desired.

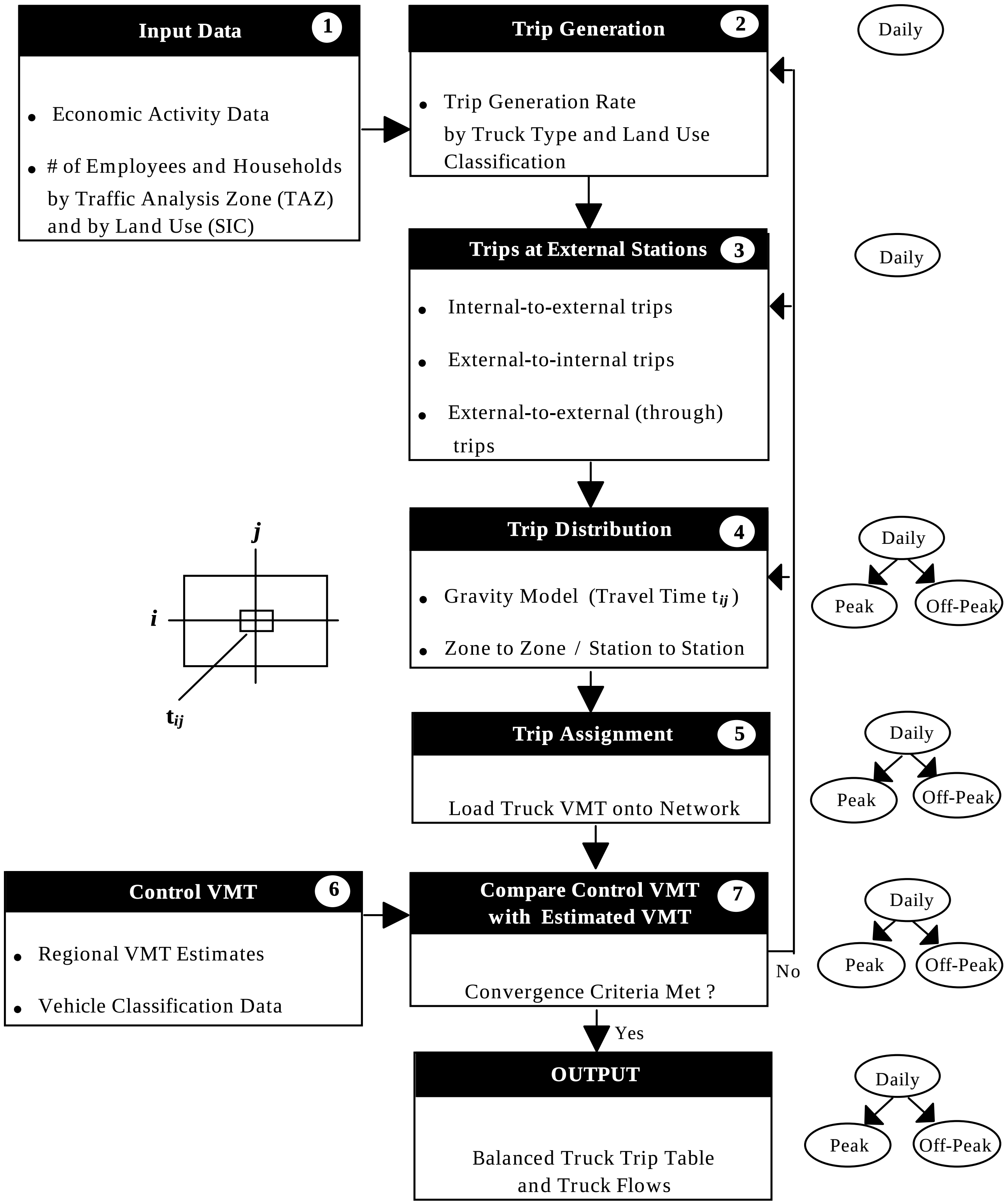
The procedure produces trip tables that can be assigned to highway networks for three classes of commercial vehicles:

- Four-tire commercial vehicles, including delivery and service vehicles,
- Single unit trucks with six or more tires,
- Combination trucks consisting of a power unit (truck or tractor) and one or more trailing units.

Figure 4.1 shows the simplified quick-response procedure as consisting of the following steps:

1. Obtain data on economic activity for traffic analysis zones (including employment by type and the number of households),
2. Apply trip generation rates to estimate the number of commercial vehicle trip destinations for each traffic analysis zone,
3. Estimate commercial vehicle volumes at external stations,
4. Estimate the number of commercial vehicle trips between pairs of traffic analysis zones or external stations,
5. Develop a preliminary estimate of commercial vehicle VMT by assigning trips to a network (or using a table of zone-to-zone distances),

Figure 4.1 Simplified Quick Response Freight Forecasting Procedure



6. Develop control totals for commercial VMT based upon (1) estimates of total VMT in the region for each functional class, and (2) vehicle classification data indicating the percentage of total VMT associated with commercial vehicles

7. Compare the results of Step 5 and Step 6, and, if necessary, develop adjustment factors to trip generation rates or trip distribution factors.

Steps 2 through 7 are repeated until the estimates of commercial vehicle VMT developed in Step 5 is reasonably close to the control totals developed in Step 6. The following sections describe each of these steps. A hypothetical example is included to illustrate the procedures.

Finally, a section on time-of-day characteristics discusses the temporal distribution of travel by commercial vehicles.

■ 4.2 Trip Generation

In the quick-response procedure, the number of commercial vehicle destinations per day in each traffic analysis zone is calculated by:

- Estimating (or obtaining data on) the number of employees who work in the traffic analysis zone for each of the following employment categories:

  1. Agriculture, Mining and Construction (SIC 1-19)

  2. Manufacturing, Transportation/Communications/Utilities and Wholesale Trade (SIC 20-51)

  3. Retail Trade (SIC 52-59)

  4. Office and Services (SIC 60-88),

- Estimating (or obtaining data on) the number of households located in the traffic analysis zone,

- Applying the trip generation rates shown in Table 4.1 to the data obtained above.

The trip generation rates shown in Table 4.1 are for trip destinations (which, on an average day, are equal to trip origins). These rates were taken from a Phoenix, Arizona study[1,2]. The Phoenix study results are used as the basis for default values because they

[1] Earl Ruiter; Cambridge Systematics, Inc.; *Development of an Urban Truck Travel Model for the Phoenix Metropolitan Area*; February 1992; Report Number FHWA-AZ92-314; prepared for Arizona Department of Transportation and the Federal Highway Administration.

provide an internally-consistent set of trip generation rates and trip times, compared with potentially inaccurate rates derived from mixing results from a large number of studies in which the exact trip generations, vehicle definitions and employment categories used are mostly unclear or unknown. Appendix D, however, contains site-specific trip generation rates and regression equations that a user may find more suitable for a particular state or region being analyzed.

Table 4.1 Trip Generation Rates

Generator	Commercial Vehicle Trip Destinations (or Origins) per Unit per Day			
	Four -Tire Vehicles	Single Unit Trucks (6+ Tires)	Combinations	TOTAL
Employment: *				
• Agriculture, Mining and Construction	1.110	0.289	0.174	1.573
• Manufacturing, Transportation, Communications, Utilities and Wholesale Trade	0.938	0.242	0.104	1.284
• Retail Trade	0.888	0.253	0.065	1.206
• Office and Services	0.437	0.068	0.009	0.514
Households	0.251	0.099	0.038	0.388

* If employment data is available only in terms of retail and non-retail employment, the trip generation rates shown above for non-retail employment should be weighted by the following national employment average percentages: (1) Agriculture, Mining and Construction - 10.9%; (2) Manufacturing, Transportation, Communications, Utilities and Wholesale Trade - 29.5%, (3) Office and Services - 59.6%.

Information on the number of households and employees by traffic analysis zone may be available to States or metropolitan/regional planning agencies through local data used for passenger transportation planning. If not, other sources and methodologies may be used including allocation of business-specific county or zip code data to census tracts.

For example, *County Business Patterns* presents county-level data on establishments (total and by employment size class) as well as total employment by SIC code (see Appendix C for listing and description of SIC codes). This data is tabulated by industry as defined

[2] The trip generation rates in Table 4.1 were increased to account for under-reporting and the fact that the survey did not cover trips with one end outside the region. The rates for combinations were increased disproportionately because combinations tend to be used for intercity shipments to a much greater degree than the other two classes of commercial vehicles.

in the 1987 *Standard Industrial Classification (SIC) Manual.* This tabulation is consistent with the classification methods used to create the default values in Table 4.1.

The same categories may also be obtained at the zip code level by special order from the Bureau of Census.[3]

County Business Patterns examines activity by specific sites or establishments. An establishment is a single physical location at which business is conducted or services or industrial operations are performed. It is not necessarily identical with a company or enterprise, which may consist of one or more establishments. When two or more activities are carried on at a single location under a single ownership, all activities generally are grouped together as a single establishment. For example, the administrative and shipping personnel of a manufacturing facility will be classified as manufacturing. However, administrative and auxiliary establishments that primarily manage or support the activities of other establishments of the same company (such as the headquarters of a multi-establishment conglomerate) are shown separately by industry division.

County Business Pattern data by major SIC code and by zip code may be allocated to associated census tracts where there is reasonable correspondence, based on total employment in each census tract from the *Census Transportation Planning Package* (CTPP). Comparisons of total employment between the two data sources should be performed, recognizing that County Business Patterns excludes self-employed and government workers, and that CTPP includes 1990 Census data. Local knowledge should also be employed to fine-tune allocations. For example, if County Business Patterns identifies 2,000 persons engaged in manufacturing employment in a zip code area, and the regional planning organization knows that the manufacturing site in a single census tract employs approximately that many people, it is appropriate to allocate the zip code manufacturing employment to that single census tract, rather than distribute it among all census tracts in the zip code area.

A general caution in using Bureau of Economic Analysis (BEA) or Census data for employment is that in some cases a headquarters office or central administrative facility is used as the address for dispersed activities such as construction, transportation, or electric and gas utilities. Data are excluded for self-employed persons, domestic service workers, railroad employees, agricultural production workers, most government employees, and employees on ocean-borne vessels or in foreign countries.

If the planning agency cannot secure employment by business type at the regional, county or zip code level, analysis can be performed using total employment by census tract. Under this method (not recommended for quick-response freight planning) total employment by census tract is multiplied by the average trip generation rate per employee. Employment by census tract is available from the CTPP. It includes tabulations by small areas of work, which are traffic analysis zones (TAZ's) in areas where the MPO supplied block-to-zone correspondence (Part 2 in MPO tabulations) and tabulations by census tract of work (Part 7 in MPO tabulations). Tabulations for CTPP do not include business type.

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[3] Efforts are currently underway to increase accessibility to this data . See Appendix K, Part 1.

To achieve a higher level of accuracy, it is necessary to identify employment by type and by census tract or TAZ, rather than allocate from zip code or county level. If even greater accuracy is desired, commercial data sources can provide detailed information in various formats, including employment by census tract and by SIC code (see Chapter 6 and Appendix L for details).

4.2.1 Example

Figure 4.2 shows a hypothetical study area consisting of three traffic analysis zones (TAZ's) and a number of major radial and circumferential highways. Four external stations have also been designated for the study area as shown.

Data on employment and number of households for each zone in the study area are given in the table below.

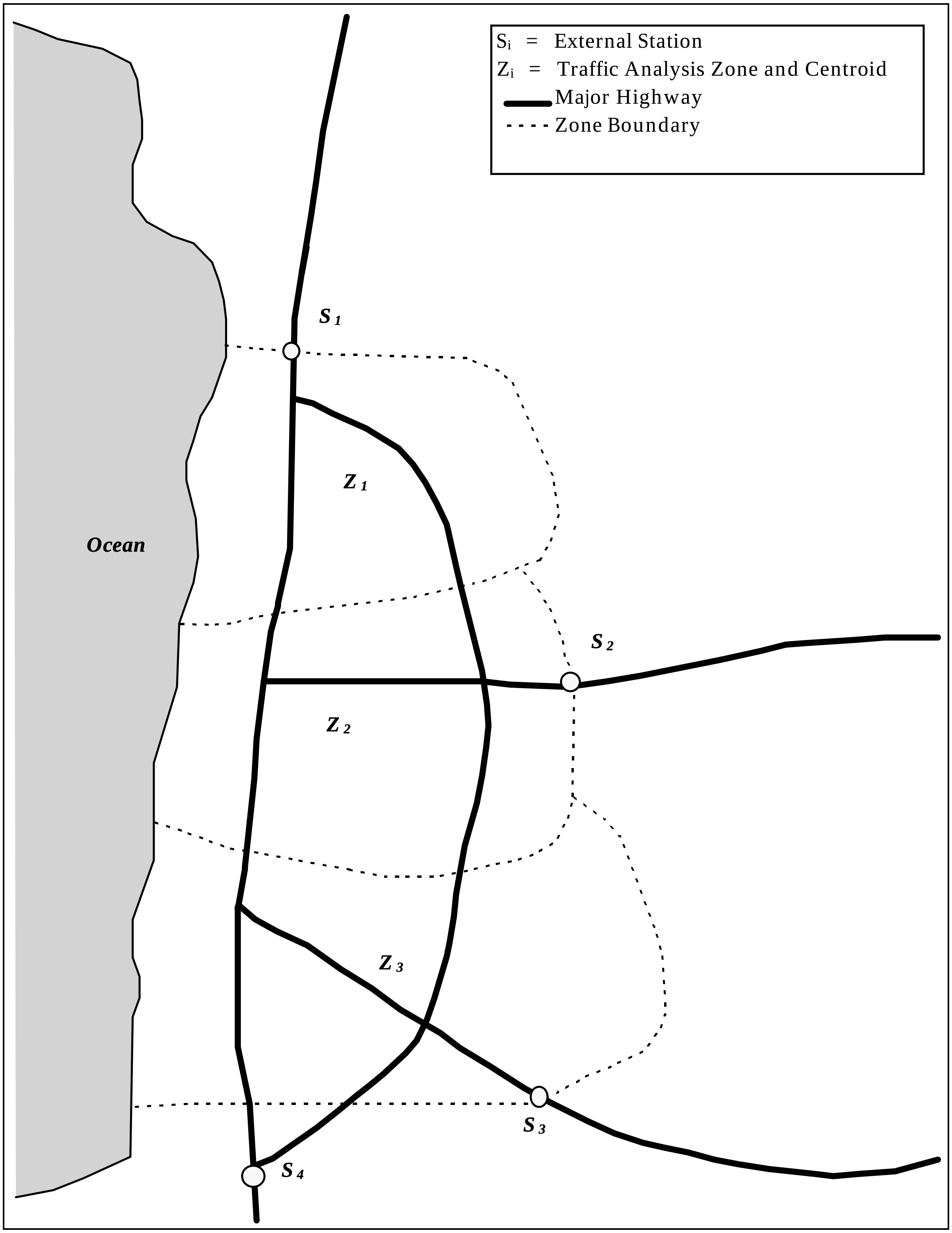
Number of Households and Employees in Each Zone

	Zone		
Land Use Type	**Z_1**	**Z_2**	**Z_3**
No. of Households	3,120	4,364	5,985
No. of Employees:			
Agriculture, Mining and Construction	0	0	0
Manufacturing, Transportation / Communications / Utilities and Wholesale Trade	6,241	9,362	20,209
Retail Trade	8,916	17,831	7,430
Office and Services	23,775	8,916	5,944
Total Employment	38,932	36,109	33,583

Multiplying the numbers in this table with the trip generation rates in Table 4.1 gives the estimated number of commercial vehicle destinations per day for each vehicle type in each zone. For example, the estimated number of 4-tire commercial vehicle destinations generated by office / services employees for Zone Z_1 is:

= [23,775] * [0.437] = 10,390 destinations / day.

Figure 4.2 Map of Hypothetical Study Area for the Example



The estimated total daily commercial vehicle destinations generated for the vehicle types and land use classification in the three zones are shown in the tables below.

Estimated Total Daily 4-Tire Commercial Vehicle Destinations Generated

	Zone		
Land Use Type	**Z_1**	**Z_2**	**Z_3**
Households	783	1,095	1,502
Employees:			
Agriculture, Mining and Construction	0	0	0
Manufacturing, Transportation / Communications / Utilities and Wholesale Trade	5,854	8,782	18,956
Retail Trade	7,917	15,834	6,598
Office and Services	10,390	3,896	2,598
TOTAL	24,944	29,607	29,654

Estimated Total Daily Single Unit (6+ tire) Commercial Vehicle Destinations Generated in Each Zone

	Zone		
Land Use Type	**Z_1**	**Z_2**	**Z_3**
Households	309	432	593
Employees:			
Agriculture, Mining and Construction	0	0	0
Manufacturing, Transportation / Communications / Utilities and Wholesale Trade	1,510	2,266	4,891
Retail Trade	2,256	4,511	1,880
Office and Services	1,617	606	404
TOTAL	5,692	7,815	7,767

Estimated Total Daily Combination Vehicle Destinations Generated in Each Zone

Land Use Type	Zone Z_1	Z_2	Z_3
Households	119	166	227
Employees:			
Agriculture, Mining and Construction	0	0	0
Manufacturing, Transportation / Communications / Utilities and Wholesale Trade	649	974	2,102
Retail Trade	580	1,159	483
Office and Services	214	80	53
TOTAL	1,561	2,379	2,866

The total estimated daily commercial vehicle destinations generated for each land use type in each zone and the total trips for all zones are shown in the table below.

Estimated Total Daily Commercial Vehicle Destinations Generated for Each Vehicle Type and Zone

Vehicle Type	Zone Z_1	Z_2	Z_3	TOTAL
4-Tire Trucks	24,944	29,607	29,654	84,205
Single Unit (6+ Tire) Trucks	5,692	7,815	7,767	21,274
Combination Vehicles	1,561	2,379	2,866	6,806
All Commercial Vehicles	32,197	**39,801**	**40,287**	**112,285**

4.2.2 Alternative Approaches

As stated above, the trip generation rates proposed in the quick response method were derived from Phoenix, Arizona data. In many situations one would want to use site-specific trip generation rates particularly if the site characteristics are very much different from the Phoenix area. In addition, the trip generation rates presented in Table 4.1 are for four groups of land use or industrial classification. Each group pertains to several specific land use and employment characteristics (see Appendix C for Standard Industrial Classification (SIC) codes). More accurate estimates of commercial vehicle trips can be obtained using trip generation rates that correspond to specific land use or industrial classification, if the employment data as well as trip generation rates exist for the specific employment category.

Tables D-1a through D-1d in Appendix D contain trip generation rates (per employee) gathered from a large number of locations throughout the United States and Australia.[4] The tables are arranged according to the four groups of SIC codes pertaining to the land use classification in Table 4.1. Specific SIC codes for some trip generation rates in many locations have been identified (e.g. SIC 42 for Truck Transportation). This information can be very useful in detailed site analysis and planning for specific types of establishments, and for more accurate estimation of commercial vehicle trip generation in a traffic analysis zone. Land use types that could not be classified under any one of the SIC codes are shown in Table D-1e.

Chapter 6 also presents other data collection methods and data sources pertaining to truck trip generation. Chapter 5 also describes procedures for estimating trip generation rates for major intermodal facilities and other special trip generators.

If employment data are not available for estimating commercial vehicle trips, other measures of economic activity such as total floor space or total land area devoted to specific employment categories can be used. Trip generation rates per one thousand square feet (TSF) and per acre of various employment (SIC) categories are shown in Table D-2b through D-2e, and Table D-3a through D-3e, respectively. These tables are arranged according to SIC codes (similar to Table D-1). Tables D-2e and D-3e contain trip generation rates for sites whose land use category cannot be classified under any one of the SIC codes.

More elaborate procedures (compared to the one-variable, fixed-rate approach in the quick response method) for predicting commercial vehicle trips involve various forms of equations as well as more than one independent variable. These equations have been developed and calibrated using a variety of estimation techniques, most commonly the ordinary least squares regression. Table D-4a through D-4e summarize some of the regression equations developed from various site studies and which can be used for predicting number of commercial vehicle trips as a function of one or more variables. If the required information exists, these equations can produce more accurate trip generation estimates compared with the simple fixed-rate approach.

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[4] The trip generation rates shown for Phoenix, Arizona in Appendix D are the unadjusted rates reported in the Ruiter study. See Footnote 1.

■ 4.3 External Stations

Most metropolitan area and regional travel forecasting networks include external stations through which trips with one or both ends outside the study area are loaded onto the network. Trips through external stations include:

- Internal-to-external trips which begin in a traffic analysis zone and end outside the study area;
- External-to-internal trips which begin outside the study area and end in a traffic analysis zone; and
- External-to-external (through) trips which begin and end outside the study area.

These trips are usually classified into one of the following four categories:

1. Passenger vehicles (which may be subdivided into Light vehicles and Buses),
2. Four-tire commercial vehicles,
3. Single unit trucks with six or more tires, and
4. Combination vehicles.

In the quick-response procedure, commercial vehicle volumes at external stations may be estimated by applying percentages to estimate volumes for each of the three commercial vehicle classes based on the functional classification of the highway.

In some cases, however, a comprehensive data gathering effort to determine actual volumes and vehicle classifications at external stations (possibly including an origin-destination survey, see Chapter 6) may be warranted as a means for estimating volumes for each of the three commercial vehicle classes. Such effort will be particularly useful for a small study area and/or an area with significant volumes of through trips. Sources of actual data include traffic counts using field surveys, weigh-in-motion equipment or pneumatic tubes. Field counts will generally include truck counts by truck class (axles/weight or both), site, roadway type and time of day, usually accumulated as parts of other studies from one or combinations of the following:

- HPMS counts (visual and automated)
- Turning-vehicle-movement counts
- Weigh-in-Motion counts and classifications
- Turnpike or bridge-toll counts
- Weigh-station counts and records
- Site studies (counts and forecasts)

- Safety studies
- Cordon counts
- Origin-destination surveys

It may be necessary to perform new counts on major external stations with old, suspect or missing data. Select data from sites near the border of the region in question, preferably without intervening roads to add or divert traffic. If data are available for a broad representation of lane and highway classifications, it is possible to expand the data to lanes and highways that were not sampled.

Agencies should be alert to a number of cautions and potential definitional problems in all counts related to freight movement, both internal and external. Research suggests wide variances in truck counts or classifications based on tube counts due to equipment calibrations, vehicle speed and traffic density. Therefore caution should be exercised in applying tube counts for vehicle classification to the model. Weigh-in-motion data, and even some visual classification schemes, may not clearly identify small commercial vehicles from other four-tired vehicles such as autos and vans. Further, truck classifications such as pickups, mini-vans and panel or full-sized vans are used for personal transportation as well as business applications. A key parameter of freight forecasting is to identify and model vehicle trips which are not typically captured in a household survey. If the survey or classification method does not clearly distinguish between personal and commercial vehicle use, then counts of pickups, mini-vans and panel or full vans should be discounted by the number of vehicles used for personal transportation. The 1992 Truck Inventory and Use Survey (TIUS) identifies the national average commercial use percentages for these vehicle types:

- Pickup - 32.2 %
- Mini-van - 25 %
- Panel or full-size van - 45.7 %

As illustrated below, these percentages can be applied to counts of four-tire trucks to estimate commercial vehicle traffic:

Type	**Total Count**	**Percent Commercial**	**4-Tire Commercial Vehicle**
Pickups	1,200	32.2%	386
Mini-vans	500	25.0%	125
Panels or Vans	400	45.7%	183
TOTAL	2,100		694

If it is not practical to conduct traffic count and classification studies at external stations, the default percentages shown in Table 4.2 may be used to obtain estimates of volumes at external stations for each of the three commercial vehicle classes. The percentages are based on: (1) vehicle classification data collected by States and compiled by the Federal

Highway Administration, and (2) information from the Bureau of the Census' Truck Inventory and Use Survey (TIUS) on the use of light trucks[5].

Table 4.2 Percent Distribution of Traffic by Vehicle Class

Functional Class	Non-Commercial Vehicles	Commercial Vehicles			Total
		Four-Tire	Single Unit	Combination	
RURAL					
Interstate	81.6%	3.3%	2.9%	12.2%	100%
Other Principal Arterials	87.2%	4.7%	3.2%	4.9%	100%
Minor Arterial, Collector and Local	88.5%	5.3%	3.6%	2.6%	100%
Average - Rural	86.6%	4.7%	3.4%	5.3%	100%
URBAN					
Interstate	88.2%	5.5%	1.8%	4.5%	100%
Other Freeways and Expressways	90.5%	5.5%	1.7%	2.3%	100%
Other Principal Arterials	89.5%	6.6%	1.7%	2.2%	100%
Minor Arterials	90.4%	6.4%	1.7%	1.5%	100%
Collectors	90.3%	6.4%	1.8%	1.5%	100%
Local	91.0%	6.4%	1.8%	0.8%	100%
Average - Urban	89.8%	6.2%	1.7%	2.3%	100%

Source: Vehicle Classification Data of FHWA and Census' Truck Inventory User Survey.

If data on average daily traffic for all vehicles at one or more external stations are not available, data on annual average daily traffic per lane from *the Highway Performance Monitoring System* (HPMS) database can be used to estimate AADT (see Table 4.3 below). The minimum information needed to accomplish this method is an inventory of the number of lanes by functional class, classified as urban or rural, for all highways where the stations are located. However, it should be noted that the variability in AADT per lane across facilities and geographic areas is huge, and estimates of AADT based on the default values given in Table 4.3 could be off by an order of magnitude, as indicated by the 10^{th} percentile and 90^{th} percentile values of traffic volumes in the HPMS database as shown in the table.

[5] Specifically, the TIUS was used to estimate the percentage of VMT by four-tire trucks associated with personal use. In Table 4.2, personal use VMT by four-tire trucks is included in the "Non-Commercial Vehicles" column.

Table 4.3 Annual Average Daily Traffic (AADT) per Lane

Functional Class		2-Lanes	4-Lanes	6-Lanes	8-Lanes	10-Lanes
RURAL						
Interstate						
	Average	2,581	4,251	8,500	9,004	----
	10th %-ile	304	1,493	4,613	5,888	----
	90th %-ile	20,355	7,325	13,299	15,788	----
Other Principal Arterial						
	Average	2,268	3,159	7,100	----	----
	10th %-ile	671	975	3,416	----	----
	90th %-ile	4,432	6,425	9,546	----	----
Minor Arterial						
	Average	1,758	2,752	7,878	----	----
	10th %-ile	335	712	5,047	----	----
	90th %-ile	3,900	5,518	16,533	----	----
Major Collector						
	Average	1,062	2,774	4,970	----	----
	10th %-ile	84	650	2,183	----	----
	90th %-ile	2,665	5,909	8,167	----	----
Minor Collector						
	Average	407	926	----	----	----
	10th %-ile	24	79	----	----	----
	90th %-ile	1,035	2,500	----	----	----
URBAN						
Interstate						
	Average	8,321	8,649	12,940	15,700	16,654
	10th %-ile	3,115	3,020	6,249	8,160	10,579
	90th %-ile	15,300	15,063	21,000	23,865	23,420
Other Freeways/Expressways						
	Average	6,887	7,448	11,932	17,084	19,145
	10th %-ile	2,420	2,495	4,140	7,000	14,330
	90th %-ile	13,475	14,000	21,500	26,638	25,965
Other Principal Arterials						
	Average	4,823	4,924	6,075	6,936	----
	10th %-ile	1,500	1,833	2,650	2,743	----
	90th %-ile	9,000	8,550	9,779	10,918	----
Minor Arterials						
	Average	3,242	3,993	4,747	5,004	----
	10th %-ile	705	1,335	2,200	1,500	----
	90th %-ile	6,748	7,065	8,200	10,594	----
Collectors						
	Average	1,737	2,696	3,243	----	----
	10th %-ile	285	528	1,286	----	----
	90th %-ile	4,025	5,407	5,793	----	----

Source: Highway Performance Monitoring System (HPMS) Database, Federal Highway Administration

4.3.1 Example

To illustrate the methods discussed above, the characteristics of the four external stations in the hypothetical study area shown in Figure 4.2 are given in the table below:

Characteristics of External Stations in Hypothetical Study Area

	External Station			
Characteristic	**S_1**	**S_2**	**S_3**	**S_4**
Functional Class	Urban Interstate	Rural Interstate	Urban Principal Arterial	Urban Interstate
No. of Lanes	8	6	4	8
AADT per Lane	13,400	9,100	not available	11,500

No vehicle classification data are available, hence the composition of traffic at these external stations is unknown. Using Table 4.2 and Table 4.3, the total commercial vehicle trips at each station can be estimated as shown in the table below:

Estimated Daily Vehicle Trips at External Stations

	External Station				
Characteristics	S1	S2	S3	S4	Total
Functional Class	Urban Interstate	Rural Interstate	Urban Princ. Arterial	Urban Interstate	
AADT per Lane	13,400	9,100	4,924 (Table 4.3)	11,500	
No. of Lanes	8	6	4	8	
AADT	107,200	54,600	19,696	92,000	
<u>% Distribution:</u>	(from Table 4.2)	(from Table 4.2)	(from Table 4.2)	(from Table 4.2)	
Four-Tire	5.50%	3.30%	6.60%	5.50%	
Single Unit	1.80%	2.90%	1.70%	1.80%	
Combination	4.50%	12.20%	2.20%	4.50%	
<u>Truck AADT: (2-Way)</u>					
Four-Tire	5,896	1,802	1,300	5,060	14,058
Single Unit	1,930	1,583	335	1,656	5,504
Combination	4,824	6,661	433	4,140	16,059
Total	12,650	10,046	2,068	10,856	35,620
<u>Truck AADT: (1-Way)</u>					
Four-Tire	2,948	901	650	2,530	7,029
Single Unit	965	792	167	828	2,752
Combination	2,412	3,331	217	2,070	8,029
Total	6,325	5,023	1,034	5,428	17,810

4.3.2 Alternative Approaches

Chapter 6 provides additional detail on how to obtain more accurate data on external stations by conducting vehicle classification counts and origin-destination surveys at major external stations to develop external-external, external-internal and internal-external trip tables. Surveys at external stations, in which individual vehicles are stopped and asked about their origin and destination, are the preferred method for analyzing traffic at these stations. However, as stated earlier, budget limitations or other constraints may prevent the agency from conducting such surveys at all external stations. If such surveys are not possible, the agency should consider the possibility of at least conducting traffic classification counts at external stations, either manually or by using automatic classification equipment.

■ 4.4 Trip Distribution

Trip distribution is the process by which trips between traffic analysis zones, or between external stations, are connected. The output of trip distribution is a trip table in which the origins and destinations of individual trips are identified.

The quick-response procedure uses the following standard gravity model for trip distribution:

$$V_{ij} = \frac{O_i D_j F_{ij}}{\sum_{j=1}^{n} D_j F_{ij}}$$

where

V_{ij} = trips (volume) originating at analysis area i and destined to analysis area j;
O_i = total trip originating at i;
D_j = total trip destined at j;
F_{ij} = friction factor for trip interchange ij,
i = origin analysis area number, i = 1, 2, 3 . . . n;
j = destination analysis area number, j = 1, 2, 3 . . . n; and
n = number of analysis areas.

Applying the above equation for each zone pair can result in a trip table in which the total number of trips ending in a given zone differs significantly from the desired number of destinations (D_j). To address this problem, the Gravity Model can be applied in an iterative manner. After each iteration, the adjusted destination total to be used for the next iteration is calculated by the following equation:

$$D_j^q = D_j^{q-1} \bullet \frac{D_j}{C_j^{q-1}}$$

where

D_j^q =adjusted destination factor for destination analysis area (column) j, iteration q;
D_j^{q-1} =D_j when $q = 1$;
C_j^{q-1} =destination (column) total for analysis area j, resulting from the previous iteration of the gravity model;
D_j=original and desired destination total for destination analysis area (column) j, developed from trip generation;
j =destination analysis area, $j = 1, 2, \ldots n$;
n =number of analysis areas; and
q =iteration number.

For the quick response procedure involving manual calculations, it would be tedious to perform more than three iterations using the above equation, especially if the study area consists of numerous zones. The option to iterate more depends upon the level of accuracy required which is the percentage difference between the destination totals at the end of each iteration and that originally input for each analysis area. According to the NCHRP Report No. 187 - *Quick-Response Urban Travel Estimation Techniques and Transferable Parameters Users Guide*[6], a 5- to 10- percent difference is generally acceptable. However, these levels of accuracy may not be attained within three iterations. A computer program may be utilized if the planning agency wishes to achieve a certain accuracy level without manually going through multiple iterations.

Friction factors (F_{ij}) for use with the gravity model can be based on travel time or distance between analysis areas. Most state or regional planning agencies have well-developed databases describing road networks that include distances and travel times. If an assignment network is available it should be modified to represent available truck facilities and operational characteristics and used to develop the necessary input to trip distribution. For example, the planning agency should annotate roads on the network that may restrict certain classes of trucks due to height or weight, or conversely may be designated as truck routes. The agency may also add a time-value to particular segments to represent the effect of large tolls.

If a network is not available, the agency may develop trip distribution estimates based on map distances. The minimum data needed for the quick response method are distances in miles between zones. These may be derived from actual miles on the existing network or using methods identified in NCHRP Report No. 187. In addition, either map tracings using a map wheel or driven surveys with odometer may be used for distances. Distances should be calculated to and from zone centroids, using appropriate routes.

The following data sources for networks may supplement local data. (Data sources for rail and other modal networks are included in Chapter 6).

[6] Sosslau, Hassam, Carter and Wickstrom. *Quick-Response Urban Travel Estimation Techniques and Transferable Parameters Users Guide.* National Cooperative Highway Research Program Report 187. Transportation Research Board. 1978.

- The *National Highway Planning Network (NHPN)* is available through the Bureau of Transportation Statistics and is based on the U.S. Geological Survey (USGS) 1:2,000,000 digital line graphs (DLG's). The network includes number of lanes, degree of access control, and FHWA functional classification codes. It is available on disk, hard copy and CD-ROM, as well as on the Internet (see Appendix K, Part 2 for details).

- The *Highway Performance Monitoring System (HPMS) Database* includes the county designation, section ID, toll status, signage, and other identifying information for all public road mileage in the state (termed "universe data"). Principal arterials and higher road levels include the average annual daily traffic (AADT), median type, number of lanes, route number, and others. Currently the data is in ASCII format. Data can be downloaded to a disk and can be sorted or selected by county, Federal Aid Urbanized Area, State, etc. The Department of Transportation is converting the database into GIS format as part of the National Highway Planning Network for ease of use (see Appendix K, Part 2).

- The *National Commodity Flow Network* includes information on highway, railroad, waterway, aviation and pipeline networks with intermodal connections. Networks are based on 1:2,000,000 maps and are generally accurate to 1,000 meters (see Appendix K, Part 2).

In the quick response method, for the different types of commercial vehicles, the following friction factors based on travel time (t_{ij}) in minutes between analysis areas are recommended:

Four-tire commercial vehicles:

$$F_{ij} = e^{-0.08 * t_{ij}}$$

Single unit trucks (6+tires):

$$F_{ij} = e^{-0.1 * t_{ij}}$$

Combinations:

$$F_{ij} = e^{-0.03 * t_{ij}}$$

These friction factors are based on average trip times from Phoenix, with a judgmental adjustment to account for the fact that the Phoenix survey did not cover trips beginning or ending outside the MPO region.[7]

If information on external-to-external trips can be obtained from other sources (e.g., from a special survey or statewide network analysis), these trips should be treated separately from other trips in the trip distribution step. Section 8.2 of this report demonstrates how trip distribution might be carried out for an external-to-external trip table.

If separate information on external-to-external trips is not available, then it will be necessary to apply the trip distribution model to both external and internal trips. In this case, we recommend that the analyst review a map showing the location of external stations and identify all pairs of external stations that are unlikely to share trips. Usually these will be pairs of stations that are adjacent to one another or on the same side of the metropolitan area. Examples include external stations on two highways that intersect outside the metropolitan area or serve the same nearby city. The analyst should then put a very small number or zero in the friction factor matrix to greatly reduce or eliminate trips between such pairs of external stations.

In applying the gravity model to external stations, it is necessary to estimate: (1) the travel time from origin to external station for trips that begin outside the study area, and (2) the travel time from external station to destination for trips that end outside the study area. The following default values can be used if no other information is available:

- Four-tire commercial vehicles -- 40 minutes
- Single unit trucks (6+tires) -- 30 minutes
- Combinations -- 200 minutes

These default values are based on an analysis of data about the primary range of operations for trucks from the Bureau of the Census' Truck Inventory and Use Survey. While these default values may be reasonable on average, their use could considerably understate or overstate travel times for a given external station. Accordingly, the analyst is urged to examine state or regional highway maps and make judgmental adjustments if necessary.

4.4.1 Example

Assume that the origin-destination travel times for the three commercial vehicle types in the hypothetical study area are as shown in the tables below (<u>*Note*</u>: Z*i* = Origin Zone i , S*j* = External Station destination *j*, the entry Z*i* - S*j* in the table corresponds to the average

[7] Friction factors for Phoenix were adopted in this manual to be consistent with trip generation default values.

travel time from Zone *i* to anywhere outside the study area through S*j*, and the entry S*i* - Z*j* in the table corresponds to the average travel time from outside the study area to destination Zone *j* through external station S*i*) :

Travel Time (tij) Matrix for Four-Tire Trucks, in Minutes

Origin Zone (i)		Destination Zone (j)						
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4
	Z_1	10	18	24	54	60	70	75
	Z_2	18	12	18	60	55	65	68
	Z_3	24	18	12	70	62	55	55
	S_1	54	60	70	---	98	115	115
	S_2	60	55	62	98	---	105	108
	S_3	70	65	55	115	105	---	90
	S_4	75	68	55	115	108	90	---

Travel Time (tij) Matrix for Single-Unit Trucks, in Minutes

Origin Zone (i)		Destination Zone (j)						
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4
	Z_1	12	22	28	54	50	60	65
	Z_2	22	14	20	50	45	55	58
	Z_3	28	20	14	60	52	45	45
	S_1	54	50	60	---	78	95	95
	S_2	50	45	52	78	---	85	88
	S_3	60	55	45	95	85	---	70
	S_4	65	58	45	95	88	70	---

Travel Time (tij) Matrix for Combination Trucks, in Minutes

Origin Zone (i)		Destination Zone (j)						
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4
	Z_1	14	25	30	214	220	230	235
	Z_2	25	16	22	220	215	225	228
	Z_3	30	22	16	230	222	215	215
	S_1	214	220	230	---	422	438	435
	S_2	220	215	222	422	---	428	428
	S_3	230	225	215	438	428	---	413
	S_4	235	228	215	435	428	413	---

Using the formulae for friction factor given earlier, the matrix of friction factors to be used in the gravity model have been calculated as shown in the following tables:

Friction Factors (Fij) Matrix for Four-Tire Trucks

Origin Zone (i)		Destination Zone (j) Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4
	Z_1	0.4493	0.2369	0.1466	0.0133	0.0082	0.0037	0.0025
	Z_2	0.2369	0.3829	0.2369	0.0082	0.0123	0.0055	0.0043
	Z_3	0.1466	0.2369	0.3829	0.0037	0.0070	0.0123	0.0123
	S_1	0.0133	0.0082	0.0037	---	0.0004	0.0001	0.0001
	S_2	0.0082	0.0123	0.0070	0.0004	---	0.0002	0.0002
	S_3	0.0037	0.0055	0.0123	0.0001	0.0002	---	0.0007
	S_4	0.0025	0.0043	0.0123	0.0001	0.0002	0.0007	---

Friction Factors (Fij) Matrix for Single-Unit Trucks

Origin Zone (i)		Destination Zone (j) Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4
	Z_1	0.3012	0.1108	0.0608	0.0045	0.0067	0.0025	0.0015
	Z_2	0.1108	0.2466	0.1353	0.0067	0.0111	0.0041	0.0030
	Z_3	0.0608	0.1353	0.2466	0.0025	0.0055	0.0111	0.0111
	S_1	0.0045	0.0067	0.0025	---	0.0004	0.0001	0.0001
	S_2	0.0067	0.0111	0.0055	0.0004	---	0.0002	0.0002
	S_3	0.0025	0.0041	0.0111	0.0001	0.0002	---	0.0009
	S_4	0.0015	0.0030	0.0111	0.0001	0.0002	0.0009	---

Friction Factors (Fij) Matrix for Combination Trucks

Origin Zone (i)		Destination Zone (j) Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4
	Z_1	0.6570	0.4724	0.4066	0.0016	0.0014	0.0010	0.0009
	Z_2	0.4724	0.6188	0.5169	0.0014	0.0016	0.0012	0.0011
	Z_3	0.4066	0.5169	0.6188	0.0010	0.0013	0.0016	0.0016
	S_1	0.0016	0.0014	0.0010	---	0.0000	0.0000	0.0000
	S_2	0.0014	0.0016	0.0013	0.0000	---	0.0000	0.0000
	S_3	0.0010	0.0012	0.0016	0.0000	0.0000	---	0.0000
	S_4	0.0009	0.0011	0.0016	0.0000	0.0000	0.0000	---

For the four-tire truck, the gravity model is applied as follows:

1. Create an origin-destination matrix (trip table) which shows the row (origin) and column (destination) totals from the results of trip generation step for the internal zones and traffic estimates at external stations. The distribution of these trips (e.g. Vij) are still unknown. (See matrix below)

2. For each origin-destination pair, multiply the column (destination) total by the friction factor for origin-destination pair (e.g. Dj*Fij). Calculate the total for each row. For example, for Z_1, $\sum$(Dj*Fij) = (24,944*0.4493) + (29,607*0.2369) + (29,654* 0.1446) + (901*0.0082) + (650*0.0037) + (2530*0.0025) ≅ 22,626. The results are shown below:

Four-Tire Truck Trip Table

Iteration = 0

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total (Oi)	Sum(Dj*Fij)
Origin Zone (i)	Z_1	?	?	?	?	?	?	?	24,944	**22,625.56**
	Z_2	?	?	?	?	?	?	?	29,607	24,321.98
	Z_3	?	?	?	?	?	?	?	29,654	22,082.25
	S_1	?	?	?	0	?	?	?	2,948	685.74
	S_2	?	?	?	?	0	?	?	901	778.49
	S_3	?	?	?	?	?	0	?	650	622.03
	S_4	?	?	?	?	?	?	0	2,530	555.32
	Total (Dj)	24,944	29,607	29,654	2,948	901	650	2,530	91,234	

3. <u>First Iteration</u>: Distribute the row totals to each cell in the trip table by using the trip distribution formula for V_{ij} given earlier. For example, V_{12} = (24,944 * 29,607 * 0.2369) / 22625.56 ≅ 7,734. Calculate the total for each column (destination). Determine the percentage difference (% Diff.) between the column totals and the original column total. For example, the % Difference for Column 2 (Destination Z_2) is equal to [(33,177-29,607) / 29,607] * 100% ≅ 12.1%. If one or more of the % Differences exceed the threshold value (say ± 5%), adjust the destination totals using the adjustment formula discussed earlier (i.e. D_j^q).

Four-Tire Truck Trip Table

Iteration = 1

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Oi	Sum(Dj*Fij)
Origin Zone (i)	Z_1	12,357	**7,734**	4,793	43	8	3	7	24,944	22,723.50
	Z_2	7,194	13,800	8,553	30	13	4	13	29,607	23,960.30
	Z_3	4,911	9,420	15,248	15	8	11	42	29,654	22,426.45
	S_1	1,426	1,047	471	0	2	0	1	2,948	655.17
	S_2	238	421	241	1	0	0	1	901	774.10
	S_3	96	171	380	0	0	0	2	650	665.19
	S_4	282	585	1,659	1	1	2	0	2,530	546.87
	Total Dj	26,503	**33,177**	31,344	90	33	20	66		
	% Diff.	6.3%	**12.1%**	5.7%	-96.9%	-96.4%	-96.9%	-97.4%		
	Adj. Dj	23,476	**26,421**	28,055	96,126	24,908	20,716	97,603		

Note that for the first iteration (q=1), all the column totals are above the 5% threshold limits. Therefore we need to adjust the column totals. For example, for Column 2, the adjusted column total is:

$$D_2^1 = D_2^0 \bullet \frac{D_2}{C_2^0} = 29{,}607 \bullet \frac{29{,}607}{33{,}177} = 26{,}421$$

4. Second Iteration: Repeat Step 3 above, but using the adjusted column total in the trip distribution formula. Again, for V_{12}, the new value is (24,944 * 26,421 * 0.2369) / 22,724 ≅ 6,872. The results of the calculation are shown below. Note that the % Differences are all below the threshold value, which means that the no further iteration is necessary.

Four-Tire Truck Trip Table

Iteration = 2

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Oi	Sum(Dj*Fij)
Origin Zone (i)	Z_1	11,579	**6,872**	4,515	1,403	225	84	266	24,944	22,704.55
	Z_2	6,873	12,501	8,213	978	378	141	523	29,607	23,950.49
	Z_3	4,551	8,277	14,204	470	231	336	1,584	29,654	22,450.34
	S_1	1,405	978	467	0	44	9	44	2,948	654.51
	S_2	225	378	229	44	0	5	20	901	773.76
	S_3	85	142	337	9	5	0	71	650	666.39
	S_4	269	530	1,593	45	20	72	0	2,530	547.64
	Total Dj	24,987	29,678	29,558	2,949	904	648	2,509		
	% Diff.	**0.2%**	**0.2%**	**-0.3%**	**0.0%**	**0.3%**	**-0.3%**	**-0.8%**		

As stated earlier, more than two iterations may be needed in other cases to meet the level of accuracy criterion. A computer program may have to be implemented if a very accurate trip table is desired, especially if it involves many iterations. The table below shows that five iterations are needed to balance the trip table for the above example.

Four-Tire Truck Trip Table

Iteration = 5

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Oi	Sum(Dj*Fij)
Origin Zone (i)	Z_1	11,566	6,861	4,536	1,404	224	84	268	24,944	22,701.13
	Z_2	6,861	12,475	8,247	977	377	142	528	29,607	23,950.08
	Z_3	4,536	8,247	14,238	469	230	337	1,597	29,654	22,453.43
	S_1	1,404	977	469	0	44	9	45	2,948	654.41
	S_2	224	377	230	44	0	5	20	901	773.74
	S_3	84	142	337	9	5	0	72	650	666.52
	S_4	268	528	1,597	45	20	72	0	2,530	547.75
	Total Dj	24,944	29,607	29,654	2,948	901	650	2,530		
	% Diff.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		

For the single-unit trucks and combination trucks, the same procedures will be followed to distribute the trips to various origin-destination pairs. The following tables show the results of each iteration:

Single Unit Truck Trip Table

Iteration = 0

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total (Oi)	Sum(Dj*Fij)
Origin Zone (i)	Z_1	?	?	?	?	?	?	?	5,692	3,063.99
	Z_2	?	?	?	?	?	?	?	7,815	3,627.48
	Z_3	?	?	?	?	?	?	?	7,767	3,336.91
	S_1	?	?	?	0	?	?	?	965	98.02
	S_2	?	?	?	?	0	?	?	792	168.57
	S_3	?	?	?	?	?	0	?	167	133.32
	S_4	?	?	?	?	?	?	0	828	118.85
	Total (Dj)	5,692	7,815	7,767	965	792	167	828	24,026	

Single Unit Truck Trip Table

Iteration = 1

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Oi	Sum(Dj*Fij)
Origin Zone (i)	Z_1	3,185	1,609	877	8	10	1	2	5,692	3,089.45
	Z_2	1,359	4,152	2,265	14	19	1	5	7,815	3,611.32
	Z_3	806	2,462	4,458	6	10	4	21	7,767	3,369.23
	S_1	253	518	190	0	3	0	1	965	94.00
	S_2	180	408	201	2	0	0	1	792	164.73
	S_3	18	40	108	0	0	0	1	167	142.67
	S_4	60	165	601	1	1	1	0	828	112.83
	Total Dj	5,860	9,353	8,700	30	43	8	31		
	% Diff.	2.9%	19.7%	12.0%	-96.9%	-94.5%	-95.3%	-96.2%		
	Adj. Dj	5,529	6,530	6,934	30,907	14,492	3,539	21,926		

Single Unit Truck Trip Table

Iteration = 2

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Oi	Sum(Dj*Fij)
Origin Zone (i)	Z_1	3,068	1,333	777	257	180	16	61	5,692	3,091.16
	Z_2	1,326	3,485	2,031	451	348	31	144	7,815	3,609.45
	Z_3	775	2,037	3,942	177	184	91	562	7,767	3,369.91
	S_1	256	452	176	0	61	3	17	965	93.96
	S_2	179	349	184	61	0	3	16	792	164.68
	S_3	16	31	90	3	3	0	23	167	142.80
	S_4	61	145	565	17	16	24	0	828	112.81
	Total Dj	5,681	7,831	7,765	965	793	168	822		
	% Diff.	-0.2%	0.2%	0.0%	0.0%	0.2%	0.3%	-0.7%		

Combination Truck Trip Table

Iteration = 0

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total (Oi)	Sum(Dj*Fij)
Origin Zone (i)	Z_1	?	?	?	?	?	?	?	1,561	3,325.11
	Z_2	?	?	?	?	?	?	?	2,379	3,701.76
	Z_3	?	?	?	?	?	?	?	2,866	3,647.99
	S_1	?	?	?	0	?	?	?	2,412	8.68
	S_2	?	?	?	?	0	?	?	3,331	9.57
	S_3	?	?	?	?	?	0	?	217	8.91
	S_4	?	?	?	?	?	?	0	2,070	8.44
	Total (Dj)	1,561	2,379	2,866	2,412	3,331	217	2,070	14,835	

Combination Truck Trip Table

Iteration = 1

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Oi	Sum(Dj*Fij)
Origin Zone (i)	Z_1	481	528	547	2	2	0	1	1,561	4,047.04
	Z_2	474	946	952	2	3	0	1	2,379	4,338.80
	Z_3	499	966	1,393	2	3	0	3	2,866	4,160.67
	S_1	706	899	802	0	3	0	1	2,412	7.69
	S_2	739	1,309	1,278	3	0	0	2	3,331	7.75
	S_3	38	68	110	0	0	0	0	217	9.49
	S_4	332	624	1,110	1	2	0	0	2,070	7.40
	Total Dj	3,270	5,339	6,193	10	14	1	8		
	% Diff.	109.5%	124.4%	116.1%	-99.6%	-99.6%	-99.5%	-99.6%		
	Adj. Dj	745	1,060	1,326	586,755	782,233	43,714	522,948		

Combination Truck Trip Table

Iteration = 2

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Oi	Sum(Dj*Fij)
Origin Zone (i)	Z_1	189	193	208	369	410	17	175	1,561	4,066.69
	Z_2	193	360	376	438	678	28	307	2,379	4,362.02
	Z_3	209	377	565	407	690	48	569	2,866	4,175.37
	S_1	381	452	419	0	779	27	353	2,412	7.70
	S_2	435	720	730	800	0	50	596	3,331	7.67
	S_3	17	28	48	26	47	0	50	217	9.51
	S_4	181	318	587	353	581	51	0	2,070	7.40
	Total Dj	1,605	2,448	2,933	2,393	3,186	220	2,049		
	% Diff.	2.8%	2.9%	2.3%	-0.8%	-4.3%	1.7%	-1.0%		

4.4.2 Alternative Approaches

As stated above, instead of travel time, distance can be used to calculate a friction factor in the gravity model for trip distribution. Friction factors based on travel time can be easily converted to friction factors based on distance by assuming average truck speeds (i.e. Travel Time = Distance/Speed). In addition, the ideal trip distribution procedure will require several iterations in order to not only balance the row and column totals but also to come up with the original (target) column totals. Note that in the quick response method and the example given in this manual, no more than three manual iterations were carried out and the final column totals are not necessarily identical to the original numbers (i.e., within ± 5% of the original, which was the criterion used). A computer program may be implemented to allow numerous iterations of the gravity model and come up with a balanced trip table (i.e., row totals equal column totals).

The literature on freight demand forecasting contains a variety of alternative approaches for distributing commercial vehicle trips into the origin-destination trip table. Apart from the gravity model (which is probably the most popular), commercial vehicle trips can be distributed into the origin-destination matrix using: (1) the *Intervening Opportunity Model* which assumes that the trip interchange between origin and destination zone is equal to the total number of trips emanating from the origin multiplied by the probability that each trip will find an acceptable terminus at the destination zone, and (2) the *Fratar Model* which assumes that the change in the number of trips in an origin-destination pair is directly proportional to the change in the number of trips in the origin and destination.

The following describes some of the methodologies found in literature:

- The trip distribution methodology adopted for freight movements in the *Puget Sound Region*[8] is also a simple gravity-type model. Trip distribution involves the allocation of the trips generated to the destinations using an algorithm which incorporates transportation performance measures. These measures include distance, travel time, travel cost, or some function of these variables.

- Trip distribution for the Portland's *Columbia Corridor Transportation Study*[9] involves the creation of a regional distribution based upon the Port of Portland survey of origins and destinations of trucks for two terminals. Information gathered from the survey includes truck type, time, origin, route taken to the terminal, commodity delivered, exiting destination, route taken from the terminal, and commodity received. A trip table was produced, approximating truck movements to and from the 38 industrial area origin-destination districts, by applying the percentage distribution of trips derived from one of the terminal

[8] Transmode Consultants, Inc. *Planning for Freight Movements in the Puget Sound Region*. Puget Sound Regional Council. January 1995.

[9] City of Portland, Office of Transportation. *Columbia Corridor Transportation Study*. Technical Report 2: Truck Routing Model. April 1994.

surveys to the commercial vehicle trip control totals. The "gradient method" was used to modify the trip table until the estimated truck volumes closely approximated the observed truck counts.

- List and Turnquist[10] developed a new technique for estimating multi-class truck trip matrices for truck flows in urban areas which allow for wide variations in input data. The methodology assumes that the links in the analysis network consist of at least three attributes: (1) a "directional flag" (i.e., $i \rightarrow j$, $j \rightarrow i$, or both), (2) a use label (e.g. truck class), and (3) a travel time which may vary according to the time of day. In addition, the methodology assumes that the study area is divisible into non-overlapping zones and each zone must have a centroid where trips originate and terminate. The input data are of three types namely: (1) link volumes or classification counts, (2) partial O-D estimates for various zones, time periods, and truck classifications, and (3) originating/terminating data. Nine O-D matrices were estimated from three time periods (6:00-10:00 A.M., 10:00 A.M.-3:00 P.M., and 3:00-8:00 P.M.) and three truck classifications (van, medium truck, and heavy truck). A case study analysis focusing on the Bronx in New York City was conducted to test the procedures.

- Memmott and Boekenkroeger[11] discussed the development of freight flow tables for a freight generation and distribution growth factor model in Florida. Four sets of truck freight O-D tables were produced indicating the volume of freight shipped between each origin and destination zone by mode of transportation and commodity group. The four O-D tables were: (1) true O-D truck freight volumes (not including ports), (2) truck freight volumes to ports, (3) truck freight volumes from ports, and (4) total truck freight volumes. Due to the long and complicated process involved in developing the various O-D freight flow tables, its use is not suitable for a quick response method. A full description of the procedures can be found in two reports prepared for the Florida Statewide Multi-Modal Planning Process Project.

- The *Chicago Area Transportation Study (CATS)*[12] planning and modeling procedures distribute truck trips in the region based on employment distribution. Using the 1986 survey data for average trip lengths and the regional highway network, O-D trip matrices were developed for each of the vehicle weight categories. The O-D matrices were then converted into vehicle equivalents by weight category, and subsequently combined. The combined

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[10] List and Turnquist.. *Estimating Truck Travel Patterns In Urban Areas.* Transportation Research Record No. 1430. 1994.

[11] Memmott and Boekenbroeger. *Practical Methodology for Freight Forecasting.* Transportation Research Record No. 889.

[12] Rawling and DuBoe. *Application of Discrete Commercial Vehicle Data to CATS' Planning and Modeling Procedures.* CATS Research News. Spring 1991.

trip table matrix is added to the O-D matrix for autos and the O-D matrix for external truck trips.

■ 4.5 Calibration

Calibration is the process through which travel forecasting models are adjusted to achieve a better match with ground counts and perhaps other measures of travel. Use of ground counts on screenlines or cutlines is the preferred method for calibration. Unfortunately, many planning agencies do not have counts of commercial vehicles on screenlines or cutlines. Accordingly, a coarser approach is adopted in the quick response procedure -- calibration based on an estimate of regional VMT by commercial vehicles. However, if study resources permit, the analyst is strongly urged to obtain or collect commercial vehicle count data for major links within the study area, and to compare these counts with assigned volumes (see Chapter 6). FHWA's *Calibration and Adjustment of System Planning Models*[13] is recommended as an excellent guide on how to use a comparison of ground counts with assigned volumes to diagnose and correct problems in highway system planning models.

In the quick-response procedure, calibration is performed for the three commercial vehicle classes as follows (corresponding to Step 5 through Step 7 in Figure 4.1):

- Develop a preliminary estimate of commercial vehicle VMT by assigning trips to a network or using a table of zone-to-zone distances (*Step 5*) ,

- Develop control totals for commercial VMT based upon: (1) estimates of total VMT in the region for each highway functional class, and (2) vehicle classification data indicating the percentage of total VMT associated with commercial vehicles, i.e. Table 4.2 (*Step 6*),

- Compare the preliminary estimate of commercial vehicle VMT with the control totals and, if necessary, develop and apply adjustment factors to trip generation rates or trip distribution factors (*Step 7*).

Initial estimates of commercial VMT can be calculated by multiplying the numbers in the trip distribution O-D matrix by the zone-to-zone distances. Alternatively, if a preliminary network assignment has been made the VMT can be calculated by multiplying the number of trips assigned to a highway segment by the length of the segment.

Establishing control totals for VMT requires at a minimum an estimate of total VMT in the region by functional class. If available, truck volumes across screenlines would be desirable. Agencies are advised to begin with the state HPMS AADT and EPA-recommended methodologies. Many regions are currently required to estimate regional

[13] Dane Ismart; *Calibration and Adjustment of System Planning Models*; Federal Highway Administration Publication No. FHWA-ED-90-015; December 1990.

VMT for air quality conformity purposes. The recommended method relies on HPMS data collection counts. Areawide HPMS data includes travel by functional system and travel activity by vehicle type. HPMS AADT counts are available for all principal arterials and higher road designations.

Control totals for regional VMT can be determined from HPMS collected data using the methodology described in the EPA publication *Section 187 VMT Forecasting and Tracking Guidance*. The guide includes tiers of procedures based on air quality status. Regions that are not currently required to report current VMT for air quality purposes may wish to apply the least stringent methodologies. The guidance also includes procedures for forecasting VMT.

Control VMT for commercial vehicles can also be estimated using the national average percentage distribution of traffic by vehicle class as shown in Table 4.2. Again, these percentages represent the vehicle type in each highway functional classification as a percentage of annual vehicle miles traveled for the entire country.

Several different types of adjustments can be made as part of the calibration process including:

- Increasing or decreasing the commercial vehicle trip generation rates for traffic analysis zones,
- Increasing or decreasing the commercial vehicle volume estimates at external stations, and
- Modifying the travel time friction factors (by changing the exponents) to increase or decrease average trip lengths.

The simplest approach, and the one recommended for the quick response method, is to develop three adjustment factors -- one for each of the three commercial vehicle classes -- and apply these factors to both trip rates for traffic analysis zones and volumes at external stations. This approach eliminates the need to redo the trip distribution step.

4.5.1 Example

Suppose the zone-to-zone distances (in miles) for the hypothetical study area are as shown in the table below:

Zone-to-Zone Distance (miles)

		Destination Zone (j)						
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4
Origin Zone (i)	Z_1	5.0	9.0	12.0	7.0	10.0	15.0	17.5
	Z_2	9.0	6.0	9.0	10.0	7.5	12.5	14.0
	Z_3	12.0	9.0	6.0	15.0	11.0	7.5	7.5
	S_1	7.0	10.0	15.0	0.0	9.0	17.5	17.5
	S_2	10.0	7.5	11.0	9.0	0.0	12.5	14.0
	S_3	15.0	12.5	7.5	17.5	12.5	0.0	5.0
	S_4	17.5	14.0	7.5	17.5	14.0	5.0	0.0

Initial estimates of daily VMT for each commercial vehicle type are determined by multiplying the trip tables from the trip distribution step by the table of zone-to-zone distance shown above. For example, the daily VMT for four-tire trucks originating in zone Z_1 and destined to Z_2 is: 6,872*9 = 61,848. The resulting daily VMT estimates for all three vehicle types are given below:

Estimated Daily VMT

Four-Tire Truck

		Destination Zone (j)							
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Origin Zone (i)	Z_1	57,895	**61,848**	54,180	9,821	2,250	1,260	4,655	191,909
	Z_2	61,857	75,006	73,917	9,780	2,835	1,763	7,322	232,480
	Z_3	54,612	74,493	85,224	7,050	2,541	2,520	11,880	238,320
	S_1	9,835	9,780	7,005	0	396	158	770	27,944
	S_2	2,250	2,835	2,519	396	0	63	280	8,343
	S_3	1,275	1,775	2,528	158	63	0	355	6,153
	S_4	4,708	7,420	11,948	788	280	360	0	25,503
	Total	192,432	233,157	237,320	27,992	8,365	6,123	25,262	730,650

Estimate of Daily VMT

Single-Unit Truck

		Destination Zone (j)							
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Origin Zone (i)	Z_1	15,340	11,997	9,324	1,799	1,800	240	1,068	41,568
	Z_2	11,934	20,910	18,279	4,510	2,610	388	2,016	60,647
	Z_3	9,300	18,333	23,652	2,655	2,024	683	4,215	60,862
	S_1	1,792	4,520	2,640	0	549	53	298	9,851
	S_2	1,790	2,618	2,024	549	0	38	224	7,242
	S_3	240	388	675	53	38	0	115	1,508
	S_4	1,068	2,030	4,238	298	224	120	0	7,977
	Total	41,464	60,795	60,832	9,863	7,245	1,520	7,935	189,653

Estimate of Daily VMT

Combination Truck

Destination Zone (j)

Origin Zone (i)

	Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Z_1	945	1,737	2,496	2,583	4,100	255	3,063	15,179
Z_2	1,737	2,160	3,384	4,380	5,085	350	4,298	21,394
Z_3	2,508	3,393	3,390	6,105	7,590	360	4,268	27,614
S_1	2,667	4,520	6,285	0	7,011	473	6,178	27,133
S_2	4,350	5,400	8,030	7,200	0	625	8,344	33,949
S_3	255	350	360	455	588	0	250	2,258
S_4	3,168	4,452	4,403	6,178	8,134	255	0	26,589
Total	15,630	22,012	28,348	26,901	32,508	2,318	26,400	154,114

Assume that based on regional studies the total daily passenger VMT for the study area is approximately 10 million; and about 95% of the passenger VMT in the region is in urban areas, while the remaining 5% is in rural areas. Likewise, assume that no breakdown of roads by functional classification is available.

From the above information, the daily control VMT for each type of commercial vehicle can be calculated using the percent traffic distribution given in Table 4.2. Since no highway functional classification is available, the average rural and urban percentages from Table 4.2 are used as follows:

Control VMT for Four-Tire Truck:

$$= 10,000,000 * [\ (0.05*4.7/86.6) + (0.95*6.2/89.8)\ ]$$

$$= 683,038$$

Control VMT for Single-Unit Truck:

$$= 10,000,000 * [\ (0.05*3.4/86.6) + (0.95*1.7/89.8)\ ]$$

$$= 199,475$$

Control VMT for Combination Truck:

$$= 10,000,000 * [\ (0.05*5.3/86.6) + (0.95*2.3/89.8)\ ]$$

$$= 273,919$$

For each trip table, the estimated daily VMT is adjusted using the ratio of the control VMT (calculated above) and the estimated total VMT. For example, the adjustment factor for four-tire truck is equal to 683,038 / 730,650 ≅ 0.935. The adjusted trip tables are shown below:

Adjusted Daily VMT

Four-Tire Truck

Destination Zone (j)

Origin Zone (i)

	Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Z_1	54,122	57,818	50,649	9,181	2,103	1,178	4,352	179,404
Z_2	57,826	70,118	69,100	9,143	2,650	1,648	6,845	217,330
Z_3	51,053	69,639	79,671	6,591	2,375	2,356	11,106	222,790
S_1	9,194	9,143	6,549	0	370	147	720	26,123
S_2	2,103	2,650	2,355	370	0	58	262	7,799
S_3	1,192	1,659	2,363	147	58	0	332	5,752
S_4	4,401	6,936	11,169	736	262	337	0	23,841
Total	179,892	217,964	221,855	26,168	7,819	5,724	23,616	683,038

Adjusted Daily VMT

Single-Unit Truck

Destination Zone (j)

Origin Zone (i)

	Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Z_1	16,134	12,618	9,807	1,892	1,893	252	1,123	43,720
Z_2	12,552	21,993	19,226	4,744	2,745	408	2,120	63,788
Z_3	9,782	19,283	24,877	2,793	2,129	718	4,433	64,014
S_1	1,885	4,754	2,777	0	577	55	313	10,361
S_2	1,883	2,753	2,129	577	0	39	236	7,617
S_3	252	408	710	55	39	0	121	1,586
S_4	1,123	2,135	4,457	313	236	126	0	8,390
Total	43,611	63,944	63,982	10,374	7,620	1,599	8,346	199,475

Adjusted Daily VMT

Combination Truck

Destination Zone (j)

Origin Zone (i)

	Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Z_1	1,680	3,087	4,436	4,591	7,287	453	5,443	26,978
Z_2	3,087	3,839	6,015	7,785	9,038	622	7,639	38,025
Z_3	4,458	6,031	6,025	10,851	13,490	640	7,585	49,080
S_1	4,740	8,034	11,171	0	12,461	840	10,980	48,226
S_2	7,732	9,598	14,272	12,797	0	1,111	14,830	60,340
S_3	453	622	640	809	1,044	0	444	4,012
S_4	5,630	7,913	7,825	10,980	14,457	453	0	47,258
Total	27,780	39,124	50,384	47,812	57,778	4,119	46,922	273,919

Adjusted Daily VMT

All Commercial Vehicles

Destination Zone (j)

Origin Zone (i)

	Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Z_1	71,936	73,523	64,893	15,664	11,284	1,884	10,918	250,102
Z_2	73,466	95,950	94,341	21,671	14,433	2,677	16,604	319,143
Z_3	65,293	94,952	110,573	20,234	17,995	3,713	23,124	335,884
S_1	15,819	21,931	20,496	0	13,409	1,042	12,012	84,709
S_2	11,718	15,001	18,756	13,745	0	1,209	15,328	75,756
S_3	1,898	2,689	3,713	1,011	1,142	0	897	11,350
S_4	11,153	16,985	23,451	12,029	14,955	916	0	79,488
Total	251,283	321,031	336,222	84,354	73,217	11,441	78,884	1,156,432

Note that the calibration procedure using control VMT's are not only meaningful for adjusting base-year commercial vehicle trip tables. The adjustment factors can also be used to calibrate estimates of future commercial vehicle trip volumes and VMT's for which no control VMT is available to check against. For example, if trip tables corresponding to future freight travel demands are estimated, the volumes in these tables can be adjusted using the adjustment factor (i.e. dividing the future forecasts by the adjustment factor) determined for the base year, assuming that the ratio between estimated VMT and control VMT remains constant over time.

4.5.2 Alternative Approaches

Variations of the calibration procedures discussed above have been applied in literature and other freight modeling studies, as described below:

- For the *Columbia Corridor Transportation Study*[14] the method involves a linear regression between observed counts and model volumes.

- The paper *Truck Travel in the San Francisco Bay Area*[15] includes a discussion of how daily and afternoon peak hour trip tables were created for two-axle, three-axle, and four or more axle truck trips. The trip tables were assigned to the Bay Area highway network. From these assignments, the estimated vehicle-miles traveled (VMT) and percent Root Mean Square Error (RMSE) were calculated. Percent RMSE represents the variation between observed and estimated data that is expected to occur approximately 68 percent of the time. The truck

[14] See Footnote 9.

[15] Schlappi, Marshall, and Itamura. *Truck Travel in the San Francisco Bay Area*. TRB 72nd Annual Meeting, Paper No. 930477. January 1993.

forecast seemed reasonable when examined both by county subareas and on a link by link basis.

- In the Phoenix report titled *Development of an Urban Truck Travel Model for the Phoenix Metropolitan Area*[16] calibration involved the use of the 1988 modeling process (internal truck generation and distribution models) to perform the final adjustments required to match current vehicle-miles of travel (VMT) to the vehicle trip modeling system. A regionwide factor of 1.38 was applied to the results of the trip generation and distribution models. The 38% adjustment factor represents the effects of:

  ◊ The expansion of truck vehicle trips to the equivalent number of two-axle counts;

  ◊ The adjustment of the estimated internal truck travel with the actual internal truck travel; and

  ◊ The expansion of internal truck travel to compensate for any under-reporting in the latest travel survey or under-estimation in the updated non-truck Phoenix models.

  The calibration process for the new models consists of two steps, namely:

  1. Expanding the commercial vehicle trips by weight class to account for the average number of axles per vehicle in each class; and

  2. Expanding total commercial vehicle trips so that total estimated and observed VMT in the Phoenix region are equal. This expansion factor represents the new effect of internal trips by all commercial vehicles versus those by vehicles registered in Maricopa County, and of any under-reporting or under-estimation in any of the Phoenix models which affect the number of truck and non-truck vehicle trips.

- The report titled *Truck Trip Generation Rates by Land Use in the Central Artery/Tunnel (CA/T) Project Study Area*[17] addresses validation of daily truck trip arrivals. The geographic distribution of calculated daily light, medium, and heavy truck trip arrivals was consistent with observed vehicle classification counts on study area streets and arterials. Classification counts on neighborhood streets indicate miles of truck travel more accurately than truck trip ends. More accuracy has been obtained by establishing a cordon line within the study area, correcting for truck trips that pass through without stopping or those traveling entirely within the cordon, and comparing one-half of the number of crossing to the estimated arrivals into the cordoned zones.

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[16] See Footnote 1.

[17] Nixon, Tom (Central Transportation Planning Staff - Boston). *Truck Trip Generation Rates by Land Use in the Central Artery/Tunnel Project Study Area*. September 1993.

4.6 Traffic Assignment

The calibrated commercial vehicle trip tables can be assigned to a network along with personal vehicle trip tables to produce estimates of total traffic on network links. There are, however, some special considerations that may affect the assignment of commercial vehicle trips including:

- Heavy vehicles typically have more impact on congestion than automobiles on a per VMT basis; and

- On some highways, trucks are not permitted.

The *Highway Capacity Manual*[18] provides "passenger car equivalence" (PCE) factors that can be used to quantify the relative impact of different types of vehicles on congestion. For example, a PCE value of 2.0 indicates that the vehicle in question has the same effect on congestion as 2.0 passenger cars. Specifically, the HCM recommends a PCE value of 1.5 for trucks and buses on level terrain[19], with trucks defined as commercial vehicles with six or more tires.

Hence, to reflect the effect of heavier vehicles on congestion, the trip tables for single unit trucks with six or more tires and combinations can be multiplied by 1.5 and 2.0, respectively, before being assigned to the network. The resulting assignment volumes will then be expressed in PCEs, not number of vehicles. This refinement is appropriate if heavy vehicles are expected to account for a significant portion of traffic (e.g., more than 10 percent) on key links. No adjustments to PCE values are needed for four-tire commercial vehicles, since these vehicles are generally similar to passenger cars in terms of acceleration and deceleration capabilities.

If trucks are prohibited from using key network links, the analyst should consider conducting separate traffic assignments for the prohibited vehicles if it is not possible to code and enforce truck prohibitions in the basic network description. Usually, four tire commercial vehicles such as pickup trucks and vans are not considered to be trucks for the purpose of enforcing truck bans, so that such vehicles would be combined with passenger cars in the assignment process.

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[18] Transportation Research Board; *Highway Capacity Manual*; Special Report 209; updated October 1994.

[19] Level terrain is any combination of grades and horizontal or vertical alignment that permits heavy vehicles to maintain the same speed as passenger cars; this generally includes short grades of no more than 2 percent. The HCM defines rolling terrain as any combination of grades and horizontal or vertical alignment that causes heavy vehicles to reduce their speeds substantially below those of passenger cars but that does not cause them to operate at crawl speeds for any significant length of time. The HCM recommends a PCE value of 3.0 for trucks and buses on rolling terrain. The HCM defines mountainous terrain as that which causes heavy vehicles to operate at crawl speeds for significant distances or frequent intervals, and recommends a PCE value of 6.0 for trucks and buses on mountainous terrain.

An example of traffic assignment for the hypothetical study area is provided in Chapter 5, Site Analysis.

■ 4.7 Time-of-Day Characteristics

Analysts may need to know the temporal distribution of travel by commercial vehicles for several reasons, including:

- To conduct separate traffic assignments for different time periods (e.g., peak and off-peak assignments),
- To calculate peak hour or design hour volumes on a link, based on the assignment of daily traffic to that link, and
- To conduct environmental analyses that are based on hourly traffic distributions (e.g., there are one-hour and eight-hour standards for carbon monoxide)

Table 4-4 shows typical temporal distributions for commercial vehicle traffic in urban areas. These distributions are based on unpublished traffic data collected by State DOTs and compiled by FHWA.

Table 4-4. Temporal Distribution of Commercial Vehicle Traffic in Urban Areas

Hour		Commercial Vehicles		
From	To	Four-Tire Trucks	Single Units (6+ tires)	Combinations
12	1	0.7%	0.7%	2.3%
1	2	0.4%	0.6%	1.8%
2	3	0.4%	0.6%	1.5%
3	4	0.4%	0.5%	1.7%
4	5	0.6%	1.1%	2.3%
5	6	2.0%	3.0%	3.7%
6	7	6.9%	5.0%	4.3%
7	8	6.6%	7.3%	6.0%
8	9	6.4%	7.2%	5.1%
9	10	5.2%	7.8%	7.1%
10	11	5.7%	7.0%	6.3%
11	12	5.4%	7.5%	6.8%
12	1	5.5%	6.8%	6.9%
1	2	5.8%	7.1%	6.3%
2	3	6.4%	7.7%	6.2%
3	4	7.8%	7.7%	5.3%
4	5	8.6%	6.6%	5.1%
5	6	7.1%	5.1%	4.0%
6	7	5.8%	3.5%	3.9%
7	8	3.3%	2.4%	3.0%
8	9	2.9%	1.6%	2.9%
9	10	2.6%	1.3%	2.6%
10	11	2.0%	1.0%	2.5%
11	12	1.3%	1.0%	2.3%
Total		100.0%	100.0%	100.0%

The temporal distribution of commercial vehicles differs considerably from that of passenger vehicles, with the latter showing much more pronounced morning and afternoon peaks due to travel to and from work.

5.0 Site Analysis

5.0 Site Analysis

5.1 Overview

Transportation planners and analysts in local/municipal agencies are often interested in predicting the impacts of new facilities, commercial developments and other types of establishments on the volume and spatial distribution of freight traffic in their respective jurisdictions. The purpose of site analysis is to estimate, within an acceptable level of accuracy, the number of new commercial trips generated by a new or planned facility and determine whether or not the existing network of primary highways, local roads, municipal streets and other transportation facilities can sufficiently handle the projected traffic demands. Thus, in addition to number of new trips, the analyst is also concerned about which routes these new trips will take and at what time periods during the day. The generic term "facility" is used in this chapter to refer to any site location where some type of economic activity is carried out.

Site analysis is appropriate only for planned facilities that have significant impacts on freight traffic including strip malls, industrial factories or plants, major retail stores and special trip generators such as intermodal transfer facilities.

While site analysis can be applied to both existing and planned facilities, usually the procedures for analyzing existing sites involve simple traffic counts and observing where and when these counts are taken. This chapter focuses on the relatively more complicated analysis of planned sites, in which the following steps are involved:

1. Obtain relevant land use and economic activity data pertaining to the facility from the owner, developer, designer or constructor.

2. Identify the network of highways, roads, streets and other transportation facilities in the immediate vicinity of the site which will serve the traffic generated by the facility.

3. Predict the number of freight trips (by mode) that will be generated by the facility based upon the information gathered from Steps 1 and 2. These trips include those going into as well as those coming out of the site.

4. Determine the origins and destinations of the new trips. These include short-haul (i.e. nearby or adjacent) as well as long-haul (remote) origins and destinations.

5. Assign the trips to the adjacent highways and transportation facilities based upon the characteristics of the network and knowledge of trip origins and destinations.

6. Determine the changes in level of service of the transportation facilities as a result of the new trips.

This manual focuses on commercial vehicles. However, there are also changes in passenger vehicle demands that would result from the new facility. In estimating the changes in traffic volumes and levels of service on the transportation network, the total freight and passenger trips attributed to the site should be calculated.

The following sections describe in detail the steps involved in site analysis, including additional information on how data collection and trip generation estimation may be conducted for major intermodal terminals and special trip generators. An example of site analysis in Green Bay, Wisconsin is presented in Chapter 9, Section 9.3.

■ 5.2 Data Gathering

Site analysis normally begins with data gathering in which all information pertaining to the proposed facility that is relevant to the analysis is assembled. This information can be obtained from various sources including the developer, designer, owner, contractor or the local/municipal/city engineer's office which issues construction permits and approves plans and specifications. Data gathering for site analysis includes but is not limited to the following:

- Company/Owner name and address;
- Type of facility to be operated in site (e.g. retail, industrial, manufacturing, warehousing, etc.) and the activities involved;
- Size of the facility in terms of land area, floor area, number of employees;
- Type of commodities, products or services produced and consumed;
- Anticipated volume of shipments and receipts expressed in either weight, volume, dollar value or other freight units;
- Type of vehicles or carriers to be used for transportation as well as the company or agency who will be responsible for shipping;
- Locations of markets for commodities and services produced (e.g. local, intercity, out-of-state, international, etc.);
- Locations of markets for materials, commodities or services used (e.g. local, intercity, out-of-state, international, etc.);
- Locations of intermediate facilities (i.e. warehouses, consolidation points, etc.) which will serve the new facility.

- Frequency and timing (schedule) of shipping operations.

While basic information such as owner/company name, size of facility and type of activity can be determined mostly from available documents, the more detailed data may only be obtained by conducting interviews or surveys with the appropriate individuals. These include questions relating to the type and volume of commodities used and produced, the locations of origins and destinations of the shipments, and the schedules.

An interview with the potential shippers and receivers may also be necessary to obtain some of the information listed above.

■ 5.3 Network Identification

All transportation facilities surrounding the site need to be identified prior to conducting freight traffic analysis. These facilities include all types of roads (i.e. primary, arterial, suburban streets, etc.), transportation terminals, railroad tracks, waterways and airports. The types of mode available for freight transport in the area around the site and their level-of-service characteristics have a substantial influence on the choices made by shippers and carriers for the planned facility (see Chapter 2 - Factors Affecting Freight Demand).

Maps of the general area showing streets, railroads and other transportation features in relation to the site not only help identify what options are available for freight transport but also help establish the relationships among these options. For example, the presence of a nearby railroad terminal may make it more attractive for the new facility to ship its products and commodities by rail instead of other alternative modes such as highway. In reality, other modal service attributes (e.g. cost), and site-specific characteristics such as those identified in Section 5.2 (Data Gathering), will influence this decision.

In identifying the network of transportation facilities, all their existing physical and operational characteristics have to be described including size, capacity, traffic volumes, geometry, speed limits and any other restrictions on use or access (e.g. truck size and weight limits). The characteristics of the traffic which the facilities serve may also be relevant to the analysis.

Sources of transportation network and traffic data include the Design and Traffic Divisions of City or Local Governments, Departments of Transportation, Metropolitan Planning Organizations and other planning agencies.

■ 5.4 Trip Generation

Predicting the number of freight trips (by mode) generated by a new facility uses much of the information described above. In Chapter 4, Section 4.2, we described a simple and direct procedure for estimating commercial vehicle (truck) trips using trip generation rates per employee and household. The rates for four different land use/employment categories were derived from Phoenix data and recommended for use in trip estimation.

However, unlike the aggregate planning problem presented in Chapter 4, detailed site analysis requires a more accurate estimate of the number of trips generated. These estimates should ideally be based on the comprehensive knowledge of the characteristics of the planned facility, including but not limited to the number of employees and households. More precise traffic projections can be inferred from such additional information as type, weight and volume of commodities produced and consumed, the sizes and capacities of vehicles, modes and carriers that are available, the frequency and scheduling of shipments, the storage and handling operations, and other factors that influence the total demand for freight transportation by the facility.

The volume of freight movement is closely associated with commodity classifications and land use. Volume is generally expressed in tons and ton-miles, or in truck load equivalents (TLE's). The specific cubic space occupied by a particular commodity may impact the number of truckloads required to move a given measure of that product. Manufacturing plants are destinations for raw materials or parts, and origins for finished goods or parts that will move elsewhere, perhaps across the county or across the country. A grocery store warehouse is likely to receive goods from near and far, but will then distribute them to local stores in a regular "daisy chain" type pattern.

The analyst should explore these and the many other types of relationships between anticipated freight traffic and the site/facility characteristics. For example, Appendix D contains tables of trip generation rates for various types of commercial vehicles in different locations. The tables also identify the specific land use/SIC code for which the rates can be used. In addition to the total number of employees, the total floor/building area or total land area of the facility can be used to predict the trips in case the number of employees is unknown or deemed inappropriate for trip prediction.

A combination of different land uses and other factors affecting freight demand can also be used to more accurately estimate freight trips by mode. Some regression equations, such as those included in Appendix D for truck trips, predict daily freight trips as a function of land use category, number of employees, building/floor area and total area.

In addition to the total number of new trips, the analyst may also be interested in the distribution of these trips on a given day, week, or even month. These temporal characteristics are important in determining the impacts of the new traffic on the peaking patterns around the site.

Using site-specific trip generation rates, regression equations or other methods can significantly improve the forecasts of the demands for freight transportation due to the new facility. Aside from the information on trip generation provided in Chapter 4 and Appendix D (which only pertain to trucks and commercial vehicles), the analyst can utilize a variety of local, statewide and national data sources or organizations which deal with the impacts of new facilities on freight traffic for different modes. Appendix F through M contain a listing of these sources.

In the case of special trip generators such as intermodal terminals, trip generation estimates can be obtained through direct contacts with a limited number of firms and with specific limited questions, in particular if the planning agency has been building contacts with the freight community over a period of time. Actual trip generation data can generally be obtained through direct contacts, observation, or surveys. If not, the default values found in Appendix D may be applied. The following describes types of data that may be sought for different modes.

Highway

Average daily truck activity per site, by truck classification- inbound and outbound. This may require a visual classification count, depending on the size and importance of the facility, however, in many cases the fleet manager of the planned facility will be able to provide accurate estimates.

Water

For ports, loadings and unloadings will likely be provided in twenty foot equivalent units (TEUs), or forty foot equivalent units (FEUs). Maritime data sources such as the *Port Facilities Inventory* provide extensive data on over 4,000 major river and ocean ports, including location, cargo handling capacity, and physical characteristics. Maritime data sources such as *U.S. Waterborne Exports and Outbound Intransit Shipments* and the converse for imports include shipping weight and value by port, and the percentage of containerized cargo. *Tonnage for Selected United States Ports* includes tons handled - total, domestic and foreign. (See Appendix K-4d).

Tonnage into or out of a port facility will require an additional analysis step to distinguish between rail and truck movements. One method is to calculate total tons, convert to truck load equivalents, identify total rail tons in or out of the port (see below), and subtract rail tons from port tons. Several commercial firms provide "value-added" services to databases such as the above, to decrease the need for user manipulation and increase the utility. (See Appendix K - 3b).

Rail

The primary rail data source related to trip generation is the *Carload Waybill Sample*. The public use version of the sample is aggregated to the BEA-to-BEA level. (There are 173 Bureau of Economic Analysis regions in the country). However, state agencies may access the confidential information, that contains extensive rail shipment data. Data include origin and destination points, number of cars, tons, length of haul, participating railroads and interchange locations. (See Appendix K-4c).

Air

The *Airport Activity Statistics of Certificated Route Air Carriers* publication presents detailed data on freight express and mail traffic carried for each airport and individual airline. *The Air and Expedited Motor Carriers Network Guide* and the *Express Carriers Association Service Directory*, both produced by the Film, Air and Package Carriers Conference, include operational information on AEMCC members by airport code. (See Appendix K-4a).

If actual trip generation data cannot be obtained through primary surveys or secondary data sources, the default values in Table 5.1 may be applied to either firm or employee data. Caution should be used, as the values are based on a single study of truck trip rates for air cargo operations at JFK International Airport.

Table 5.1 - Trip Generation Rates for Air Cargo Operations

Type of Firm	No. of Firms	Number of Workers per Firm	Truck/Van Trips per Day per Firm	Truck/Van Trips per Day per Employee
Courier	3	35	26	0.75
Forwarder	9	39	27	0.67
Broker	5	20	22	0.91
Trucking	1	20	25	0.50
Total/Average	18	33	25	0.73

Source: *Characteristics of Urban Freight Systems*, Table 57; original source *Transportation Issues Survey Summary,* furnished by New York Metropolitan Transportation Council.

Other Modes

The specialized database section (Appendix K-4) also includes data sources for pipelines, coal movements, military transportation, Mexican and Canadian trade, imports and exports, and other topics. State or regional planning agencies with even more specialized needs may refer to the *Directory of Transportation Data Sources*, *TruckSource*, or commercial sources.

5.5 Trip Distribution

The estimated freight trips generated by the planned facility may have origins and destinations at several different locations. Depending upon the characteristics of the facility and the types of products and shipments involved, the freight trips can range from very short-distance local trips to long-haul (interstate) and even international trips. Origins and destinations of trips have considerable influence on the modes used and routes taken.

The following classifications of origin-destination trips can be used in site analysis :

1. **Long haul -** Trips into or out of the site with origins or destinations more than 250 miles away from it. These trips usually carry many of the inputs used in both manufacturing and wholesale distribution operations. Long-haul trucks are usually large and compete with rail and water. These trips may also include linkages to ports (particularly container traffic).

2. **Short haul (interstate or interregional)** - Moving within about a 250-mile radius of the site. Example of these trips are delivery movements from a wholesale distribution warehouse to outlying retail establishments.

3. **Local trips** - Essentially short-distance local delivery operations. This type of traffic includes small shipments from wholesale distribution centers to retail stores or to local manufacturers. It also includes drayage, which is the short-range transfer of cargo to or from rail or port facilities to manufacturing or distribution facilities. Large trucks are frequently used for drayage.

The origins and destinations of trips that end in the planned facility may be established based upon the types of materials, raw products, goods and commodities that are used or produced by the facility. For example, a major auto dealer will most likely have freight trips that originate from auto assembly plants or factories. Similarly, a dairy plant will generate trips that include distribution to grocery and retail stores.

Knowledge of trip origins and destinations for the site allows the trips predicted in Section 5.4 to be assigned to various elements of the transportation network identified in Section 5.3.

5.6 Trip Assignment

Trip assignment relies essentially on all pieces of information derived and developed from data gathering, network identification, trip generation and trip distribution. Trip assignment is the penultimate step in site analysis -- one which involves the 'loading' of predicted freight trips, by mode and origin/destination, to the transportation facilities around the site. Again, the modes can include streets and highways, railroads, waterways, terminals and airports. Origins and destinations may be classified as local, intercity, intra-state, interstate or international.

The criteria that can be used to assign trips to the transportation network include capacity, cost, distance, travel time, traffic volumes, level-of-service (i.e. congestion), speed/weight/volume/height limits and other parameters. In some cases the choice of route taken is implicit in the choice of mode. For example, if some freight trips are to be made by barge and there is only one waterway within the vicinity of the site, the trips are automatically assigned to the existing waterway. On the other hand, for truck trips on streets and highways, there are usually a number of routing options and the trips need to be assigned based on the factors identified above.

As mentioned earlier, both the passenger and freight trips added onto the transportation network as a result of the planned facility have to be determined and used in calculating the impacts on traffic conditions and levels-of-service of the affected area.

■ 5.7 Level-of-Service Analysis

Depending upon the volume of traffic added and the existing capacity of the transport facilities, the level-of-service of roads, highways and other facilities in the area may be seriously impacted by the introduction of the new development. These impacts can be measured in terms of delay, congestion, accidents, physical and functional deterioration, air quality, noise and other level-of-service characteristics which are influenced not only by the volume of traffic but the presence of freight-related vehicles such as trucks.

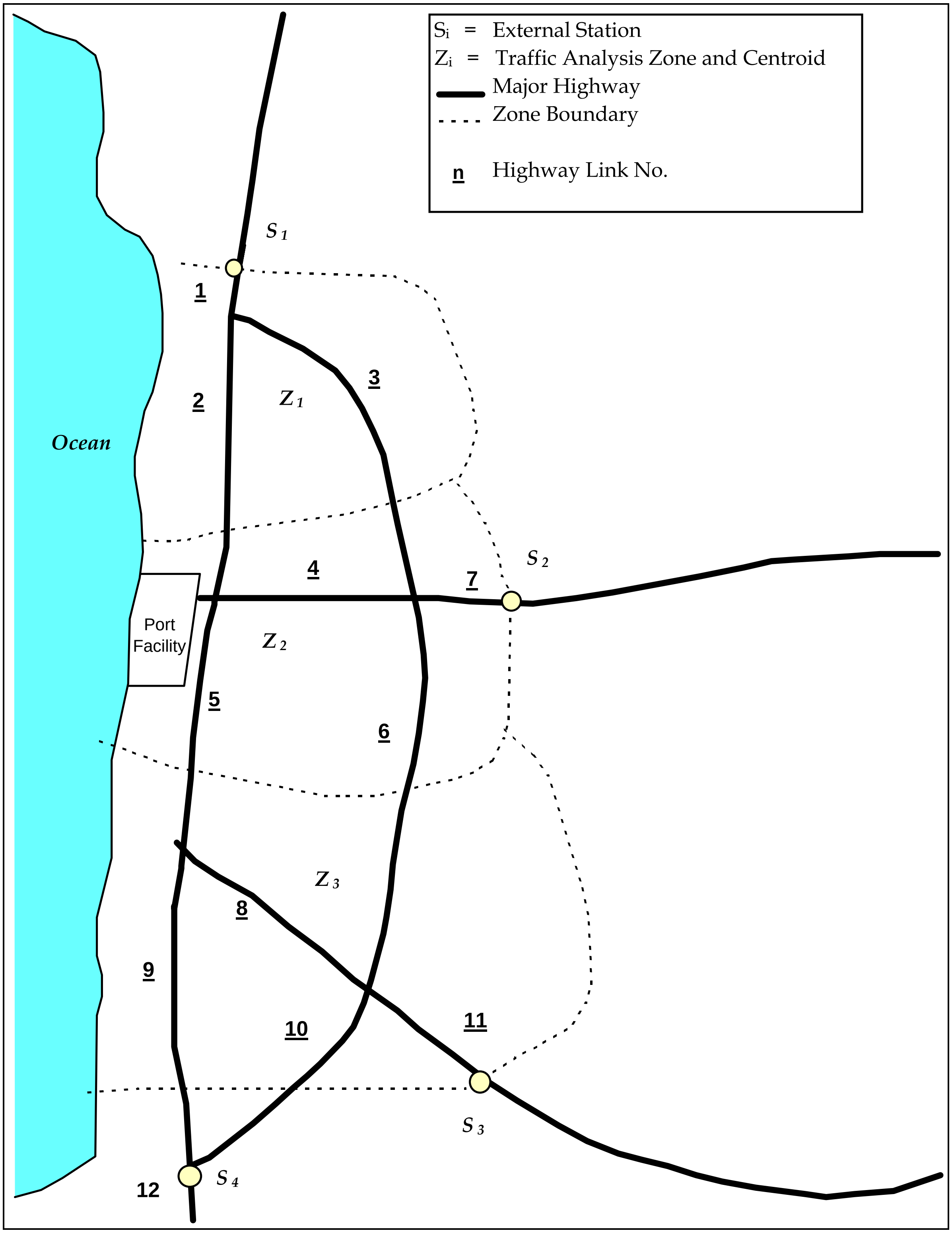
Since level-of-service characteristics are a function of time, it would be important to determine the impacts of the new freight trips on both the peak and off-peak traffic around the site.

The purpose of level-of-service analysis is not only to determine what the potential negative impacts of added freight traffic will be, but also to identify ways that can alleviate these problems or even prevent them from happening. In this way the analyst can make appropriate plans or recommendations.

■ 5.8 Illustrative Example

Suppose that a major port terminal is being planned for the hypothetical study area used as example in Chapter 4. Figure 5.1 shows the proposed location of this large facility in Zone 2 of the area. The planning agency wants to determine the impacts of the proposed facility on the traffic volumes and service levels on the major arteries in the area. For the purpose of the site impact analysis, the road segments have been numbered as shown in the figure.

Figure 5.1 Location of Planned Port Facility in the Hypothetical Study Area



The number of lanes, capacities, existing traffic volumes (commercial and non-commercial vehicles) and daily volume to capacity (V/C) ratios in each link are shown in the table below:

Existing Link Characteristics and Traffic Conditions

Highway Segment	No. of Lanes	Traffic Volume (pces/day)	Traffic Capacity (pces/day)	Volume/ Capacity
1	8	120,188	384,000	0.31
2	6	106,695	288,000	0.37
3	6	121,421	288,000	0.42
4	6	81,940	288,000	0.28
5	6	102,145	288,000	0.35
6	6	114,524	288,000	0.40
7	6	71,904	288,000	0.25
8	4	103,082	192,000	0.54
9	6	94,665	288,000	0.33
10	6	91,324	288,000	0.32
11	4	20,920	192,000	0.11
12	8	103,104	384,000	0.27

Three thousand (3,000) new employees are expected to work in the proposed port facility whose major operations include:

- Processing of export/import products
- Warehousing
- Containerization of commodities

The changes in non-commercial vehicle trips in various zones that can be attributed to the port facility are shown below:

Non-Commercial Vehicle Trips at Zones (vehicles/day)

Zone	No. of Trip Ends (w/o Facility)	No. of Trip Ends (w/ Facility)	Change
Zone 1	48,000	49,000	1,000
Zone 2	58,000	62,000	4,000
Zone 3	52,000	54,000	2,000

At each external station, it is estimated that the non-commercial vehicle trips will change due to the presence of the port facility as follows:

Non-Commercial Vehicle Trips at External Stations (vehicles/day)

External Station	No. of Trip Ends (w/o Facility)	No. of Trip Ends (w/Facility)	Change
Station 1	47,275	47,775	500
Station 2	22,277	22,677	400
Station 3	8,814	9,114	300
Station 4	40,572	41,072	500

The change in employment for Zone 2 and the resulting changes in commercial vehicle trips (using Trip Generation rates from Table 4.1 for Manufacturing, Transportation etc.) for each vehicle type are shown below:

New Commercial Vehicle Trip Origins/Destinations for Zone 2

	Without Facility	With Facility	Change
Employment	9,362	12,362	3,000
Trip Origins/ Destination	(Using Trip Generation Rates from Table 4.1 for Manufacturing, Transportation, Utilities, etc.)		
• Four-Tire	8,782	11,596	2,814
• Single Unit	2,266	2,992	726
• Combination	974	1,286	312

The resulting total commercial vehicle trips for each vehicle type and zone in the study area, with the port facility, is given below:

Forecasted Total Daily Commercial Vehicle Trips Generated for Each Vehicle Type and Zone (with Port Facility)

	Zone			
Vehicle Type	**Z_1**	**Z_2**	**Z_3**	**TOTAL**
4-Tire Trucks	24,944	32,421	29,654	87,019
Single Unit (6+ Tire) Trucks	5,692	8,541	7,767	22,000
Combination Vehicles	1,561	2,691	2,866	7,118
All Commercial Vehicles	**32,197**	**43,653**	**40,287**	**116,137**

At external stations, the commercial vehicle trips for each vehicle type with and without the port facility are as shown below:

Commercial Vehicle Trip Origins/Destinations at External Stations

	External Station											
	S1			S2			S3			S4		
Truck AADT: (1-Way)	Before	After	Net	Before	After	Net	Before	After	Net	Before	After	Net
• Four-Tire	2,948	3,048	100	901	1,001	100	650	750	100	2,530	2,630	100
• Single Unit	965	1,025	60	792	852	60	167	227	60	828	888	60
• Combination	2,412	2,452	40	3,331	3,371	40	217	257	40	2,070	2,110	40
Total	6,325	6,525	200	5,023	5,223	200	1,034	1,234	200	5,428	5,628	200

Using the information above, the following trip tables are estimated for the study area with the proposed port facility:

Four-Tire Truck Trip Table
(Vehicles/day)

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total (Oi)	Sum(Dj*Fij)
Origin Zone (i)	Z_1	?	?	?	?	?	?	?	24,944	23,295.15
	Z_2	?	?	?	?	?	?	?	32,421	25,402.51
	Z_3	?	?	?	?	?	?	?	29,654	22,752.43
	S_1	?	?	?	0	?	?	?	3,048	708.96
	S_2	?	?	?	?	0	?	?	1,001	813.12
	S_3	?	?	?	?	?	0	?	750	637.66
	S_4	?	?	?	?	?	?	0	2,630	567.63
	Total (Dj)	24,944	32,421	29,654	3,048	1,001	750	2,630	94,448	

Single Unit Truck Trip Table
(Vehicles/Day)

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total (Oi)	Sum(Dj*Fij)
Origin Zone (i)	Z_1	?	?	?	?	?	?	?	5,692	3,145.26
	Z_2	?	?	?	?	?	?	?	8,541	3,808.02
	Z_3	?	?	?	?	?	?	?	7,767	3,437.00
	S_1	?	?	?	0	?	?	?	1,025	102.94
	S_2	?	?	?	?	0	?	?	852	176.68
	S_3	?	?	?	?	?	0	?	227	136.36
	S_4	?	?	?	?	?	?	0	888	121.11
	Total (Dj)	5,692	8,541	7,767	1,025	852	227	888	24,992	

Combination Truck Trip Table
(Vehicles/Day)

		Destination Zone (j)								
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total (Oi)	Sum(Dj*Fij)
Origin Zone (i)	Z_1	?	?	?	?	?	?	?	1,561	3,472.50
	Z_2	?	?	?	?	?	?	?	2,691	3,894.73
	Z_3	?	?	?	?	?	?	?	2,866	3,809.15
	S_1	?	?	?	0	?	?	?	2,452	9.11
	S_2	?	?	?	?	0	?	?	3,371	10.06
	S_3	?	?	?	?	?	0	?	257	9.28
	S_4	?	?	?	?	?	?	0	2,110	8.78
	Total (Dj)	1,561	2,691	2,866	2,452	3,371	257	2,110	15,307	

Following the trip distribution and calibration processes described in Chapter 4, Sections 4.4 and 4.5 respectively, the adjusted daily trip tables (in passenger car equivalents or PCE's) for the commercial vehicles are determined as follows:

Daily Trip Table (PCEs)

Four-Tire Truck (PCE = 1)

Destination Zone (j)

		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Origin Zone (i)	Z_1	10,186	6,544	3,964	1,272	218	86	244	22,513
	Z_2	6,543	12,885	7,804	958	395	155	520	29,261
	Z_3	3,997	7,872	12,452	425	223	341	1,451	26,762
	S_1	1,273	960	422	0	44	10	42	2,752
	S_2	218	395	221	44	0	6	20	904
	S_3	87	157	342	10	6	0	76	678
	S_4	247	527	1,460	42	21	76	0	2,374
	Total	22,552	29,341	26,666	2,752	907	674	2,352	85,244

Daily Trip Table (PCEs)

Single Unit Truck (PCE = 1.5)

Destination Zone (j)

		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Origin Zone (i)	Z_1	4,540	2,121	1,141	398	283	32	97	8,611
	Z_2	2,107	5,960	3,206	749	587	68	245	12,922
	Z_3	1,141	3,225	5,759	272	287	180	885	11,750
	S_1	396	750	271	0	100	6	27	1,551
	S_2	281	588	286	100	0	8	27	1,290
	S_3	32	68	180	6	8	0	50	343
	S_4	97	248	893	29	27	51	0	1,345
	Total	8,594	12,962	11,735	1,554	1,292	345	1,331	37,812

Daily Trip Table (PCEs)

Combination Truck (PCE = 2)

Destination Zone (j)

		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Origin Zone (i)	Z_1	640	736	702	1,262	1,390	69	602	5,401
	Z_2	736	1,546	1,431	1,687	2,586	128	1,189	9,304
	Z_3	705	1,435	1,902	1,390	2,330	190	1,954	9,906
	S_1	1,304	1,743	1,431	0	2,666	111	1,227	8,482
	S_2	1,473	2,742	2,462	2,735	0	201	2,047	11,659
	S_3	69	128	190	107	190	0	204	889
	S_4	622	1,231	2,012	1,227	1,999	207	0	7,299
	Total	5,549	9,560	10,131	8,409	11,161	906	7,223	52,940

The non-commercial vehicle trip table is also developed as follows:

Non-Commercial Vehicle Trip Table
(PCEs)

		Destination Zone (j)							
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total (Oi)
Origin Zone (i)	Z_1	?	?	?	?	?	?	?	49,000
	Z_2	?	?	?	?	?	?	?	62,000
	Z_3	?	?	?	?	?	?	?	54,000
	S_1	?	?	?	0	?	?	?	47,775
	S_2	?	?	?	?	0	?	?	22,677
	S_3	?	?	?	?	?	0	?	9,114
	S_4	?	?	?	?	?	?	0	41,072
	Total (Dj)	49,000	62,000	54,000	47,775	22,677	9,114	41,072	285,638

Non-Commercial Vehicle Trip Table

		Destination Zone (j)							
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total(Oi)
Origin Zone (i)	Z_1	12,604	8,424	4,524	16,557	3,209	512	3,170	49,000
	Z_2	8,424	17,254	9,266	12,985	6,068	968	7,035	62,000
	Z_3	4,524	9,266	12,996	5,064	3,008	1,869	17,273	54,000
	S_1	16,557	12,985	5,064	0	6,813	621	5,735	47,775
	S_2	3,209	6,068	3,008	6,813	0	433	3,145	22,677
	S_3	512	968	1,869	621	433	0	4,712	9,114
	S_4	3,171	7,035	17,274	5,736	3,145	4,712	0	41,072
	Total Dj	49,000	62,000	54,000	47,775	22,677	9,114	41,071	

The total commercial and non-commercial trips are determined by adding the trip tables above, resulting in the following:

Daily Trip Table (PCEs)

All Vehicles

		Destination Zone (j)							
		Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Origin Zone (i)	Z_1	27,970	17,825	10,330	19,489	5,100	698	4,113	85,524
	Z_2	17,811	37,645	21,707	16,380	9,637	1,319	8,989	113,488
	Z_3	10,367	21,798	33,109	7,151	5,849	2,581	21,563	102,418
	S_1	19,530	16,439	7,188	0	9,623	747	7,032	60,559
	S_2	5,181	9,794	5,977	9,692	0	647	5,239	36,531
	S_3	699	1,321	2,581	744	637	0	5,042	11,024
	S_4	4,137	9,041	21,639	7,034	5,192	5,047	0	52,090
	Total	85,696	113,862	102,532	60,490	36,037	11,039	51,978	461,633

The trips above may be assigned to various segments in the study area using distances between origins and destinations. A trip incidence matrix below shows which highway segments can be used for each origin/destination pair (see Figure 5.1):

Traffic Assignment Segments

All Vehicles

Destination Zone (j)

Origin Zone (i)

	Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4
Z_1	**2,3**	2,3,4,5,6	2,3,4,5,6,8, 9,10	1,2,3	2,3,4,7	2,3,4,5,6,8	2,3,4,5,6,8, 9,10,12
Z_2	2,3,4,5,6	4,5,6	4,5,6,8,9,10	1,2,3,4,5,6	4,5,6,7	4,5,6,8,11	4,5,6,8,9,10,12
Z_3	2,3,4,5,6,8, 9,10	4,5,6,8,9,10	6,8,9,10	1,2,3,4,5,6, 8,9,10	4,5,6,7,8, 9,10	8,9,10,11	8,9,10,12
S_1	1,2,3	1,2,3,4,5,6	1,2,3,4,5,6, 8,9,10	None	1,2,3,4,7	1,2,3,4,5,6, 8,11	1,2,3,4,5,6, 8,9,10,12
S_2	2,3,4,7	4,5,6,7	4,5,6,7,8, 9,10	1,2,3,4,7	None	6,7,11	6,7,10,12
S_3	2,3,4,5,6,8	4,5,6,8,11	8,9,10,11	1,2,3,4,5,6, 8,11	6,7,11	None	10,11,12
S_4	2,3,4,5,6,8, 9,10,12	4,5,6,8,9, 10,12	8,9,10,12	1,2,3,4,5,6, 8,9,10,12	6,7,10,12	10,11,12	None

For example, for the origin-destination pair Z_1 -Z_1, it is assumed that Segment 2 and Segment 3 will each have 60% of the total daily trips (i.e. some of the trips will be using both segments). The assignments for these two segments for all origin-destination pairs are shown in the following tables:

Segment 2

	Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Z_1	**16,782**	8,913	5,165	9,744	1,530	349	2,056	44,539
Z_2	8,905	0	0	8,190	0	0	0	17,095
Z_3	5,184	0	0	3,576	0	0	0	8,759
S_1	9,765	8,219	3,594	0	481	336	4,922	27,318
S_2	1,554	0	0	485	0	0	0	2,039
S_3	350	0	0	335	0	0	0	684
S_4	2,069	0	0	4,924	0	0	0	6,992
Total	44,609	17,132	8,759	27,253	2,011	686	6,978	107,428

Segment 3

	Z_1	Z_2	Z_3	S_1	S_2	S_3	S_4	Total
Z_1	**16,782**	8,913	5,165	9,744	2,805	349	2,056	45,814
Z_2	8,905	0	0	8,190	0	0	0	17,095
Z_3	5,184	0	0	3,576	0	0	0	8,759
S_1	9,765	8,219	3,594	0	9,142	411	2,109	33,241
S_2	2,850	0	0	9,207	0	0	0	12,057
S_3	350	0	0	409	0	0	0	759
S_4	2,069	0	0	2,110	0	0	0	4,179
Total	45,904	17,132	8,759	33,237	11,947	760	4,166	121,904

After all the trips have been assigned to all the highway segments, the levels of service of the roads with the proposed facility are compared with their levels of service without the facility as follows:

Link Characteristics and Traffic Conditions with Port Facility

Highway Segment	No. of Lanes	Traffic Volume (pces/day)	Traffic Capacity (pces/day)	V/C Ratio	Change in Volume (pces/day)	V/C Before
1	8	121,049	384,000	0.32	861	0.31
2	6	107,428	288,000	0.37	733	0.37
3	6	121,904	288,000	0.42	484	0.42
4	6	87,435	288,000	0.30	5,495	0.28
5	6	106,619	288,000	0.37	4,474	0.35
6	6	119,275	288,000	0.41	4,751	0.40
7	6	72,568	288,000	0.25	664	0.25
8	4	106,338	192,000	0.55	3,256	0.54
9	6	97,047	288,000	0.34	2,383	0.33
10	6	92,930	288,000	0.32	1,606	0.32
11	4	22,063	192,000	0.11	1,143	0.11
12	8	104,067	384,000	0.27	963	0.27

As can be seen in the table, segments 4, 5, 6, 8 and 9 will experience relatively higher increases in traffic volume and a drop in service levels due to the proposed port facility.

6.0 Data Collection to Support More Accurate Freight Analysis

6.0 Data Collection to Support More Accurate Freight Analysis

6.1 Overview

For some applications, State Departments of Transportation, Metropolitan Planning Organizations and other planning agencies may seek more accurate and reliable estimates of freight activity and may find the quick-response freight planning approaches presented in previous chapters inadequate. For example, the truck trip generation rates recommended in this manual (Table 4.1) which are obtained from Phoenix may not be suitable for a specific site. Estimates of truck traffic volumes and travel times at external stations (see Section 4.3) which are derived from the Truck Inventory and User Survey (TIUS) may be too rough for the desired level of accuracy. Simple growth factor methods presented in Chapter 3 may be inadequate in representing the complex relationships between freight demand and the economic indicator variables in a given area. Agencies always have the alternative to adopt their own procedures to make more accurate estimates. However, this will usually require additional data collection on their part.

As stated in the introduction to the manual (Chapter 1), the methods adopted for the quick-response freight planning approach assume that very little data on freight travel exists within planning agencies, and that they have limited time and resources necessary to develop this information. But what if these agencies are willing to allocate some of their resources to collect more data in order to improve the accuracy of their forecasts? Which data and data collection efforts should they pursue and what costs are involved?

Data collection can be very costly to undertake. In general the time, costs and level of effort required to obtain more accurate and comprehensive freight data depend upon the following factors:

- type and volume of information needed;
- whether the data already exists or still needs to be collected;
- availability of the data, and cost to purchase it (if not free);
- the types of equipment needed to conduct surveys or interviews;
- time needed to perform the data collection in the field or in the office; and
- the level of detail or accuracy desired.

This chapter describes a number of strategies that can be employed by State DOT's, MPO's and other planning agencies to collect better freight information pertaining to various economic indicators, demand characteristics, transportation network, origin-destination flows, and shipper/carrier characteristics -- all of which are needed to support enhanced freight analysis and produce more accurate freight forecasts. To simplify the discussions, the data collection strategies have been classified as either involving *primary* or *secondary* data sources.

Primary data sources include:

1. Survey techniques such as tube counts, classification counts, "postcard" and other roadside surveys, and surveys of freight terminal operators and port authorities,

2. In-depth interviews of shippers and carriers;

3. Establishment of freight advisory committees comprised of key shippers, carriers and other knowledgeable individuals.

While more accurate and desirable, primary data collection activities are both expensive and time-consuming.

Secondary data sources include existing reports, abstracts, or statistics from various public and private agencies at the local, state, and national levels which can be adopted in the freight analysis. These data sources should be explored first especially if the agency has limited resources to conduct the more costly primary data collection techniques. However, more often these data sources either have restricted applicability or are outdated.

■ 6.2 Primary Data Collection

Gathering primary data on freight and traffic flows at the federal, state or local level is a costly and time-consuming process, and data collection programs for most agencies (particularly at the local level) are rarely a funding priority. In addition, the political, technological, and operating changes within the transportation industry have rendered many traditional and often modal-oriented data collection programs inappropriate for intermodal and multimodal planning purposes. While the freight movement and origin-destination data available from federal and commercial sources for rail, water, and air modes are often adequate for planning purposes at the state and local level, comprehensive and detailed information on truck movements is inadequate in most cases. Because the vast majority of all freight movements at some point move by truck, such information is critical to effectively plan and provide the infrastructure and facilities needed for efficient movement and transfer of freight. Accordingly, while the primary data collection methods and procedures discussed below could apply to all modes, there is particular focus on gathering data on truck movements.

6.2.1 Surveys

A critical component of any survey data collection effort is sampling. While there is no definitive way of selecting a sample size, generally the larger the sample, the more reliable the sample estimates. However, it would be impossible and prohibitively expensive to collect data from every transportation carrier, facility, shipper, or location. It is much less expensive to gather data from a sample of the population, which, if drawn accurately, can provide reliable results

In determining the optimal survey sample size, one must consider not only the survey design, but also the logistics of implementing the survey. In the case of roadside/intercept surveys, telephone surveys or personal interviews, this would include factors such as the number of interviewers, length of survey, traffic flow, time frame, location, etc. In the case of mail surveys, this would include reliability of mailing lists and points of contact, method of transmission and return (mail vs. fax or e-mail), etc.

According to the Bureau of Census' *Truck Inventory and Use Study (TIUS)*, about 36 percent of the vehicle miles traveled by trucks occur on trips of less than 50 miles, and an additional 30 percent fall into the category of 50-200 miles. Moreover, 95 percent of all trips are less than 200 miles in length, with 81 percent less than 50 miles. Thus, the majority of all truck trips are local, and most vehicle miles can be considered local. Therefore the sampling strategy for truck surveys should emphasize local travel more than other trip types.

A recent study prepared for the Metropolitan Transportation Commission (MTC) in Oakland, California[1] provides a comprehensive review of what has been and what is being done at the state and local level with regard to truck surveys and truck travel demand forecasting. While the methods and procedures discussed in the report relate to actual truck travel surveys, most can also be applied to other modes of transport. The primary data collection methods and related findings are as follows:

- Telephone interviews generally yield a high response rate and facilitate follow-up; however, the survey must be conducted during normal business hours; the respondent may have limited time, data, or information available at the time of the initial contact and may be unwilling to return calls or accept follow-up calls; and may require mail or fax follow-up to verify data and information recorded by the interviewer. Depending on the sample size, time frame, and nature of the survey, the number and skills of the interviewers may make this method too costly.

- Mailout/mailback surveys are less costly, but generally have a lower response rate. The reliability and completeness of the response may depend on whether the survey form finds its way to the appropriate individual within an

[1] Samuel W. Lau, *Truck Travel Surveys: A Review of the Literature and State of the Art*, prepared for the Metropolitan Transportation Commission, Oakland, California, January 1995. This report includes an extensive bibliography as well as 13 sample forms used in truck surveys throughout the U.S. and Canada.

organization or company. This method also requires some type of tracking so that one can easily identify and follow up with non-responses. The follow-up may be done by telephone/fax, postcard reminders, or re-mail of the survey package.

- Combined telephone-mailout/mailback surveys will generally yield a higher response rate than mailout/mailback; however, it is likely to be more expensive. One variation of this procedure involves contacting a company by telephone to advise that a survey form is being mailed and identify the appropriate department/individual to which the form should be addressed. In this manner, one can often determine whether a company is likely to respond and adjust the sample size accordingly. One can also utilize broadcast fax to distribute survey forms, although the quality of the transmission may affect the response.

- Roadside/intercept interviews are often used for truck surveys and generally yield a high response rate, offer better control over the sample, and enable the interviewer to respond to any questions the respondent may have when completing the form. The disadvantages of this method include potential disruption to traffic flow, safety hazards for the interviewers, less ability to follow up with respondents, the effect of factors such as weather, time of day, lighting etc. on implementation, and restricting the sample to a particular location rather than an entire region.

A paper presented at the 1995 Transportation Research Board (TRB) Meeting[2] provides a comprehensive outline for gathering truck movement data and information on a statewide basis. The paper describes the methodology and procedures employed to interview a total of 30,000 truck drivers at 28 weigh stations located throughout the State of Washington. The interviews were conducted in each of four seasons to take into account seasonal differences in truck movements. The researchers established a goal of conducting 300 surveys over a 24-hour period at each survey site, and ultimately interviewed approximately 7500 drivers during each of the survey periods. The following summarize the significant aspects of the methodology and procedures:

- The survey gathered information on vehicle configuration, origin and destination, highway route, cargo type, vehicle and cargo weight, and the use of intermodal facilities. Identification of routes was accomplished with the aid of a map attached to each questionnaire. The primary data collection sites included permanent weigh stations, ports of entry, and border crossings along major interstate and state highway corridors. The questionnaire was designed so that it could be completed within three minutes, with about half the questions answered by the interviewer through direct observation of the vehicle. Terms (such as "payload weight") that were not readily understood by truck drivers were identified during a pretest and replaced by simpler language (e.g., "the weight of the cargo being carried").

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[2] William R. Gillis, Kenneth L. Casavant, and Charles Howard, Jr., *Survey Methodology for Collecting Freight Truck Origin and Destination Data*, presented at the TRB Annual Meeting, Washington, D.C. January 1995.

- Interview teams, totaling up to 90 people on any given day, were recruited from community service clubs, comprised of individuals with personal knowledge of local roads, industries, and transportation facilities. They were trained, supervised, and periodically evaluated by members of the project management team. Training included instruction in personal interviewing techniques, how to accurately identify different truck and trailer configurations, and safety procedures and requirements. Each team was provided with equipment ranging from clipboards and pens to reflective safety vests, headlamps, and hats. Each site was equipped with a survey crew sign and traffic cones. Cooperation and assistance was provided by uniformed Commercial Vehicle Enforcement Officers and Customs officials, helping to ensure the safety of the interviewers and, by directing selected trucks to the interview site, creating an atmosphere that produced a high response rate. Trucks were selected, on the basis of the sequence in which they were weighed, at a rate that made it possible for the interview to begin without delay.

- At each site, a member of the project management team was available to check completed questionnaires for accuracy and to address any problem areas with interview personnel. Weather and other unforeseen events also had an effect on the quality of data gathered, with some interviews conducted inside the scale house during particularly inclement weather. In addition, during high-volume traffic periods, there were occasions when enforcement and interviewing activities had to be suspended to enable traffic to clear. There were a few instances where interview activities were suspended for a period of time as a result of nearby construction activity or, in one case, a hazardous material spill.

The data collection effort was highly successful, with a 95% response rate providing data and information for an extensive database of statewide freight and goods movement in Washington. It should serve as a good example of how surveys can be made in an efficient manner. The costs, however, are a different issue.

The following describes how three survey procedures, namely: truck counts at external stations, truck surveys at external stations, and commercial vehicle origin-destination surveys can enhance freight analysis.

Truck Counts at External Stations

The planning agency may need to perform new counts for major external stations with old, suspect, or missing data, or as part of a comprehensive data collection effort. Truck counts at external stations also involve classifying commercial vehicles for calibrating and validating trip distribution forecasts. Cordon or screenline counts are recommended for most situations. Tube counts, electronic sensors, weigh stations, toll or turnpike counts, or video or visual classification counts may be used. Once data is available for a broad representation of facility and highway types, the state or regional planning agency may expand the data to similar highways that were not sampled.

Traffic volumes at external stations, as well as the types of trips involved (i.e. external-external, internal-external and external-internal) vary significantly with location. For example, a 1991 study of nine counties in the San Francisco Bay Area[3] found that 98% of all trucks surveyed involved local or intra-regional trips; that is, they either had their origin or destination in one of the nine counties, which means that only 2% are "through" trips. On the other hand, a 1990 study in Yuma, Arizona[4] found that 7% of all trips (passenger and freight) were through trips. Still a 1994 origin-destination interview survey conducted on the perimeter of Berks County, Pennsylvania[5] determined that 27% of the trucks entering or leaving the county were not stopping within the county, and were thus through trips. These wide variations indicate that data collection and analysis of actual truck traffic patterns, particularly at external stations, can produce more reliable freight forecasts than those that represent national averages such as recommended in the quick response method (see Section 4.3 - External Stations, in Chapter 4).

In conducting the truck counts, however, one must bear in mind that research suggests wide variances in truck counts or classifications based on tube counts due to equipment calibration, vehicle speed and traffic density. Therefore caution should be exercised in applying tube counts for vehicle classification in the freight trip generation and distribution models.

Truck Surveys at External Stations

Truck surveys at external stations are typically accomplished through interviews conducted at external stations to identify internal-external, external-internal, and external-external patterns of travel. These surveys provide the basis for trip generation, trip distribution and time-of-day analyses discussed in Chapter 4, and are usually performed simultaneously with truck counts.

The state or regional planning agency may face situations in which "through" freight traffic, or traffic generated from non-local, widely dispersed sources, contributes significant traffic volumes to the area. In this situation, the agency may decide to conduct vehicle classification surveys and roadside/intercept origin-destination surveys at major external stations to estimate external-external, external-internal, and internal-external trips. Roadside interviews are most easily performed at weigh stations, although toll plazas, border crossing stations and roadside pull-offs have also been used.

A summary of the advantages and disadvantages of truck interview surveys, taken from the MTC Report described above, is shown in Table 6.1.

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[3] Schlappi, Marshall, and Itamura. *Truck Travel in the San Francisco Bay Area*. TRB 72nd Annual Meeting, Paper No. 930477. January 1993.

[4] Yuma Metropolitan Planning Organization. *1990 Origin-Destination Survey*. 1990.

[5] Matherly, D. "*Stream of Traffic Interview" Truck Survey: Methodology and Recommendations on Traffic Volume Thresholds.* Paper presented at the 75th Annual Meeting of the Transportation Research Board. Paper 960581. November 1995.

A method that might serve State or regional planning agencies with a single "target route" for through trip activity would follow a particular survey strategy implemented in Des Moines, Iowa. This method involved a roadside truck survey at two major interchanges along a route, without stopping the vehicles, by verbally recording the time, the tractor color and/or name, company name on the side of the cab, and any remarks. The purpose of the survey was to identify through truck trips, defined as trucks that had an elapsed time of 11 to 19 minutes between observation points.

If Automated Vehicle Identification (AVI) information is available, it can also be very helpful in determining vehicle routing, weight and time-of-day information.

Table 6.1 Advantages and Disadvantages of Truck Interview Surveys

Advantages	Disadvantages
Complete information	Potential disruption to traffic
High response rate	Quality and conduct of survey affected by weather, lighting
Better sampling control	Hazardous to survey crew
Good representative sample of trucks entering or leaving a cordon line	Time constraint; no follow-up possible
Easy comparison with mainstream traffic through field counts at survey location	Enforcement problems at the station; drivers avoiding the survey station
	Only represents trucks traveling on road along survey stations, not entire region

Commercial Vehicle Origin-Destination Surveys

Commercial vehicle origin and destination surveys are usually accomplished through phone and mail surveys with trip logs, and are based on registered vehicles. These surveys tend to focus on internal-internal movements with internal-external and external-internal movements for locally registered vehicles. The results of commercial vehicle origin and destination surveys are used in freight analysis to provide a basis for analyzing trip generation, trip lengths (for distribution) and time-of-day characteristics.

The quick response methodology described in Chapter 4 develops trip generation rates from local land use patterns, primarily using national default values applied to local patterns. A planning agency may determine that a higher level of accuracy is required to reflect unique circumstances in its own region.

Mail and phone surveys are less geographically restricted than roadside/intercept surveys in terms of survey sites but tend to capture primarily local trips. They usually provide more detail than an intercept interview, and generally have lower response rates than an actual interview.

A key element in conducting a successful freight origin-destination survey is identifying relevant shippers, carriers and receivers, and obtaining the cooperation and participation of local and regional freight representatives. Many mail and telephone surveys establish the "universe" through state vehicle registration files. This may capture most strictly local firms, but many local shipping firms will be part of a national conglomerate that may register vehicles almost anywhere. Appendix K identifies national public sources that may assist in devising a complete sampling frame. Alternatively, the state or regional planning agency may wish to purchase specific data from a commercial data source, such as those described in Appendix L.

6.2.2 In-depth Interviews with Shippers and Carriers

Lengthy personal interviews are the most costly method of conducting surveys and generally involve a smaller, more select or targeted sample. This approach is particularly appropriate when assessing the feasibility of new or expanded facilities (see Chapter 5 - Site Analysis). Interviews with shippers to ascertain the demand for such facilities and interviews with carriers to determine whether they would consider providing/expanding service to/from the facility are critical to the freight planning and decision-making process. These types of interviews are particularly useful for analyzing special trip generators including intermodal transfer facilities and warehouses.

6.2.3 Establishment of Freight Advisory Committees

A Freight Council provides regular contact with local representatives of the freight industry. Such contacts are invaluable for identifying freight issues and opportunities and, more importantly, data. The advantage of establishing freight advisory committees such as the Freight Council is that members may be more willing to share information. Such a council will also assist the planning agency in reviewing the local road network from the freight perspective, based on the needs assessment, as well as in identifying capacity, classification and condition. For example, eight national associations representing all freight transportation modes and the nation's manufacturers and shippers have created the *Freight Stakeholders National Network*. This network is designed to promote private-public coalitions, and can help establish an effective freight council through recruiting participants from the freight sector.[6]

The data collection and analysis activities required for freight planning/modeling which are shared among freight industry representatives may also contribute to greater understanding between planning agencies and the private sector freight community.

[6] For more information, contact Rebecca Myer, American Trucking Association, (404) 873-1201.

Table 6.2 identifies typical concerns of freight carriers (see Appendix A for a glossary of the freight terminology). An agency that demonstrates a preliminary understanding of freight handlers' concerns will be more likely to obtain cooperation in gathering data of importance to the public agency. In addition, a cooperative effort, such as designing a survey that meets the needs of the freight community as well as the planning agency, will likely have a much higher response rate.

6.3 Secondary Data Collection

A recent survey on data sources used for freight analysis revealed that States, MPO's and port/airport authorities utilize and, in large part, rely on secondary data and information which are compiled and published by federal agencies and/or private and commercial sources for data related to freight movement and freight transportation.[7] The principal state-level transportation databases are primarily truck-related and include vehicle registration, operating authority, fuel and other taxes, and safety. Data on commodity movements and origins/destinations are limited as to the level of detail required or desired for forecasting and planning purposes. Of those agencies which do collect primary data as described in the previous section, most do so sporadically or infrequently.

More detailed data pertaining to the volume and type of freight movements may be helpful for fine-tuning estimation model results, for ensuring complete coverage of the region, and in some cases for estimating external-external (through) trip flows. Commodity data are also helpful in accurately forecasting future freight flows and activity levels. The U.S. Bureau of Economic Analysis (BEA) produces forecasts of employment and earnings by industry for states, counties, metropolitan statistical areas, and BEA Economic Areas. An accurate baseline with disaggregate commodity detail can take full advantage of this national forecasting resource.

A planning agency can usually identify the major shippers, carriers, and receivers in the region without conducting a primary data collection survey. It may already have significant information. Thus, the search for more detailed freight data should generally begin at the agency level, expand to local sources, and fill in remaining gaps with state and national sources. Alternatively, the state or regional planning agency may wish to purchase specific data from a commercial data source. Commercial sources may have available, for purchase, enough detailed data to eliminate the need for a full survey, or may be able to supply the data to make a survey more effective. Commercial sources are listed in Appendix L.

[7] NCHRP 8-30 Report - *Forecasting Freight Transportation Demand. A Guidebook for Planners and Policy Analysts*. Cambridge Systematics Inc., January 1996.

Table 6.2 - Freight Planning Issues for State DOT's and MPO's[8]

Physical Limitations : Delivery and Collection	
• Structural vertical clearance for doublestacking & railroad electrification	• Land-side access to airports and harbors
• Peak and off-peak delivery of freight	• Road access to rail terminals
• Structural vertical clearance for truck movements	• Loading facilities- intermodal, single mode
• Freight delivery at major centers of activity	• Parking restrictions for freight deliveries
• Horizontal radii limiting truck movement highway access to intermodal facilities	• Downtown congestion
• Structural integrity and remaining pavement life	• Truck delivery and loading interference with street traffic
• Bridge or road weight restrictions	
Accessibility and Safety	
• Accessibility time and cost to intermodal facilities	• Highway-Railroad crossing safety
• Designated truck routes	• Hazardous materials shipment
Transferability and Coordination: Legal and Regulatory	
• Movement interference between modes at highway- railroad crossings	• Truck weight limitations
• Movement interference between modes at highway-waterway crossings	• Liability of freight rail lines for transit usage
• State multimodal trust funds & funds eligibility	• Highway-ferry boat transfer delays
• Congestion and delays created by drayage	
Economics and Environmental	
• Economics tradeoffs between modes and combinations of modes	• User fees and subsidization of transportation modes
• Air, noise, and wetland impacts of intermodal facilities	• Economic impact of railroad abandonment roads

[8] Adapted and expanded from an assessment of issues originally developed by Dane Ismart of Federal Highway Administration and published in Meyer, Michael; *Rail, Intermodalism and ISTEA, Symposia on Partnerships with Railroads,* June 1994.

Depending upon the size and location of the State or metropolitan/local area within a National Transportation Region (NTAR), other secondary data sources briefly described in Chapter 4 and/or contained in the Appendix may provide enough information to avoid a major primary data collection effort. There are 89 NTAR's in the country, comprised of 179 Bureau of Economic Analysis (BEA) regions. Certain flow data, such as the *Commodity Flow Survey*, are available by commodity type at the NTAR to NTAR region, and may thus provide more reliable information pertaining to "through" trips for large regional or state studies (see Appendix K).

FHWA is also a major source of freight data, and is currently publishing an update of the Travel Survey Manual (last released in 1987). The manual will include sections on freight and truck surveys. It will be available through FHWA. A CD-ROM version may be distributed through the Bureau of Transportation Statistics (BTS).

Appendix M describes additional truck and freight surveys conducted by metropolitan planning organizations throughout the country, plus others in the planning stages. Contact names are provided for further information.

The following describes other additional secondary data sources at the local, state, regional and national levels which can be used to obtain more accurate data for freight analysis.

Other Local Sources

The local chamber of commerce typically has listings of the major employers in the region, usually including information on key products, annual sales volume, floor space, and number of employees. This may or may not include the number of trucks, loading docks, etc. If so, trip generators can be readily mapped into the appropriate zones.

The local tax assessment office will have similar information, possibly more current and accurate but local laws on confidentiality may restrict access.

The local phone book (business-to-business directory or commercial directory) may help identify key employers who do not belong to the chamber of commerce. Local Yellow Pages and business-to-business directories can also assist in building linkages between a terminal or warehouse and retail outlets, such as grocery stores. Electronic business address files for the entire country are also available on CD-ROM.

Other State Sources

Appendix H lists the trucking association for each State. These associations are an excellent source of information about the trucking industry, and is the natural conduit for sharing information within the industry. A list of trucking members in the State will not provide 100 percent coverage of truck related organizations, but should provide a major starting place. Types of firms that may not typically belong to the state trucking associations include many single, owner-operated trucks, service firms (office equipment repair, etc.), construction firms, extraction firms (gravel, mining), and government-related firms such as municipal waste disposal, postal service, military goods movement, etc.

Other National Sources

Appendix J lists a sampling of national trade associations concerned with freight movement. Brief descriptions of each association or reference source are included. More complete listings of associations and databases are available from the following:

- *TruckSource,* published by the American Trucking Association (ATA) and updated each year, also includes directories, contacts, etc. The ATA can be contacted at: *American Trucking Associations, Customer Service, 2200 Mill Road, Alexandria, VA 22314-4677.*

- *The Encyclopedia of Associations*, by Gale Research Co., is the most comprehensive list of associations and is available at most public libraries.

A planning agency should generally contact those associations or reference sources for which local sources are incomplete. For example, the state or regional planning agency may know of a large truck garden industry in the county, with widely dispersed owners, and does not know how or where these goods are typically transported. A call to the *United Fresh Fruit and Vegetable Association*, listed in Appendix J, would identify major local shippers of that commodity, locations of refrigerated terminals for consolidating and breaking up shipments, and possibly typical transport patterns.

National sources will also be the best for locating non-truck intermodal data, including inland or Great Lakes or ocean waterways, air cargo, rail cargo, and pipeline movement of goods. The specialized database section (Appendix K) includes data sources for pipelines, coal movements, military transportation, Mexican and Canadian trade, imports and exports, and other topics. State or regional planning agencies with even more specialized needs may refer to the *Directory of Transportation Data Sources*, *TruckSource*, or commercial sources.

7.0 Principles of Application

7.0 Principles of Application

7.1 Introduction

The purpose of this chapter is to give additional guidance on the application of the methods presented in this manual. Based on case study applications, advice is provided on determining which methods are most applicable in common planning problems. Case studies in three cities (Lawrence, Kansas; Appleton-Neenah (Fox Cities), Wisconsin; and Green Bay, Wisconsin) are presented in detail in Chapters 8 and 9. The intent of the case studies is to describe the full scope of an urban freight forecasting effort, to illustrate the best use of available data and resources, and to show where professional judgment can be exercised to expedite the work and enhance the quality of the results.

In order that the methods of this manual can be better illustrated, the case study cities were selected to be smaller urban areas. Nonetheless, the general principles of application, as described in this chapter, would apply to much larger cities. The case study cities have one other important common feature -- they are located in States that have recently created a statewide freight forecast with methods compatible to those of this manual. Thus, Chapter 8 describes the advantages and disadvantages of trying to interface the statewide and regional levels of forecasts.

7.1.1 Sizing the Effort

The earlier chapters in this manual contain numerous valuable suggestions for data collection and conducting a quick response freight forecast, but not all of the suggestions are worthwhile in any given area. When applying the methods of this manual, it is important to understand:

- the nature of the freight system in the area;
- the desired uses of the forecast;
- the availability and quality of data; and
- the needed accuracy, taking into consideration how the freight forecast relates to passenger forecasts.

Often, freight is only a small part of a larger forecast encompassing both passenger and truck travel. In these instances, the goals of the whole forecast need to be considered. The level of effort expended on the freight forecast should be proportionate to its importance in the whole forecast and to its potential contribution to the accuracy of the whole forecast. For example, if trucks comprise only 10% of the traffic in the area, then it would seem unreasonable to spend 50% of the forecasting effort on the freight portion. The challenge is to produce quality results by being resourceful, while still being efficient.

Using Error Theory to Guide the Size of Effort. Doing a brief error analysis is another way of judging the adequacy of the amount of effort. Error theory states that the most unreliable inputs have the greatest impact on the quality of the outputs. Consider the following example. Average volumes on major arterials in a city are 20,000 vehicles per day, with trucks constituting 10% of the traffic. Assume the root mean square error (RMSE) of assigned passenger car volumes to be 2,700 vehicles (about 15% = 2,700/[0.9*20,000]). Now compare the effect on total error of a 15% RMS error in truck volumes with a 30% RMS error, making the typical assumption that errors are independently distributed random variables.

$$\text{Total Error from a 15\% Truck Error} = (2{,}700^2 + 270^2)^{1/2} = 2{,}713$$

$$\text{Total Error from a 30\% Truck Error} = (2{,}700^2 + 540^2)^{1/2} = 2{,}753$$

The truck forecast can tolerate a much greater error than the passenger car forecast without adversely affecting the total vehicle forecast. Of course, this conclusion does not apply to instances where the freight forecast is of primary importance.

■ 7.2 Major Steps of Application

Once the goals and priorities have been established, a freight forecast would involve the following five steps:

1. Obtain Network and Employment Data
2. Obtain Calibration Data
3. Prepare Base-Year Forecast
4. Forecast Employment and External Station Data
5. Integrate the Freight and Passenger Forecasts

In the three case studies Step 3, preparing the base-year[1] forecast, took the largest amount of time. Step 3 would likely take the longest in most other cities, too. The base-year forecast is where all decisions on model structure are finalized, where most assumptions

[1] A "base-year forecast" is not truly a forecast, as a large amount of information about the base-year is already known. Planners frequently perform base-year forecasts to calibrate and validate their networks and parameters. The steps in conducting a base-year forecast are the same as a future-year forecast.

relating to data preparation are made, and where all parameters are locked in place. In addition, a good base-year forecast allows an assessment of the overall accuracy of the forecasts. Chapter 9 devotes a considerable amount of space to the issue of building a good base-year forecast.

Another time consuming step is employment data preparation. Reasonably good data can be adapted from the passenger forecast, but such data require substantial conversion and enhancement. The original industrial categorization of employment data may be inappropriate, as may be the selected set of special generators. Data conversion and special generator definition for the case study cities will be described later in detail.

■ 7.3 Data Stretching

A major difference between an "ideal" forecast and a "quick response" forecast is the degree of reliance on data already available. As will be seen in the case studies, data can be far from ideal. The methods in this manual permit liberal extrapolations of existing data to cover holes left by missing data items. Every forecast has a different mix of existing data, so specific rules for data stretching cannot be given. To obtain acceptable results, data stretching requires considerable amount of judgment and insight.

■ 7.4 Resolving Data Contradictions

Base-year forecasts and calibration exercises must deal with contradictions or inconsistencies in data. When assembling data from multiple sources the likelihood of major contradictions increases. In most instances it is possible to rate the quality of the sources and to use these ratings as a guide. Unfortunately, requirements for data stretching sometimes involve the joint use of two or more contradictory sets of data. Means of resolving contradictions include:

- ignoring a data item from a weaker data source;
- ignoring a data item that is inconsistent with other data from its own source;
- ignoring a data item that is illogical or that violates conventional wisdom;
- taking a weighted average of two contradictory data items;
- using data from the weaker source as advisory only, such as forming assumptions about how data from the stronger source can be stretched or reorganized; and
- using both data items, but relying on statistical measures to ensure that parameters have been adjusted properly.

Contradictions can also arise between two different forecasts of input data or between forecast data and actual data. The case studies illustrate how data from multiple sources can be used to the best advantage.

7.5 Levels of Validation

Model validation consists of comparing the results of a base-year forecast against known conditions. In general, for travel forecasting models, validation data consist mainly of link volumes and speeds. For freight forecasts, it is very helpful (though not essential) that information be available about the volumes of trucks on many highways scattered throughout the urban area.

In theory validation differs from calibration. The objective of calibration is to set the parameters of the model to obtain the best fit to reality. Thus, calibration should be performed ahead of validation. However, in practice calibration and validation are often performed at the same time with the same set of traffic count data.

There are three important levels of validation: no validation; validation of the freight forecast by itself; and joint validation of passenger and freight forecasts.

> **Level 0 - No validation.** For site impact studies and certain other forecasts where base-year data are unavailable or irrelevant, it is not possible to validate. In these instances, the methods of this manual should be trusted to produce an adequate forecast. Results should still be inspected for internal consistency and reasonableness.

> **Level 1 - Validation of the freight forecast by itself.** The methods of this manual permit a limited validation of the freight forecast against truck counts. A complete validation cannot be performed because it is not possible to use preferred methods of traffic assignment on trucks by themselves, without knowledge of the congestion effects of passenger cars.

> **Level 2 - Joint validation of passenger and freight forecasts.** Ideally, validation should include both trucks and passenger cars. The assigned traffic volumes can then be compared with known counts of passenger cars and trucks. Depending upon the selected travel forecasting software/method, it may not be possible to distinguish trucks from passenger cars in the assigned volumes. In such cases, truck traffic and passenger car traffic must be combined for comparison.

In the absence of good truck traffic counts, it is still possible to partially assess the validity of the forecast by comparing assigned volumes to approximations of the existing truck traffic on a sample of links. One way of approximating existing volumes is to factor known volumes for all vehicles by the percentages of trucks on highways of different functional classes (see Table 4.2).

7.5.1 Need for Recalibration of an Existing Forecast

When adding a new freight component to an existing passenger forecast, a complete recalibration of the whole model is essential. Because of the likelihood that the passenger vehicle model has been fudged to account for the truck traffic, this recalibration must be performed even when the freight forecast has been independently validated. The recalibration must first remove any unwanted elements in the passenger vehicle forecast before performing a *Level 2* validation on the whole forecast. One popular method of indirectly including freight into a passenger forecast had been to increase the trip generation rates for the NHB trip purpose.

7.5.2 The Need for Orderly Freight Information at Both State and Regional Levels

The preparation of a good freight forecast can be hindered when essential data are disorganized or is missing. Two sets of data are of particular concern: traffic volumes and employment.

> *Traffic Volumes.* Because it is difficult to distinguish between truck and passenger cars on automatic counting equipment, many states and cities do not regularly count truck volumes on a good sample of links. The absence of truck counts almost eliminates the possibility of an independent validation of a freight forecast. A truck counting program in support of a modeling effort should count most freeway links, most off-ramps and on-ramps, and a representative sample (10% to 25%) of major arterial links. Since the percentage of trucks in a traffic stream varies considerably throughout the day, counts should be made for a full 24 hours on enough links so that a time-of-day distribution can be ascertained for each functional class.
>
> *Employment Database.* Having an up-to-date listing of employers is important for freight forecasting. Each separate employment location should be identified by the number of employees and by TAZ. Each employer should be identified by SIC.

Management Systems. Information relevant to regionwide freight forecasting can be present in congestion management systems and in intermodal management systems that are maintained by state departments of transportation. Intermodal management systems, in particular, are discussed in Chapter 8.

■ 7.6 Issues in Using Standard Travel Forecasting Software

A freight forecast will likely be made with software originally written for passenger car forecasting. Thus, some adjustments to standard setup will be necessary. In addition, each software package has its own peculiarities that will need to be accommodated. Below are some examples.

7.6.1 Purpose Designation

This manual introduces nontraditional trip purposes that are defined primarily by vehicle class. Depending upon the software package, it may be necessary to assign each freight trip purpose to a proxy (e.g., light trucks to *Home-Based Work* or combination vehicles to *Home-Based Other*). All parameters associated with the original trip purpose should be adjusted accordingly. The *Nonhome-Based* trip purpose can also be used for a single vehicle class, but this purpose should not be the catchall for otherwise unexplained truck travel.

7.6.2 Rationalizing Production-Attraction versus Origin-Destination

The trip generation step described in this manual results in estimates of total trip ends. One may easily conclude that 50% of the trip ends are origins and the other 50% are destinations. However, some travel forecasting packages require that the results of the trip generation step be put in terms of productions and attractions. Thus, it may be necessary to split trip ends across productions and attractions rather than splitting them across origins and destinations. It is important to understand this distinction before performing the forecast and to assure that the model is correctly interpreting the trip generation information. For example, gravity models will disallow trips between two zones when both of them have only trip productions or both of them have only trip attractions.

7.6.3 Integrating Freight and Passenger Forecasts

If the modeling software has a sufficient number of trip purposes, it may be possible to perform a freight forecast at the same time as a passenger forecast. Otherwise, the freight forecast should be performed prior to the passenger forecast. The results of the freight forecast can take one of two forms: (1) truck volumes for each link that will be pre-assigned to links in the passenger forecast; or (2) a truck origin-destination trip table that can be assigned to the network at the same time as passenger car trips. Depending upon the chosen assignment method and features of the software, each form has its advantages and disadvantages.

The advantages of pre-assigning trip to links are: (1) PCE factors can be adjusted for grade and other road conditions specific to individual links (see Section 4.6); and (2) certain links and turn movements can be prohibited.

The advantages of assigning a truck trip table at the same time as a passenger car trip table are: (1) faster software execution; (2) less data manipulation; and (3) the ability to reroute trucks to avoid congested links and turns.

■ 7.7 A Quick Approach for Recategorizing Employment Data

Trip generation for freight modeling requires a fairly detailed account of the employment in a given region. Different MPO's and planning organizations have different ways of storing and presenting employment data. A typical task of freight forecasting is to recategorize existing employment data to correspond to the trip generation categories of this manual. Preferably, employment should be recategorized using original source data. However, sometimes the original data are not available or is in an inconvenient format.

The trip generation rates in Table 4.1 are used for calculating the trip ends per employee by type of industry. Rates are given for the following categories:

- office and service employment (office);
- manufacturing, transportation, communications, utilities, and wholesale trade employment (manufacturing);
- retail trade employment (retail), and;
- agriculture, mining and construction employment (other).

The case study example for Green Bay (Wisconsin) is taken to illustrate the steps in the process of recategorizing employment data.

Green Bay employment data were originally organized into three categories: commercial employment; manufacturing employment; and other employment. The SIC's within each of these categories were known. In addition, the 1990 Census provided a detailed breakdown of the Green Bay employment data by SIC codes (on Table 146, "Industry of Employed Persons: 1990").

Following is a step-by-step account of the procedure involved in the reallocation of the employment data.

Step 1. Calculate the percentage of the 1990 Census employment by category.

Table 7.1 Employment by Category in Green Bay

Industrial Sector	Persons Employed	% Employed
Agriculture	2312	2
Forest/Fishing	43	0
Mining	60	0
Construction	4790	5
Manufacturing	22405	23
Transport and Communication	7618	8
Wholesale	5065	5
Retail	20022	20
FIRE	5954	5
Services	28219	28
Public Administration	2654	3

Source: Census for the Green Bay SMSA.

Step 2. Define local and this manual's employment categories in terms of Census categories.

As seen in Table 7.1, the Green Bay employment data were split into 11 categories by SIC codes. These were reallocated into four trip generation categories, corresponding to those of Section 4.2 of this manual, using the SIC codes as a guide.

Table 7.2 Definitions of Employment Categories

Census Category	Trip Generation Category	Local Category
Retail	Retail	Commercial
Services	Office	Other (28%)
FIRE	Office	Other (5%)
Public Administration	Office	Other (3%)
Manufacturing	Manufacturing	Manufacturing
Wholesale	Manufacturing	Other (5%)
Transport/Commun	Manufacturing	Other (8)
Construction	Other	Other (5%)
Mining	Other	Other (0%)
Forest/Fishing	Other	Other (0%)
Agriculture	Other	Other (2%)

From values in Table 7.2 it is seen that 56% of all employment was originally classified as "other" by the Brown County Regional Planning Commission (Green Bay's MPO).

Step 3. Develop splits of local employment categories into trip generation categories.

A matrix of spits, relating the two sets of categories, could then be developed from the data of Tables 7.1 and 7.2.

Table 7.3 Matrix of Employment Splits

	Office	Manufact.	Retail	Other
Commercial	0.	0.	1.	0.
Manufact.	0.	1.	0.	0.
Other	(28+5+3)/56 = 0.643	(5 + 8)/56 = 0.232	0.	(5+2)/56 = 0.125

Each row of the table sums to 1.0.

Step 4. Apply the splits to zonal data.

First, remove special generators for the employment data for each zone and directly place the special generator employment into the appropriate trip generation category. For the remaining employment, divide them into their new categories according to the splits developed in Step 3. For example, consider TAZ #15 with 215 commercial employees, 51 manufacturing employees, and 152 other employees. The following table splits these employees across trip generation categories, then finds the total employment in each category.

Table 7.4 Application of Splits to TAZ #15

	Total	Office	Manufact.	Retail	Other
Commercial	215	0	0	215	0
Manufact.	51	0	51	0	0
Other	152	0.643*152 = 98	0.232*152 = 35	0*152 = 0	0.125*152 = 19
Total	418	98	86	215	19

This method should be avoided in zones with just a few large employers, as it may be easier and more accurate to use original-source data.

■ 7.8 Network Options for Site Impact Analysis

Site impact assessment requires a network with a very detailed representation of the streets and intersections in close proximity to the chosen site (see Chapter 5). There are three major strategies for drawing networks for site impact analysis.

Strategy 1 - Existing Network. A good existing regionwide network is available. Incorporate the site into the existing regionwide network, in order to include the site traffic with all other traffic (trucks and passenger vehicles). This strategy differs little from traditional regionwide forecasting. All TAZ's are shown at the usual level of detail, but the site becomes one or more additional zones. It should be recognized that many sites contribute only a few trucks to streets during any single hour. Therefore, the implementation of this strategy requires very precise applications of traffic assignment, so that the true impact from this site may be differentiated from errors inherent in the traffic assignment algorithm itself, for example, convergence errors associated with insufficient equilibrium iterations.

Strategy 2 - Special Subarea Focusing Network. Create a special purpose site impact network, implementing the concept of subarea focusing. Subarea focusing involves a precise representation of the site and neighboring streets, but uses coarse representations of the road system and urban development well away from the site. Subarea focusing requires many fewer zones and many fewer links than traditional regionwide travel forecasting. Only the incremental traffic from the site can be estimated by such a network.

Strategy 3 - Incremental Site Traffic on Regionwide Network. Adapt the regionwide network by including the site, but forecast only the incremental traffic from the site. Besides adding the site to the network, the data at centroids and at external stations must be modified to eliminate any traffic not involving the site. Eliminating unwanted traffic can be readily accomplished by allowing only trip productions at the site and allowing only trip attractions at off-site zones and external stations. This method is illustrated by the Services Plus case study in Chapter 9.

When a regionwide network is already available, strategies 1 and 3 are most efficient. Strategy 2, subarea focusing, is preferred when a regionwide network is not available.

Time Period for a Network. Each site impact network is specific to a period of time, (e.g., a morning peak hour or a full 24-hour period). The time period is considered in two ways. First, the network's time period should be known so that the correct number of trip ends can be calculated for the site. Second, the impedances on links and at nodes should properly reflect the amount of traffic during the time period and the imposition of any time-dependent restrictions on truck movements. The means of identifying the time period depend upon the chosen software package.

8.0 Statewide Freight Forecasting in Support of Regionwide Forecasting

8.0 Statewide Freight Forecasting in Support of Regionwide Forecasting

8.1 Introduction

Both Kansas and Wisconsin are unusual in that they have statewide freight forecasting models. The goals of the two models differ considerably, but both are derivatives of the methods described in NCHRP Report 260.[1] Specifically, each of the two models:

- geographically organizes its data into zones, defined primarily as counties;
- identifies the amount of commodities shipped between any two zones;
- determines the fraction of each commodity that is carried by trucks;
- estimates the number of trucks required to carry the commodity; and
- assigns the trucks to a highway network to obtain truck traffic volumes.

The principal desired outputs of both models are estimates of freight vehicle volumes on various transportation facilities. However, the models differ considerably in their use of data and the organization of the steps. A good statewide forecast can provide to the region future estimates of external-to-external traffic and external-to-internal traffic on those highways with the greatest amount of truck traffic.

Degree of Trust. A statewide model may not be intended for applications within a region. When using a statewide model for regional purposes, it is important to first determine whether the statewide model has a sufficiently detailed zone system, has incorporated a good cross-section of commodities and modes, and has been well calibrated. The degree of trust can usually be ascertained by comparing the base-year forecast to known truck volumes. When the match is consistently good throughout the State, results from the statewide model may be fully and confidently used in a regional forecast. Otherwise, the results of the statewide model should only be used in conjunction with data of known validity, such as base-year truck volume counts.

[1] Frederick W. Memmott, *Application Of Statewide Freight Demand Forecasting Techniques*, National Cooperative Highway Research Program Report 260, National Research Council. Washington D.C. 1983.

■ 8.2 The Interface at External Stations

A statewide model interfaces with the regional model at its external stations. Ideally, the following two conditions should hold true:

> **Condition 1.** Flows to and from each external station should be consistent with the forecasted volumes on the corresponding highways in the statewide network; and
>
> **Condition 2.** Through trips between two external stations should be consistent with number of trucks using both corresponding highways on the statewide network.

These conditions should hold for the base-year forecast and for any future-year forecasts. The first condition can almost always be satisfied by proper settings for external station data. However, the second condition requires the construction of an external-to-external trip table, which can be a hit-and-miss proposition even under the best of circumstances. The building of an external-to-external trip table can be facilitated when the statewide model has the capability of providing information about the amount of traffic that occurs between many pairs of links or when the statewide model has special capability of creating a trip table for a "window" on the network.

For statewide models that do not have these special capabilities, it is still possible to develop the necessary external station information for the regional model. For any link on the statewide model near a regional external station, it is essential to categorize the amount of traffic that is:

- External-to-Internal (E-I);
- Internal-to-External (I-E);
- Internal-to-Internal (I-I); and
- External-to-External (E-E).

Most cities are represented by very few centroids on the statewide network. Thus, the amount of regional I-E or E-I traffic may be readily identified by performing either a select link analysis or a select zone analysis on the statewide network. When the region is represented by more than one centroid, I-I traffic may be found by:

- inspecting the origin-destination table;
- performing a select zone analysis; or
- ignoring it altogether.

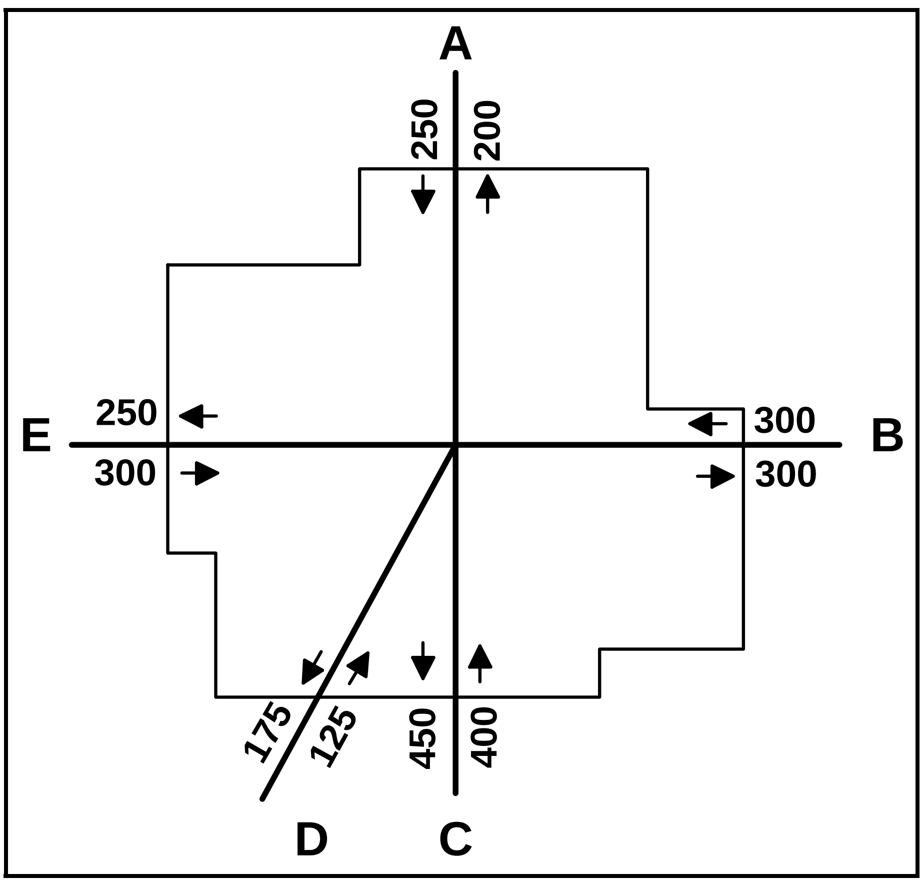
In a region represented by a single centroid, internal-to-internal traffic must always be ignored, as it would not have been assigned to the network. The remaining traffic (after accounting for E-I, I-E and I-I trips) is E-E.

Once the amount of E-E traffic on each link has been identified, it is possible to synthesize an E-E trip table. When doing so it is important to understand that there is a considerable amount of error in the link volumes coming from the statewide model, and this error *increases* as the link data are further disaggregated into a trip table. An increase in error would be expected because of the additional assumptions required to split incoming traffic into its various outgoing flows. However, a high degree of precision is not always necessary for forecasting. Consequently, a reasonably good E-E trip table can be created by following these steps:

Step 1. Obtain a drawing of the regional network, showing its external stations. Obtain a map of the region that includes neighboring cities, major generators in close proximity to the region, and barriers to travel (e.g., rivers and mountains).

Figure 8.1 below shows a small hypothetical city, Daneville, with five external stations.

Figure 8.1 Daneville External Stations



Step 2. List all pairs of external stations that are unlikely to share trips. Examples are: (a) pairs of external stations on paths leading from the region to the same

neighboring city; (b) pairs of external stations on two sides of the same divided highway; and (c) pairs of external stations where both are on paths leading to rural or suburban locations. In the Daneville example, the external stations C and D lead to the same part of the State, so they will not exchange trips.

Step 3. Create a matrix of weights, one weight for each pair of external stations. Set the weight to 0 for all elements on the diagonal of the matrix and for all pairs of external stations identified in Step 2. Set the remaining weights to 1.0. In general, the resulting matrix should be symmetrical.

Table 8.1 shows Daneville's matrix of weights.

Table 8.1 Initial Daneville Matrix of Weights

		Destination				
		A	**B**	**C**	**D**	**E**
	A	0	1	1	1	1
	B	1	0	1	1	1
Origin	**C**	1	1	0	0	1
	D	1	1	0	0	1
	E	1	1	1	1	0

Step 4. Apportion trip origins across destinations according to the total trips at each destination multiplied by the weight from Step 3.

Table 8.2 shows the weighted destinations, and Table 8.3 shows Daneville's E-E trip table. At this point the column totals will probably not agree with the needed destination totals.

Table 8.2 Daneville Weighted Destination Trips

		Destination					
		A	**B**	**C**	**D**	**E**	**Sum**
	A	0	300	450	175	250	1175
	B	200	0	450	175	250	1075
Origin	**C**	200	300	0	0	250	750
	D	200	300	0	0	250	750
	E	200	300	450	175	0	1125

Table 8.3 Initial Daneville External-to-External Trips

		Destination					
		A	B	C	D	E	Sum
	A	0	64	96	37	53	250
	B	56	0	125	49	70	300
Origin	C	107	160	0	0	133	400
	D	33	50	0	0	42	125
	E	53	80	120	47	0	300
	Sum	249	354	341	133	298	

For example Cell AC is calculated as 250*450/1175 = 96.

Step 5. Check the column sums of the E-E trip table for consistency with the number of destinations. If necessary, adjust the weights in Step 3 by multiplying them by the desired destination total and dividing them by the total obtained in Step 5. Redo Step 4 and perform another check (and adjustment, if necessary). Continue this process of adjustments until the column totals are within 1% to 2% of the needed destination totals. The first round of revisions are shown in Table 8.4 and Table 8.5. Notice that the destination totals in Table 8.5 are closer to the desired values, but they are not yet acceptable.

Table 8.4 Revised Daneville Matrix of Weights

		Destination				
		A	B	C	D	E
	A	0	0.85	1.32	1.32	0.84
	B	0.8	0	1.32	1.32	0.84
Origin	C	0.8	0.85	0	0	0.84
	D	0.8	0.85	0	0	0.84
	E	0.8	0.85	1.32	1.32	0

		Destination					
		A	**B**	**C**	**D**	**E**	**Sum**
	A	0	49	115	45	41	250
	B	40	0	149	58	53	300
Origin	**C**	102	163	0	0	134	399
	D	32	51	0	0	42	125
	E	39	62	144	56	0	301
	Sum	213	325	408	159	270	

Table 8.5 Revised Daneville External-to-External Trips

Step 6. Check the trip table for reasonableness. Change any weights that are causing unreasonable results, then repeat Steps 3 to 5. Document the logic underlying any adjustment.

It should be noted that this procedure is very similar to a doubly-constrained gravity model, except that weights are used instead of friction factors.

Presumably, this procedure could be performed individually for each of the three categories of trucks given a sufficiently robust statewide forecasting model. More likely the E-E trip table will contain a combination of all three truck categories.

These steps should only be performed if the statewide results can at least be trusted at the link level. If not, the statewide model can still be used to establish trendlines.

Validation for Reasonableness. Planners should be comfortable about the accuracy of the truck E-E trip table before it is incorporated into a forecast. Three questions must be answered, namely:

1. Are the link volumes from the statewide model sufficiently accurate?

2. Is the disaggregation process for building a truck E-E trip table yielding sufficiently accurate estimates of trips between external stations?

3. Are the flows in the truck E-E trip table plausible?

In the absence of an existing truck E-E trip table, these questions cannot be answered with a great deal of confidence. Instead, the E-E trip table should satisfy subjective tests of reasonableness, supplemented by whatever data are readily available. Data that can indicate a problem with the truck E-E trip table include:

- an old truck E-E trip table;
- a partial truck E-E trip table;
- a passenger vehicle E-E trip table;
- truck counts on ramps at interchanges of freeways and other major arterials leading to external stations; and
- interviews with shippers, carriers, state police, or state DOT officials.

Although such data may not be sufficient to build a base-year truck E-E trip table, it may be possible to use them in validating a trip table built by other means.

8.2.1 Statewide Trendlines at External Stations

Even when the statewide model cannot be trusted at the link level, it may be still be trusted to give a good approximation for the growth in truck traffic near the region (see Chapter 3). A single estimate of truck traffic growth may be made for all external stations in the region, or estimates can be made for groups of adjacent external stations. Once obtained, these estimates of growth can be used to convert base-year external station data into appropriate settings for future-year forecasts.

8.3 Kansas Statewide Agricultural Commodity Model

The Kansas DOT (KDOT) has been involved with freight forecasting since 1984, when a new computerized state highway network was established. In this initial effort, they used population, employment and agricultural sales to generate truck trips. Upon using this methodology, it was found that there was a need for a better commodity and heavy truck forecasting model. In 1992, they undertook a new freight forecasting model dealing with truck movement.[2] This was still an exploratory model, and it was limited to the movement of five commodities (e.g., corn, wheat, sorghum, soybeans and boxed beef). These commodities were chosen because the State had collected detailed data for these commodities for intrastate and interstate movement by mode. The main purpose of this second effort is to examine the assignment of truck trips from commodity flows. There

[2] Eugene R. Russell, L. Orlo Sorenson, and Rick Miller, *Microcomputer Transportation Planning Models Used To Develop Key Highway Commodity Flows and To Estimate E.S.A.L. Values*, Department of Civil Engineering, Kansas State University, September, 1992.

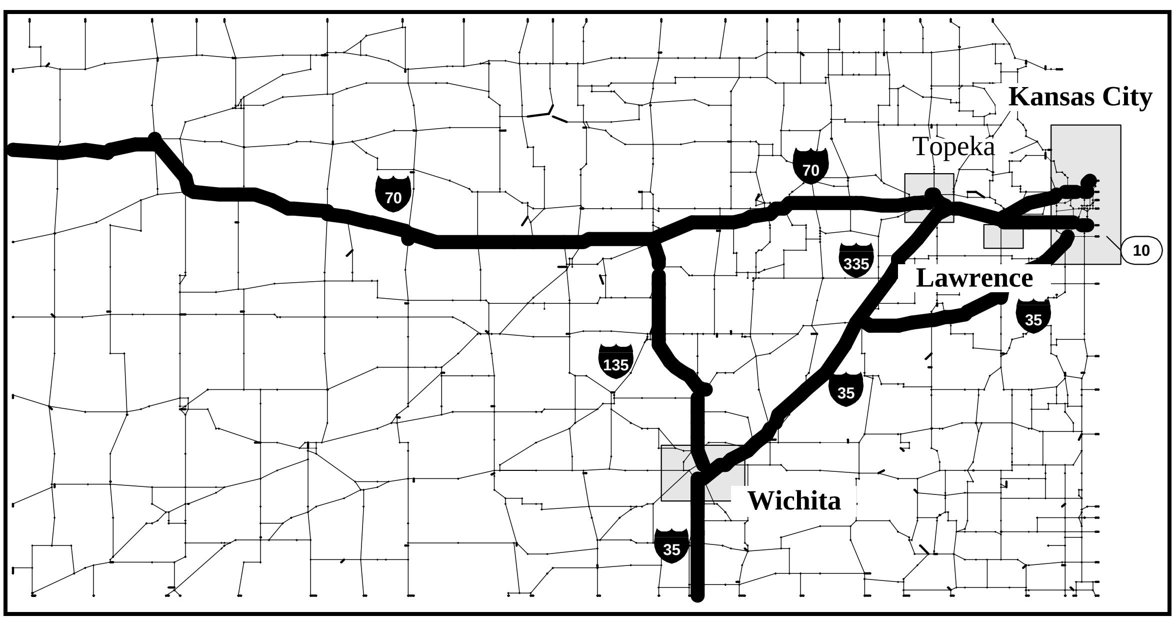
was some attempt to model non-agricultural truck movement, but this was not the main focus.

8.3.1 Elements of the Model

The development of this model consisted of five steps, namely: (1) network development; (2) data assembly and analysis; (3) trip distribution; (4) conversion of commodity flows into truck flows; and (5) trip assignment.

Step 1 - Network Development. Three separate networks were used, differing only in the way link impedances were determined: a speed network; a terrain network; and a toll facility network. The networks included 202 TAZ's and 2,200 links. Zones of interest here included 105 counties and 69 external stations. For zones corresponding to counties, the location of the county seat became the zone centroid. External stations were located where state highways cross the Kansas border and where KDOT had recent counts of total heavy trucks. The networks were derived from a network originally drawn for KDOT's UTPS mainframe model; that network was downloaded to a microcomputer for subsequent processing. The complete network is illustrated in Figure 8.2 with the freeways shown as wider lines.

Figure 8.2 Network for the Kansas Statewide Freight Model Highlighting Interstate Highways



Step 2 - Data Assembly and Analysis. The model utilized secondary data collected by the State of Kansas concerning movements of five commodities identified. It also used origin and destination data collected at monitoring stations at the border and at other key locations throughout the state. This data were supplemented by the use of mail surveys, telephone reports and personal on-site interviews. The state data also included the movement by modes (truck, rail, and barge) so that there was no need to use other sources, formulas or broad assumptions to derive the modal split for the commodity flows.

Step 3 - Trip Distribution. Three types of trip tables were created for the following movements: internal-to-internal; external-to-external; and internal-to-external. The internal-to-internal trip table was synthesized from the commodity flow data. The external-to-external trip table was developed from O-D studies at various locations around the state. The internal-to-external and external-to-internal trip tables were calculated by a gravity model.

Step 4 - Conversion of Commodity Flows into Truck Flows. Modal splits by commodity were based on actual historical flow data from producer to transfer point or processing point. Also available were flow data concerning truck movement from grain elevators to users. Truck flows were obtained from commodity flows by assuming that all trucks carried a single commodity and were equally loaded. Trucks were assumed to carry 40,000 of boxed beef or 850 bushels for grain commodities. However, the developers of the model later reasoned that 910 bushels per load for grains and 44,000 per load of boxed beef would have produced better estimates of equivalent truck loads.

Step 5 - Traffic Assignments. All-or-nothing traffic assignments were done for each of the five commodities on each of the three networks. The results by commodity by network were totaled to yield three networks that contained the sum of the loadings. To obtain a composite network, percentages were weighted 50, 30 and 20 percent, respectively. This method of creating a multipath assignment obviated the need for either estimates of passenger traffic or link capacity. The assigned volumes are illustrated in Figure 8.3. The results were judged to be smooth and realistic.

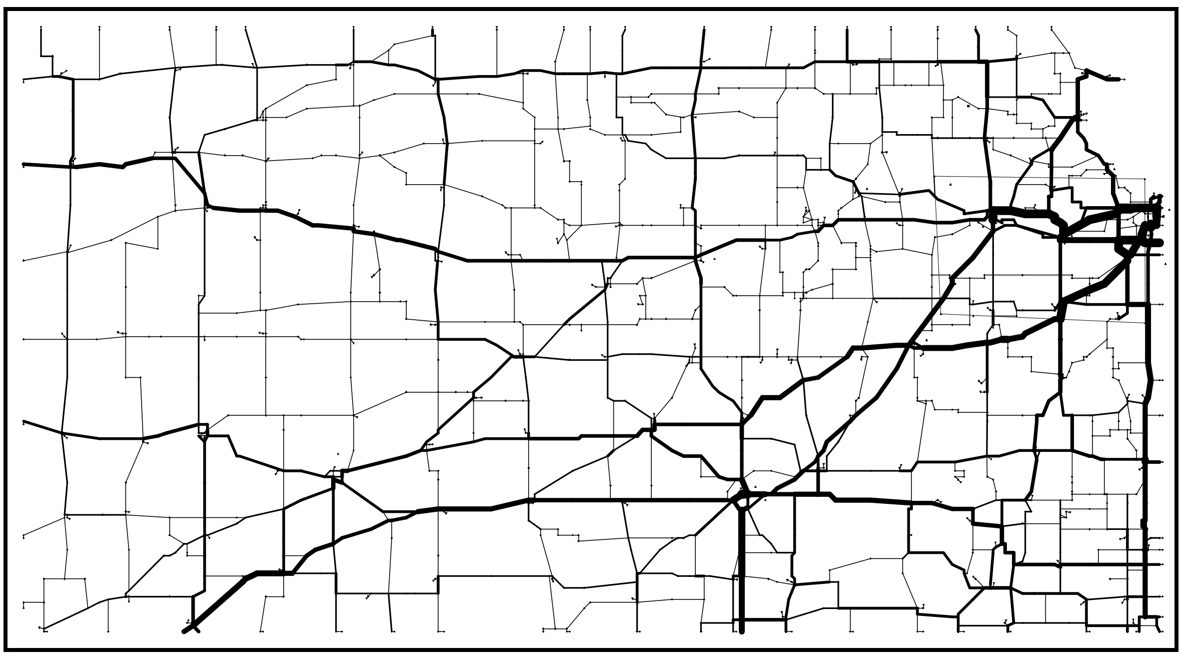
8.3.2 Weaknesses Recognized by Kansas DOT

Weaknesses recognized by KDOT include insufficient validation, assumptions about truck payload, imprecise means of determining good impedance measures, the judgmental method of weighting the results from the three networks, and an inability to precisely calibrate the gravity model for internal-to-external and external-to-internal trips. Many of these problems could have been overcome had KDOT been able to obtain a comprehensive set of reliable truck volume counts and perform a rigorous calibration. Another major problem relates to omitted commodities, both agricultural and nonagricultural. KDOT is continuing its efforts in statewide freight modeling, so better forecasts should be available in the future.

8.3.3 Overall Assessment of KDOT's Freight Model for Regionwide Forecasting

At present the usefulness of KDOT's model is limited to establishing trendlines and growth factors (see earlier section and Chapter 3). Without extensive network calibration, the model cannot reliably forecast volumes on highways leading in and out of many urban areas. However, the amount of growth in freight traffic near and through urban areas should be well predicted. Potentially and with KDOT's intended refinements, the model could permit a nearly seamless integration of statewide and regional freight forecasts.

Figure 8.3 Forecasted Truck Volumes by the Kansas Statewide Model



Note: The widths of the links are proportional to the assigned truck volumes.

■ 8.4 Wisconsin Intermodal Freight Model

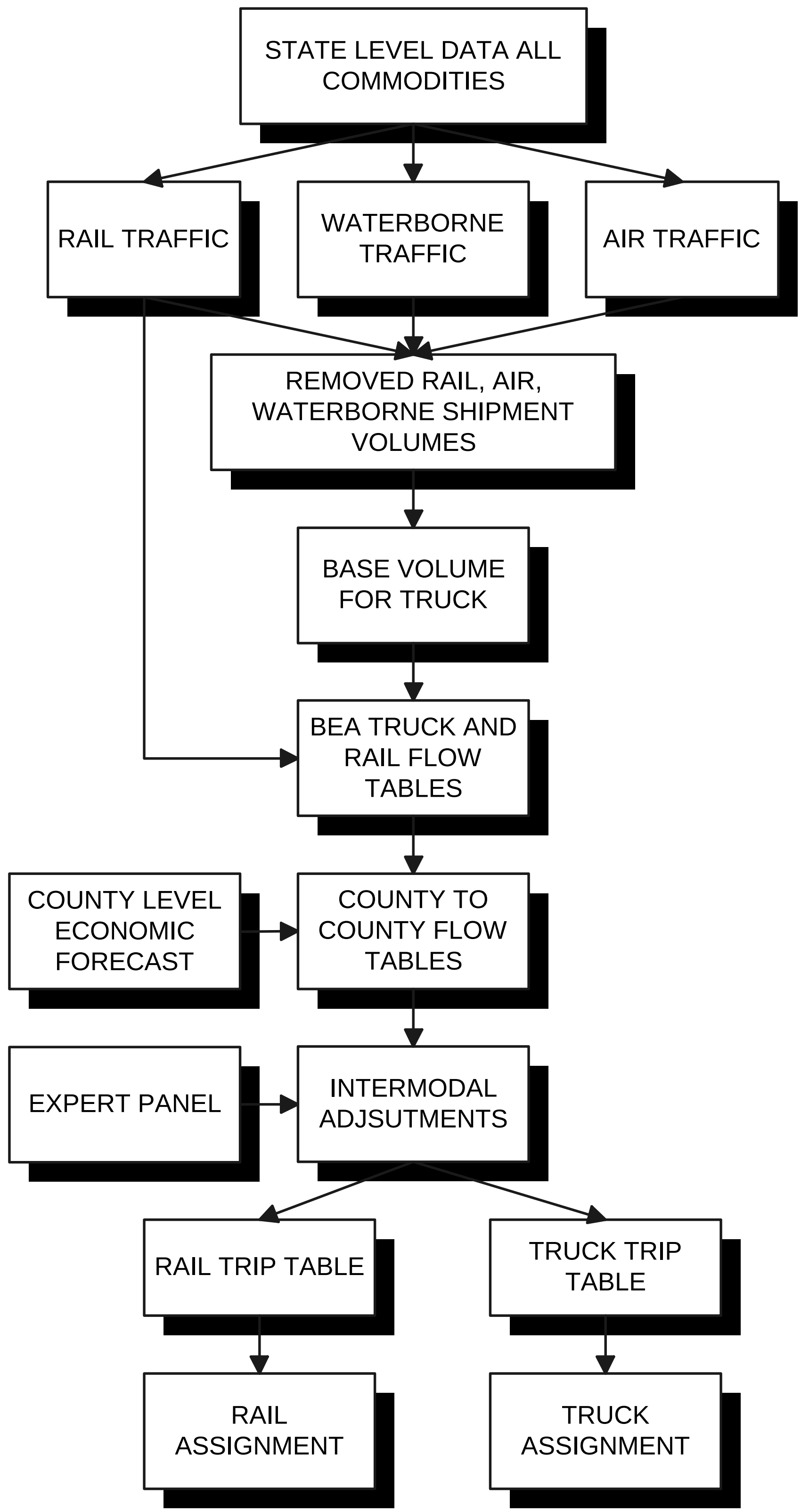
8.4.1 Overview

The Wisconsin Department of Transportation (WisDOT) undertook freight forecasting as part of its long-range multimodal plan -- Translinks 21.[3] WisDOT's goals included the construction of a database of forecasted commodity flows and the creation of the ability to ascertain forecasted link volumes for all major freight modes in the state. The process of forecasting truck volumes, in particular, is illustrated in Figure 8.4. WisDOT's forecasting method provides a good example of how data can be collected from both primary and secondary sources and then used effectively to arrive at a statewide truck traffic forecast.

WisDOT's effort involved the development and analyses of integrated sets of passenger and freight data for all intercity modes. County level commodity flow data for all modes was developed. The commodity flow data were converted to tonnages and vehicles to arrive at the traffic flow by mode. These were then assigned to their respective networks.

Figure 8.4 Overview of the Truck Component of Wisconsin's Freight Forecasting Model

[3] Wisconsin Department of Transportation, *Translinks 21 Technical Report Series: Multimodal Freight Forecasts for Wisconsin*, Draft No. 2, 1995.



The flow diagram of Figure 8.4 provides an overview of the various processes and interlinkages in the preparation of the freight movement data.

8.4.2 Building the Commodity Flow Data Set

The original database for WisDOT's multimodal plan was *Transearch* -- a proprietary database of US freight movements produced by Reebie Associates. Transearch includes descriptions of freight traffic shipments for various geographic markets, commodities, units of measures, and seven modes of transportation. The following are the four stages of Transearch data construction, as applied in Wisconsin:

> **Stage 1.** Establishment of the level and sources of production and consumption of all goods, using industrial output by state and sector, population and industry employment by county, and foreign trade.
>
> **Stage 2.** Determination of the level of railroads, water, air and pipeline traffic from commercial and industrial sources. The geographic units are all converted to BEA regions.
>
> **Stage 3.** Establishment of the level of truck flows by subtracting the known modal traffic developed in Stage 2 from the total production developed in Stage 1. The truck flows are checked against industry statistics and state flows using various trucking data sources.
>
> **Stage 4.** Disaggregation of the truck flows to county-to-county flows using county factors and inter-industrial trade patterns.

WisDOT supplemented the Transearch database with new data to make it specific to Wisconsin. These were referred to as the custom inputs, which fall into four categories:

1. population and employment data by county and industry;

2. industrial activity for the energy, agriculture and dairy, forest and paper, aggregates and mineral sectors;

3. waste generation and consumption; and

4. exports.

A mode by mode update of the 1991 Transearch data to 1992 levels was undertaken by WisDOT. Relevant indices, output measures and projections were used for updating. Volumes for certain commodities were adjusted according to the industrial output within Wisconsin. Overhead volumes (i.e., flows going through Wisconsin without originating or terminating inside the state boundary) were also included in the database.

The railroad traffic was taken from 1992 ICC Private Use Waybill Sample, which provided the commodity tonnage information for rail traffic originating and terminating in and around Wisconsin. Likewise, waterborne and airborne freight traffic data pertaining to the State of Wisconsin were generated. Truck traffic, aggregated to BEA regions in the Transearch database, was further broken down to the county level for local area analysis. Truck volumes of secondary shipments (shipments outbound from distribution centers, i.e., wholesalers or intermodal terminals) and many non-manufacturing goods were not included in Transearch. Volumes were generated based on the county level data for wholesaling and warehousing employment, industrial activity, and waste generation and consumption. In this way a unified structure of freight OD flows by different modes was developed for 1992 base year.

8.4.3 Freight Forecast

Base-year 1992 data were used to develop forecasts for year 2020 and for five intermediate target years. Industrial employment and productivity were used for the freight forecast. The trendline logic applied consisted of: (a) a change in employment due to a change in production yields a similar change in output, (b) output results in shipments, and (c) commodities can be related to output of a particular industry through SIC codes.

A projection of the employment was prepared for each year between 1992 and 2020 by using economic indicators of 92 separate classes of industry, equivalent to two digit SIC codes. Employment was calibrated to the official population projection of the State of Wisconsin, embracing all forms of economic activities. This forecast was made for each of the 106 counties, constituting the set of local analysis zones. The employment forecast for the remainder of the country was taken from the Regional Projection of the BEA. Information regarding productivity in Wisconsin was provided to WisDOT by *REMI* (*Regional Economic Models Inc.*) -- a firm specializing in regional economic projections. Factors showing change in output per employee by industry group over time were developed, which were used as a multiplier to enlarge or dampen the effect of employment change on output.

Finally, the base-year freight forecast of flows was generated. Beginning with the 1992 base-year volumes by commodity and origin, tonnage was multiplied with the combined ratio of change for employment and productivity to that origin and relevant industry. This was done for each target year assuming the same rate of change for all modes carrying a given commodity from a single origin. Adjustments in the primary freight forecast were made for certain commodities (e.g., farm outputs, fuels, waste, nonmetallic minerals) and for export and air forecasts, which were judged to grow either faster or slower than the average for all freight.

Trendlining Issues. The freight forecast was developed with econometric factors that were derived from long-term trends. Any deviations from these trends signify the varying effects by industry and locality, which result in variations in volume for freight carriers. Such deviations can affect the overall share of traffic attributed to each mode, but there is not a true modal shift as a consequence of shipper choice.

8.4.4 Intermodal Adjustments

WisDOT also needed both long-term and short-term estimates of intermodal potential (as a percentage of total flow) by commodity. They prepared these estimates primarily by referencing the commodity flow information derived from the aforementioned freight traffic database and separate results from a survey of shippers and operators conducted by WisDOT in 1994.

One of the WisDOT's future scenarios, the truck-rail scenario, is based on the state and national trends of:

- significant national growth in intermodal activity and partnerships between major trucking and railroads companies;
- increase in highway congestion;
- long-haul driver shortages; and
- development of intermodal technologies and equipment leading to increased efficiency.

The intermodal potentials for the selected commodities, i.e., the commodities being transported by trucks, were identified in the shippers' and the operators' survey. The commodities were subjectively classified into four categories based on their intermodal potential. The survey also established break points for distances at which intermodal transport was likely to be more attractive than truck-only transport. Strong preferences were shown for 500-mile thresholds, which were adopted as the minimum distance for intermodal freight movements in subsequent analysis. Frequency of shipment was identified as the principal service component necessary to meet the requirement of shippers to convert to intermodal.

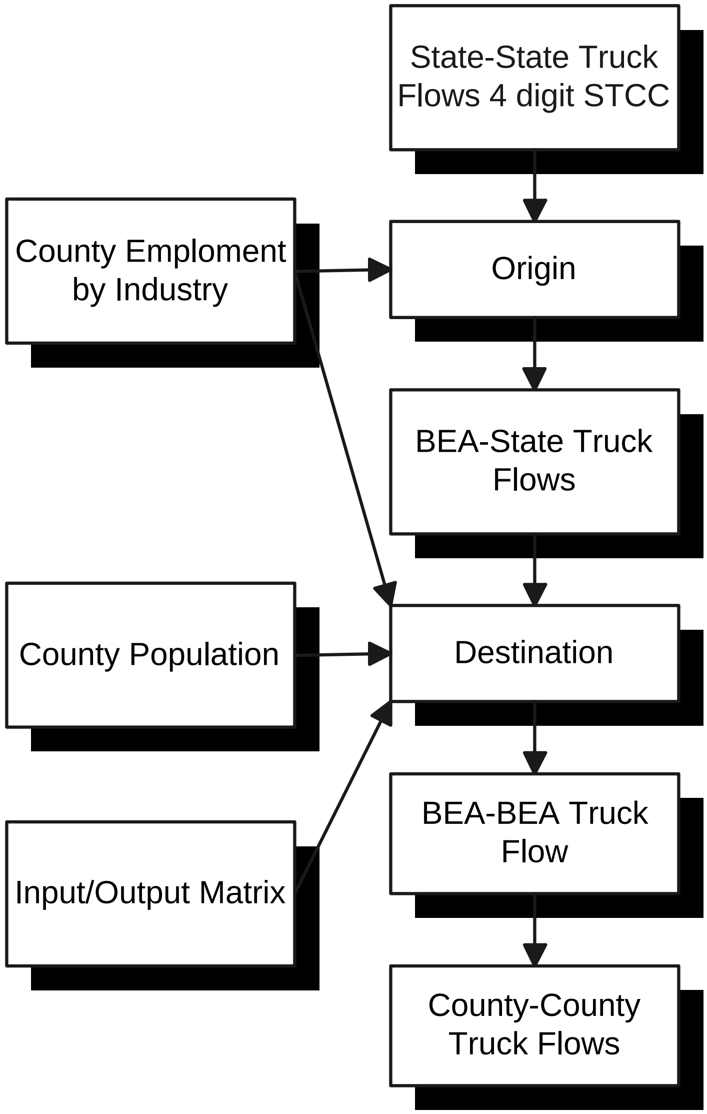
After the intermodal flows were identified, rail and truck trip tables were appropriately adjusted and assigned to railroad and highway networks. To amplify the procedure for truck forecasting, the following section provides a review of the process of truck trip generation and truck assignments.

8.4.5 Determination of Truck Traffic

As indicated in Figure 8.4, the amount of truck traffic was determined by subtracting shipment flows by competing modes from the total production and consumption of goods. The truck flows so generated were checked against trucking industry statistics and information about state-to-state flows. The truck shipments of manufactured goods were found to be about half of the tonnage.

The State-to-State truck flows were disassembled to the county level via BEA regions (see Figure 8.5) .

Figure 8.5 State-County Disaggregation Process



The four-step disaggregation process was as follows:

Step 1. Traffic volume by 4-digit commodity code was considered for each O-D flow.

Step 2. At the origin, the industry producing the commodity was identified by industrial codes and located by county. The origin volume was allocated to each county based on its share of employment in the eligible industry.

Step 3. The consumers of the commodity at the destinations were a mixed group, consisting of industry and the general public. The patterns of consumption were determined by an Input-Output table. For any given commodity the O-I matrix indicates the relative amount consumed by each industry or economic sector.

Step 4. Based on the share of population for the general public and employment for industry, the destination volume was distributed to each county.

Hence, the O-D flows for BEA regions were disassembled to the county level by using population and employment data.

The truck trip matrix was developed by converting the annual commodity tonnage to annual truckloads by using typical commodity weights per truck for each commodity. The densities of the commodities on trucks were taken from the densities generated for the rail database.

The densities were applied to truckloads using 24 tons as a maximum payload for a tractor-trailer rig. Finally, annual truckloads were divided by 312 (6 days per week multiplied by 52 weeks) to obtain daily truck loads. The resulting trip matrix was assigned to the highway network using an UTPS-style software package. A stochastic multipath assignment method, which allows all efficient paths between zone pairs to be considered likely, was used. A calibration process was then undertaken to replicate base year (1992) truck volumes on the highway network.

8.4.6 Observations about the Wisconsin Statewide Model

WisDOT's approach to freight forecasting is more ambitious than KDOT's, although its success is also heavily dependent upon achieving a good calibration to base-year truck counts. Perhaps the greatest concerns with WisDOT's methodology are possible errors associated with the process of elimination to arrive at the truck flows. In spite of all the extra effort, WisDOT's model, like KDOT's, is limited for regionwide forecasting by the use of counties for zones. Consequently, the model cannot readily provide information on intra-regional truck movements.

Notwithstanding the above concerns, WisDOT's efforts illustrate the potential of freight forecasting and can provide solid information for calibrating and forecasting external stations in regional truck networks.

■ 8.5 Use of Intermodal Management Systems

8.5.1 IMS Possibilities

There is great potential in the development of State intermodal management systems (IMS) for expanding the scope of traffic forecasting. Traditional transportation planning has paid limited attention to intermodal transportation, particularly the freight component. IMS's promise to provide for the development of an ongoing intermodal and multimodal database, which can integrate both statewide and regional information for more comprehensive travel forecasts.

The foundation of an IMS is the development of an ongoing database and a geographical information system (GIS) for spatially-referenced data. Some of the database items that could be included in an IMS are: commodity flows statewide by mode and by network; intermodal network and facility characteristics (i.e. types of runways at airports, number of cranes at ports, geometrics at key intersections and interchanges of highways, ease of transfer between intracity/intercity public transportation); long range freight forecasts; and modal counts (i.e., truck type by facility). These database items could be shared between state and regional agencies to provide the basis for short and long term intermodal plans, including regional forecasts. With the development of wide-area and local-area computer networks, and the affordability of appropriate hardware and software, a shared database should be a realistic goal.

Many States have made plans for the development of an IMS. However, the scope and detail for the various IMS's vary greatly, as does their applicability to freight forecasting. This is not surprising given the newness of this planning tool. The State IMS plans described in the next section have forecasting elements or databases that could be readily integrated into regional forecasting. The other State IMS plans have not been developed sufficiently to ascertain whether they contained these components.

8.5.2 Review of Selected State IMS Plans

California Intermodal Transportation Management System

The California Department of Transportation (Caltrans) is planning a comprehensive IMS that utilizes a statewide database.[4] Caltrans has completed the collection of a portion of its proposed IMS database including an inventory of intermodal facilities. It plans to collect data on freight and person movement, geometrics, and data elements for all modes, among other data. Future database collection will be determined according to developed performance standards.

This database will use a commercial database management system in conjunction with a geographical information system (GIS). The primary computer system will be a local-area network using client-server software. In addition, the data will be available to Caltrans' district offices by CD-ROM. The database will have a flexible architecture that will allow regional and local planners to integrate their plans and modeling efforts with the State IMS. There are also plans to incorporate expert systems and artificial intelligence components into the database programs to make the IMS more powerful.

As part of this IMS the freight demand will be estimated for 10-, 20-, and 30-year time periods. Freight data will be provided by Reebie Associates based on an econometric model and long-haul truck data obtained through a data exchange program. Training for

[4] California Department of Transportation, *California Intermodal Transportation Management System Work Plan - Preliminary Draft*, July, 1994.

Caltrans employees and regional planners on the use of computer applications will be provided.

Idaho Intermodal Management System Work Plan

The Idaho IMS Plan[5] includes an inventory and collection of modal traffic flow data. Idaho has divided its data needs into supply and demand categories. Some of the data to be collected on the supply side are: facility location; modes served; hours and frequency of service; capacity; flow rates of persons and goods; industries served; and storage and consolidation capabilities. On the demand side the following information is to be collected: freight characteristics relevant to movement such as density, containerization requirements/opportunities, hazardous qualities; goods and freight vehicle flows on links and through junctions, including intermodal facilities by time and day; origin and destination matrices of person movements and passenger vehicle movements by purpose and with diurnal characteristics; and origin and destination matrices of freight, stratified by type of commodity and characteristics relevant to modal elements of path.

The database structure is proposed to be compatible with several management systems. The database will be used in combination with other plans and performance standards to access short- and long-term needs and projects. One of the components will be the capability of using the database to develop intermodal forecasts.

Michigan Transportation Management System

MDOT's IMS Plan[6] includes an extensive existing database. MDOT is finishing the development of a GIS for all highway systems. Data still to be collected include: origins and destinations, along with access to non-highway facilities; goods movement; and vehicle classification.

The database and GIS will be integrated so that there is an interrelationship between MDOT's overall management plan for transportation facilities, such as bridge management, congestion management and intermodal management.

Nevada Intermodal Assessment System

Nevada proposes a comprehensive, spatially referenced IMS utilizing a GIS containing numerous items related to freight movement.[7] Spatially-referenced data that have been

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[5] Idaho Department of Transportation. *Idaho Intermodal Management System Work Plan*, November, 1994.

[6] Michigan Department of Transportation, *Intermodal Surface Transportation Efficiency Act: Transportation System Management Work Plan Overview*, September, 1994.

[7] Nevada Department of Transportation, *Nevada Intermodal Assessment System: System Description and Variable Documentation*, Planning Division, July, 1994.

collected include: description of highway links by a variety of attributes (such as type of facility), truck or truck restricted routes, number of lanes, commodity flow indicators; railroad links by several attributes (such as type of service and Federal rail classification); bridge inventory, including deck condition and annual average daily traffic volume; a description of airport facilities, including runway length, ownership, and enplanements.

The GIS for the IMS utilizes *TIGER* (*Topologically Integrated Geographic Encoding and Referencing*) point and line files for railroads, highways and airports. Thus, the GIS was created with minimal new data collection. The structure of the GIS enables data to be easily exported to a diverse set of software packages.

8.5.3 Discussion and Recommended IMS Elements

The range of detail and focus vary widely among States' IMS's. Some States perceive the IMS as only a short term management plan, while others perceive it as a vehicle for both long and short range intermodal planning, including freight forecasting. Still other States provide extensive detail about the establishment and use of their databases and GIS's, but were unspecific about the nature of the data itself.

Among all the plans reviewed, the previously discussed plans touched on elements of a well-constructed IMS. However, none had all of the elements. The following is a short recipe for an IMS that supports the needs of freight forecasting:

1. **Goals/Objectives and Performance Standards.** There should be a clear and distinctive delineation of goals and objectives and how these will be operationalized (i.e., responsibilities of the different actors, databases, hardware and software, implementation, and training schedule).

2. **Description of Database Items.** Existing and future database items should be selected on the basis of data availability, or on the basis of ease in collecting the data. These should be listed in the IMS plan for review by all involved agencies, including MPO's and other planning organizations. Data relevant to freight forecasting should be included within the database. Certain database items may be obtained conveniently, but they may be of limited applicability. Efforts to collect data items should be consistent with previously established goals.

3. **Database and GIS Structure.** Data should be transferable to a variety of planning organizations. The ease of transferability of data and geographic references between different software packages (existing and proposed) should be carefully planned and detailed before the implementation of the IMS. IMS plans should recognize the relationship of different agencies to the IMS in terms of whether they will be potential users of the GIS and/or database, their access to the GIS or database (i.e., local-area and wide-area computer networks), and their level of participation (i.e., updating of the database/GIS).

In conclusion, there was a wide disparity in the IMS plans. Many of the plans reviewed had elements that were extremely broad, overly ambitious, or difficult or clumsy to implement. However, there were other States that appear to be progressing such that their IMS will not be a bureaucratic exercise to satisfy federal requirements. This is a natural progression of events in the promulgation of new regulations. The next step would be for US DOT and their modal administrations (i.e., FHWA, FTA, FRA) to provide a better explanation of what an IMS should contain.

8.6 Discussion of Statewide Contributions

The case studies in this manual used statewide information to supplement local data where possible. Statewide traffic forecasts were especially helpful in setting external station data in future years. Truck traffic counts provided by the State DOT's were found to be reliable and essential for model calibration. States were also able to provide limited information on special generators, such as intermodal transfer facilities. A more comprehensive statewide database in the form of an IMS would have improved the responsiveness of the forecast and increased its accuracy. Data elements that could not be readily obtained but would have been useful include:

1. Truck counts by vehicle class on selected facilities;
2. Truck counts on a greater variety of facilities, including roads not designated as state trunk highways;
3. Lists of major truck trip generators, their commodity and employment characteristics, and their location;
4. Lists of truck routes or truck-restricted road segments;
5. A statewide, base-year truck forecast that is well calibrated to traffic counts on road segments serving as external stations for regional forecasting purposes;
6. Diurnal variation of truck trips by vehicle class and road functional class.

With this information, together with data already gathered for regionwide passenger travel forecasting, a truck forecast can be truly quick response.

9.0 Case Study Applications to Urban Areas

9.0 Case Study Applications to Urban Areas

The methods of this manual are primarily intended to provide the freight portion of a regionwide forecast of vehicular travel. Three case studies are presented here: Lawrence, Kansas; Appleton-Neenah (Fox Cities), Wisconsin; and Green Bay, Wisconsin. The Lawrence application has the fewest and roughest steps, so it is presented first. The forecasts in Green Bay and Appleton-Neenah (Fox Cities) have much in common, so they are described together with an emphasis on Appleton-Neenah (Fox Cities). In addition, a site impact analysis is presented for a moderate-sized industrial facility in Green Bay.

Of greatest interest here are data preparation as well as the process of applying quick response methods to produce base-year forecasts.

9.1 Lawrence, Kansas

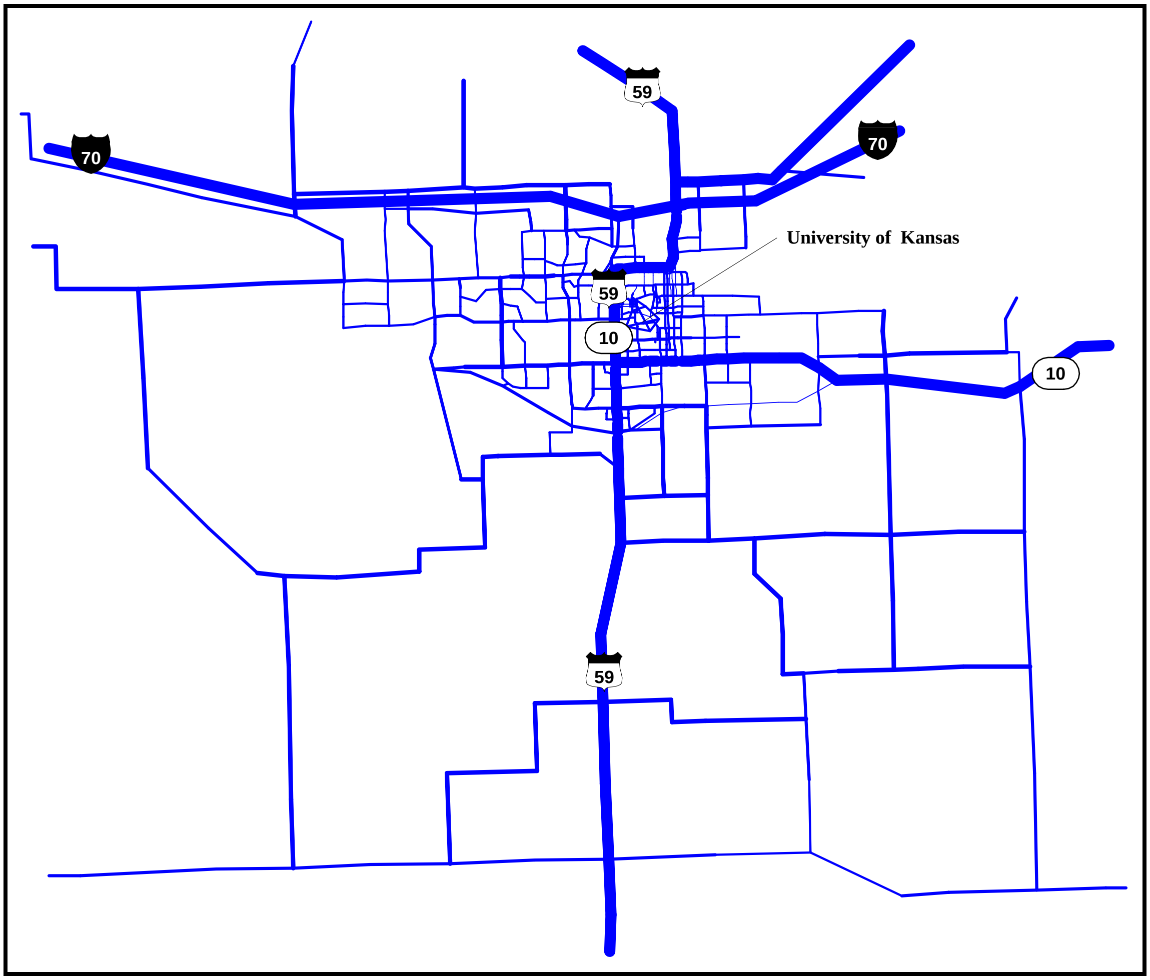
9.1.1 Background on Lawrence

Lawrence is a peaceful city with a stormy history. In the 1850's to 1860, Lawrence and its surrounding areas were sites of violence related to whether Kansas would be a free State or a slave State. The City of Lawrence was founded in 1854 by the New England Emigrant Aid Company in Boston and was planned to be the capital of Kansas.

Lawrence soon became the center of Free State activities and a haven for runaway slaves. During the Civil War, Lawrence was also the site of an attack by Confederate guerrillas, which resulted in the city being sacked and burned. After this incident, Lawrence rebuilt itself and in 1866 became the site of the first state university in the Great Plains. However, Lawrence's growth was later overshadowed by neighboring Kansas City and Wichita.

Lawrence is situated in the eastern portion of Kansas, 40 miles west of Kansas City Kansas/Missouri and 30 miles east of Topeka (see Figure 8.2). The population of the Lawrence SMSA was estimated to be approximately 80,000 in 1995, with the City of Lawrence having approximately 70,000 persons. The most prominent feature of Lawrence is the University of Kansas. However, the city should not be entirely classified as a college town. Some of the major employers include Hallmark Cards, Sallie Mae Loan Servicing Center, a K-Mart distribution center, Allied Signal, and Davol Incorporated, makers of medical and laboratory equipment. These major employers serve as examples of the diversified economy of Lawrence.

Figure 9.1 Street System in Lawrence Highlighting Major Through Routes



9.1.2 Lawrence Freight Transportation Model

Lawrence Kansas Street System and Land Use Patterns. The Lawrence street network has three major traffic arterials: Interstate 70 (part of the Kansas Tollway system); US 59 and Route 10 (see Figure 9.1 above). Interstate 70 is the key link between the Kansas City, Lawrence and Topeka areas for regional trips and for points east and west. Route 10 is an alternative limited access facility to and from the southern side of Kansas City. However, this highway becomes a regular city street within the city limits of Lawrence. As a result, a significant amount of through traffic flows through the City of Lawrence. US 59 is a major north-south facility for interurban trips as well as being a significant intercity artery in eastern Kansas. These arterials carry the bulk of the traffic in the urbanized area. This is particularly true for truck traffic, as will be seen later.

Land use in Lawrence is fairly compact. The major employers are located in the city center and in some industrial parks near Interstate 70 or near the northern part of the city. While the University of Kansas is a dominant land use and one of the highest employers in the area, there is also a diverse group of industries, services and commercial establishments that are well represented. The major employers are identified in the next section in reference to special generators.

Description of Base Network. Lawrence already had a passenger vehicle forecasting model, which needed a freight component. The end product of a freight forecast would be a truck trip table, which can then be added to the automobile trip table prior to performing an equilibrium traffic assignment.

A considerable amount of data from the passenger model were applied to the freight component. The network structure was adopted in full, although the passenger data for zones were set aside for later processing, and external station data (derived from passenger vehicle counts) were discarded. Data for each TAZ included the number of retail employees, non-retail employees and dwelling units. The network links already contained speeds and capacities. None of the links were closed to truck traffic, thereby simplifying the traffic assignment step.

Recategorizing Employment. The original employment data from the passenger network were altered to reflect the trip generation categories recommended in this manual as follows:

- retail trade employment;
- manufacturing, transportation, communications, utilities and wholesale trade employment;
- office and service employment; and
- agriculture, mining and construction employment.

Although Lawrence had raw employment information for each employer that was identified by SIC code, a more efficient approach was adopted for recategorizing employment. Employment was already available for each traffic zone in two categories - retail and non-retail, consistent with the procedures presented in NCHRP Report 187[1]. These data needed to be reorganized into the four employment categories. Retail employment, of course, was already consistent. For each traffic analysis zone (TAZ) non-retail employment was split across the three remaining freight employment categories (manufacturing and wholesale, office, and other) according to the split of non-retail employment for the entire region. A detailed explanation of the procedure is presented later in this chapter.

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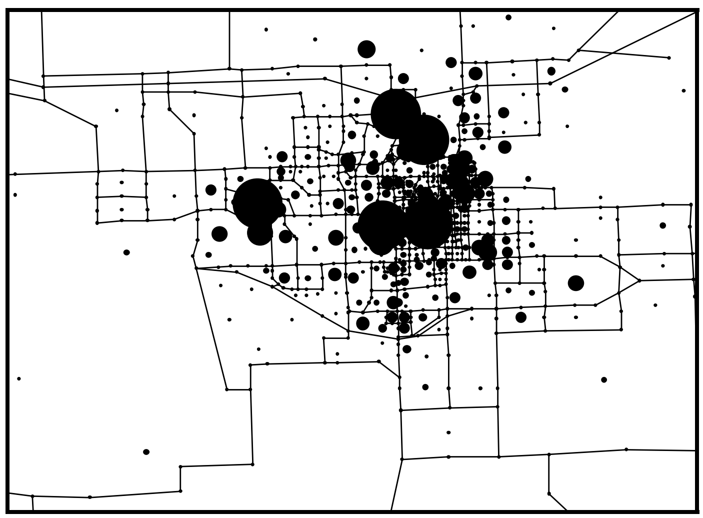
[1] Arthur B. Sosslau, et al., *Quick Response Urban Travel Estimation Techniques And Transferable Parameters, User's Guide*, National Cooperative Highway Research Program Report 187. National Research Council. Washington D.C. 1978.

Eleven special generators were identified namely: *Hallmark*, *University of Kansas*, *Lawrence Memorial Hospital*, *Sallie Mae Loan Servicing*, *Packer Plastics*, *K-Mart Distribution Center*; *University of Kansas Memorial Corp.*, *Davol Inc.*, *Allied Signal* (avionics electronics manufacturing), *E & E Specialties, Inc.* (point of purchase displays manufacturing) and *Lawrence Paper Company* (paper products). Their locations correspond to the areas of highest employment as shown in Figure 9.2 (centroid sizes are proportional to zonal employment). The employment splits for zones with special generators were adjusted accordingly, but the same default rates of Table 4.1 were used. The University of Kansas did not have much truck traffic, but it had a large employment that would distort the forecasts if no adjustments are made. The University of Kansas spanned approximately eleven zones.

Figure 9.2 Employment Concentrations in Central Lawrence



Truck Trip Generation. The forecasts included one trip purpose each for light trucks, medium trucks, and combination vehicles. Once the levels of employment were determined for each zone, total trip ends were estimated for each truck trip purpose according to the rates in Table 4.1.

A traditional travel forecasting model was used where trip generation results are provided as either productions or attractions (not origins and destinations). Different vehicle classes were handled somewhat differently in the conversion of trip ends to productions and attractions. For light and medium trucks, total trip ends were divided evenly between productions and attractions at all centroids. Because of the small size of Lawrence, combination vehicles were assumed not to make any internal-to-internal trips. To force the travel forecasting software to create only internal-to-external or external-to-internal trips for the combination vehicle "purpose", only trip productions were set at zonal centroids and only trip attractions were set at external stations.

External Stations. External stations were located in the perimeter of the region on several major arterials. The setting of external station data was greatly simplified by further assuming that only combination vehicles leave the region. Because combination truck trips at external stations were assumed to be only attractions, productions were set to zero for all trip purposes.

Attractions at external stations were taken directly from truck counts provided by KDOT or from estimates of truck volumes from the factors of Table 4.2 when counts were missing on some smaller roads. During the calculations, the software turns half of the attractions into origins and the other half of the attractions into destinations.

External-to-External Trip Table. The external-to-external trip table was developed by using the existing combination vehicle counts for the four major external stations that contained most of the external trips. These counts were divided in two to yield an equal amount of origins and destinations per external station. For trips originating from the external stations associated with Route 10 and Interstate 70, it was assumed that these trips would not double back in the Kansas City direction. In these cases, the trips were forced to the external station associated with US 59 (southern leg) or to that associated with the western leg of Interstate 70. This allocation resulted in the majority of the external trips associated with the external station along Interstate 70 staying on this facility.

Distribution and Network Assignment of Trips. The distribution of trips was determined with a gravity model using friction factors described in Section 4.4 of this manual. Lawrence did not have any data on truck trip lengths, so the friction factors could not be adjusted from the default values. Because of the assumption of no internal-to-internal trips for combination vehicles, the model was nearly insensitive to the friction factors for this purpose.

9.1.3 Calibration for Internal Consistency

The Lawrence freight model could only be made internally consistent, as there was no data on actual truck movements within the city. A Level 2 validation (see Section 7.5) can be performed at a later date.

Sampling of Calibration Links. Because only internal consistency could be checked, only a sample of links was deemed necessary. Thus, a sample of 100 links scattered throughout the network was selected. Care was taken to choose links of various functional classes so that the percentage of VMT by functional class on the sampled links was similar to the corresponding percentage on all links in the network. For each sampled link, the truck volumes were estimated using the factors of Table 4.2 applied to known counts of all vehicles.

Only four runs of the model were needed to implement the calibration procedure discussed in Section 4.5. Because passenger cars have been ignored, each run used "all-or-nothing" assignment.

Run 1 - Unadjusted. The freight model was run with the default parameters of Table 4.1. Production and attractions at external stations were set to replicate the full extent of link volumes entering and leaving the region, without using an E-E trip table. It was found that the model overestimated desired link volumes by 25 percent.

Run 2 - Productions and Attractions Reduced Based on Desired to Estimated Ratio. All productions and attractions at centroids were reduced by 25 percent while everything else (including external station data) remained constant. This resulted in approximately 9 percent overestimation by the model.

Run 3 - Introduction of External-to-External Trip Table. To create a more representative trip loading, the E-E trip table was added to the forecast and the attractions (no productions for combination vehicles) at external stations were reduced accordingly. Total productions no longer matched total attractions for combination vehicles, so the productions at centroids for combination vehicles were balanced to match attractions at external stations. This run did not change the number of truck trips on the network, but it did cause a significant redistribution of the trips across the network. The results were still approximately 5 percent greater than the desired link volumes.

Run 4 - Reduction of Production and Attractions. All productions and attractions at both centroids and external stations were reduced by five percent. The external-to-external trip table remained the same.

Given the paucity of data and the all-or-nothing assignment technique, further adjustments were unwarranted. After the fourth run the model was estimating total link volumes on the sampled links with overestimates of less than 1 percent.

Link-by-link analysis of the calibration results was considered inappropriate. The distribution of target truck traffic on the sample links was largely governed by the distribution of passenger car traffic in Lawrence. Substantial deviations at individual links were both expected and desirable. The outcome of the all-or-nothing assignment is illustrated in Figure 9.3. Link widths in the Figure are proportional to truck volumes, without removing streets with zero truck volumes.

This type of calibration exercise is performed only once for a base-year forecast to ascertain the final trip generation rates and to verify the strength of the external-to-external trip table. Forecasts for future years should not change the trip generation rates but could change the external-to-external trip table using growth factor methods.

9.1.4 Observations about Lawrence

This exercise demonstrated that truck forecasting for an urban area using quick response methodologies is a relatively simple task, easily within the reach of most of the staff of State DOT's, MPO's and other planning agencies.

Some further recommendations to improve the accuracy of truck forecasting using methods in this manual are:

- Obtain actual ground counts of trucks by truck type on freeways and a good sample of major arterials;

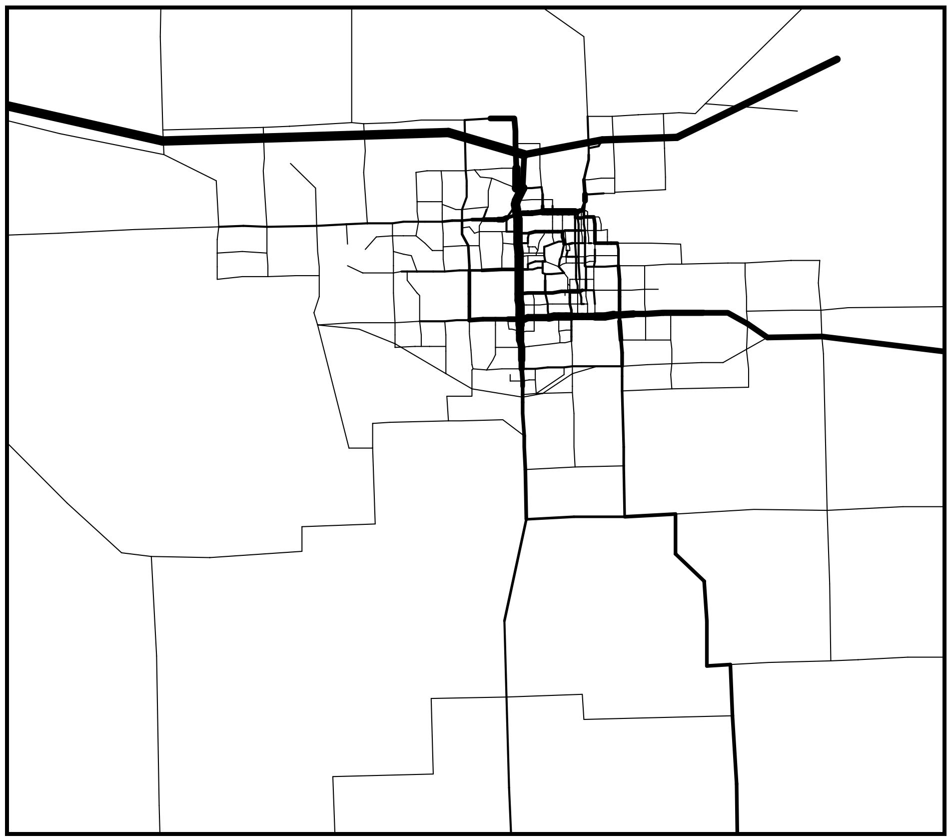
- Survey key points along major facilities to obtain actual through truck movements;

- Further calibrate the statewide freight model so it can be more useful for estimating an external-to-external trip table; and

- Develop an employee database, which would identify employees by both SIC code and zone of employment.

The above recommendations will probably not significantly improve the calibration for Lawrence's immediate purposes, but they will improve the model's credibility when looking at truck-specific issues and policies.

Figure 9.3 All-or-Nothing Assigned Truck Volumes in Lawrence with the Widths of the Links Representing the Relative Truck Volumes.



■ 9.2 Fox Cities and Green Bay, Wisconsin

9.2.1 Introduction

Appleton-Neenah (Fox Cities) and Green Bay are two separate urbanized areas located in northeastern Wisconsin and are among the fastest growing urbanized areas in the State. These areas provide the fullest expression of Wisconsin's economy and aspirations, as they are the center of the paper and food processing industries, and are home to Wisconsin's professional football team -- the Green Bay Packers. Green Bay is the transportation hub of northeastern Wisconsin, with modern truck, rail, air, and seaport facilities. The Green Bay urbanized area recorded a population of 162,000 in 1990, making it the third largest urbanized area in Wisconsin. The Appleton-Neehan urbanized area had a 1990 population of 161,000. Since similar freight forecasting procedures were employed in both case studies, only Appleton will be discussed in full. However, the calibration process is briefly detailed for both case studies.

9.2.2 Fox Cities Case Study Background

The Appleton-Neenah urbanized area is commonly referred to as the Fox Cities. The Fox Cities are 14 communities along the Fox River: Appleton, Neenah, Menasha, Kaukauna, Kimberly, Combined Locks, and Little Chute and the Towns of Menasha, Vanderbroek, Buchanan, Harrison, Grand Chute, Greenville and Neenah. This region was discovered by French explorers in the 17th century. Louise Nicolet and Father Jacques Marquette are known to have traveled the length of the Fox River, en route to discovering the Mississippi River in 1673. The region was mostly settled by northern Europeans.

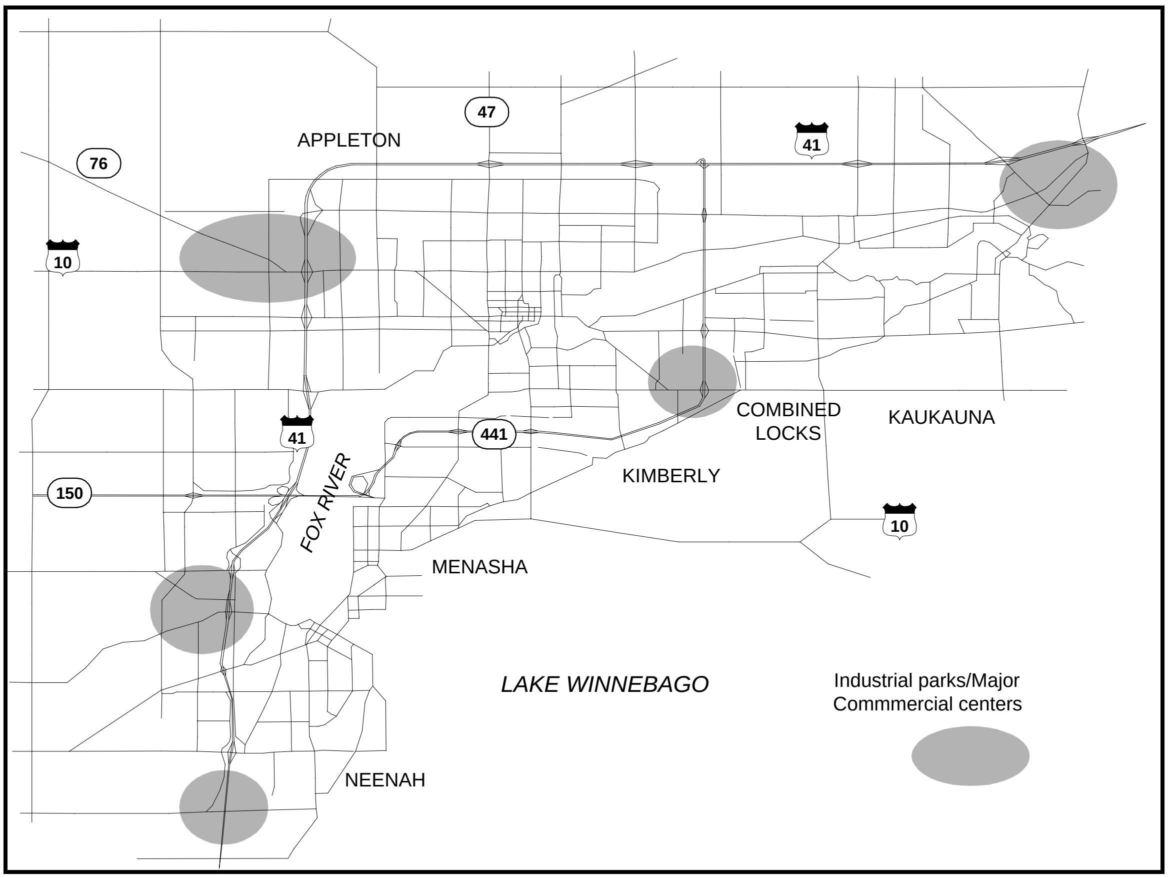
The city of Appleton is the largest of the Fox Cities. It is populated by a culturally diverse group of people. Besides those people of European ancestry, Hmongs, Hispanics, African Americans and Native Americans form significant portions of the population. The Oneida tribe represents the Native American population of Wisconsin. Their tribal heritage is preserved by the members residing in the Oneida Nation Reservation, a few miles north of Appleton. Their humane traditions and fascinating history give this region a unique blend the old and the new.

The Fox Cities, as well as Green Bay, are famous for their paper mills. The nickname "Paper Valley" is well earned as some of the nation's major paper companies are situated in the Fox River valley. *Kimberly-Clark*, *Wisconsin Tissue Mills*, *Menasha Corporation*, and *Appleton Papers* are located there. The economy of the Fox Cities is fairly diversified, but the paper industry retains its dominance over the economy. It continues to be the single largest employer in the Fox Cities. Therefore, it was not surprising to find that the "special generators" in Fox Cities mainly consisted of paper manufacturing firms.

9.2.3 Fox Cities Freight Transportation Model

As seen in Figure 9.4, US 41 traverses Fox Cities, serving as a main arterial. It carries most of the northbound and southbound traffic in the Fox Cities and beyond. A four-lane, limited access highway, US 41 provides access to the markets in Green Bay to the north, and Milwaukee and Chicago to the south. US 10 and US 45 are the other major highways serving the Fox Cities. Secondary roads include state truck highways 47, 55, 96, 110 and 114. Most of the large manufacturing firms are located along the Fox River close to US 41.

Figure 9.4 Fox Cities Urbanized Area and Major Highways



The Fox Cities, like Lawrence, already had a vehicle forecasting model[2], to which the freight component was to be added. The network structure was retained, along with the

[2] East Central Wisconsin Regional Planning Commission, *TM2, Fox Cities Urbanized Area Travel Demand Model Version 1.1*, Technical Memorandum, 1995.

speeds and the capacities on the links. All links were assumed to be able to carry truck traffic.

The employment data provided principally for passenger forecasting in the model were used to generate trip origins and destinations for freight modeling, following the procedures described in Section 7.7. The Fox Cities employment data were more detailed than the Lawrence employment data. Employment in each zone was broken down into commercial, manufacturing, services, wholesale/retail trade and others. Top employers, serving as special generators, were identified in the Fox Cities area. As mentioned earlier most of these were the paper and related products manufacturing firms, e.g., *Kimberly Clark*, *Appleton Papers*, *Outlook Graphics*, etc. High schools, malls, hospitals and similar facilities were excluded from the special generator category, as only establishments contributing a particularly large amount of truck traffic were considered.

For the Fox Cities case study, efforts were made to establish direct contacts with the management of some of the major special generators. The Fox Cities phone directory provided the addresses and the phone numbers of the 20 largest trucking firms within the area. Some of the questions asked pertaining to their trucking operations were: (a) How many of your trucks move in and out of the region; (b) Were these trucks light, medium or heavy; and (c) What was the regional extent of your trucking services? Since the firms were contacted over the phone, the questions were kept short and simple. The survey process itself was quite interesting, as it provided insights into the attitudes and policies of the firms with regard to information sharing.

Smaller firms, where the warehouse managers could be surveyed, were more forthcoming with their information. Their answers were informative, with some of them inquiring about the project and expressing their concerns regarding freight transport facilities in the region. On the other hand, larger firms were extremely restrictive with their information. Personnel departments, in particular, were unnecessarily concerned with liability issues, while parting with only the minimum amount of information. The discrepancies between the attitudes of the smaller and larger trucking firms posed great difficulties in data collection. The lesson of this exercise is that there should be a considerable amount of time allowed for even a small-scale primary data collection, during which written memoranda could be sent to the individual firms and follow-up phone calls can be made. A dialogue should be established, creating a favorable environment for gathering pertinent information.

As with the Lawrence network, truck trips at the external stations were assumed to be heavy-vehicle attractions and the productions were set to zero for all trip purposes. Fortunately, more actual truck counts were available in the Fox Cities for road segments leading to external stations. The attractions at the external stations were taken from the traffic counts provided by WisDOT, and in few cases where counts were unavailable, estimates of truck volumes as a fraction of total traffic were used (from Table 4.2). Thus, data at external stations in Fox Cities area could be set with a greater degree of confidence than in Lawrence.

The external-to-external truck trip table was provided by WisDOT for the base year. WisDOT developed its external-to-external trip table by surveying a sample of vehicles crossing cordon lines. There were 32 external stations, but only 113 of the 992 possible (non-diagonal) cells had observed truck trips. A part of the external-to-external trip table showing a few of the larger external stations (423, 400, 401, and 410) is given in Table 9.1. The availability of the external-to-external trip table greatly eased calibration and gave a higher degree of credibility to the model.

Table 9.1 Sample of External-to-External Truck Trips for the Fox Cities

Ex.Stat.	423	400	401	410
423	0	1448	110	17
400	877	0	0	64
401	57	0	0	291
410	0	301	61	0

9.2.4 Calibration to Ground Counts

Calibration was undertaken for links for which truck ADT counts were provided by WisDOT. These included the federal and state highways and some local principal arterials. Only three calibration runs were needed to achieve a suitable match between actual and average model link volumes:

Run 1 - Unadjusted. The initial run used default trip generation parameters from Table 4.1 and included the external-to-external trip table. The model overestimated link volumes by 19 percent.

Run 2 - Productions and Attractions Reduced Based on Desired to Estimated Ratio. All productions and attractions at the centroids were reduced by 19 percent, keeping everything else constant. The model overestimated the link volumes on the sampled links, by 3 percent.

Run 3 - Final Run. Again the productions and attractions were reduced. In the third run, the model overestimated the link volumes by less than 1 percent, and no further adjustments were undertaken.

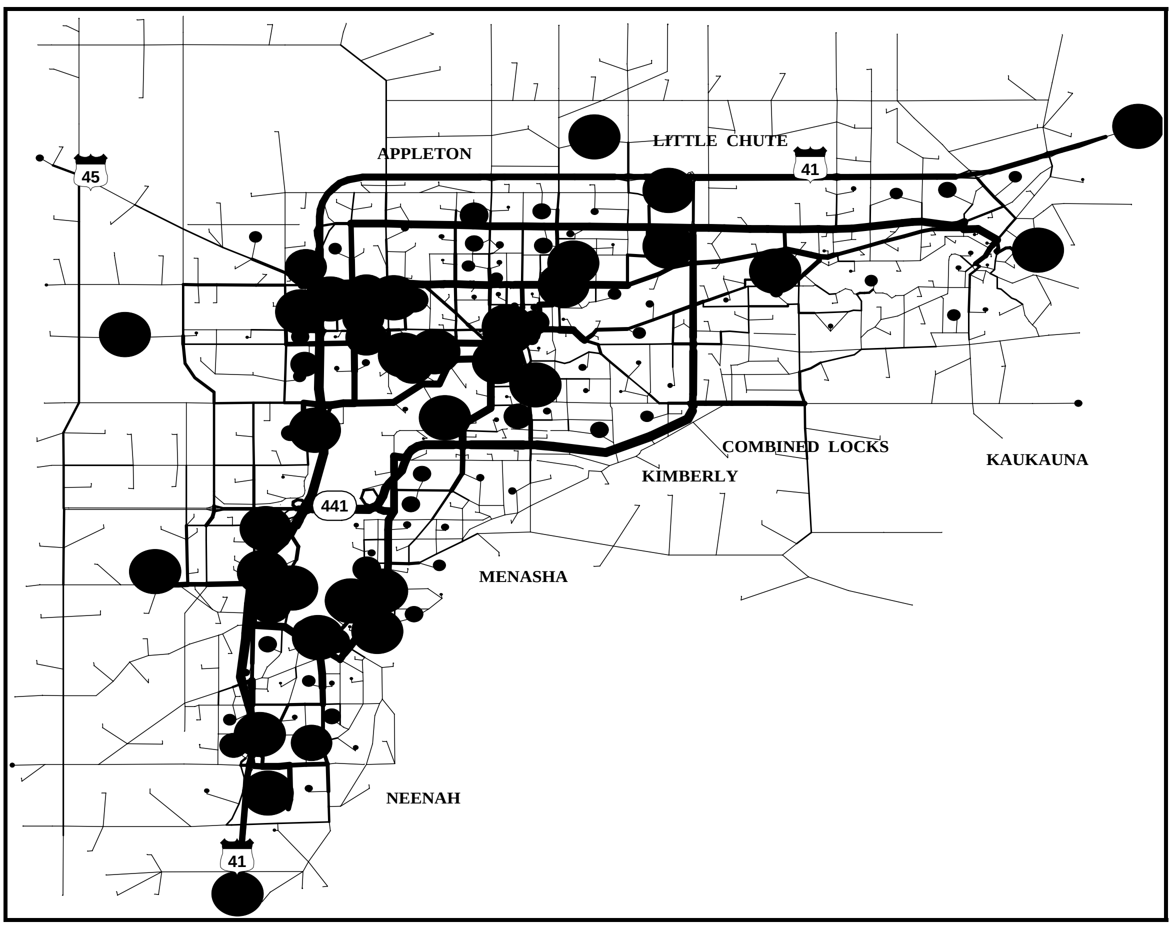
The results of the all-or-nothing traffic assignment are shown in Figure 9.5. Link widths are proportional to truck volumes, without removing streets with zero truck volumes. The sizes of centroids are roughly in proportion to their ability to attract truck trips.

As in Lawrence, the trip generation rates should be fixed for subsequent future-year forecasts.

The Fox Cities freight modeling methodology was repeated for Green Bay. However, like Lawrence, the external-to-external truck trip table for Green Bay had to be synthetically created following the procedures set out in Chapter 7. WisDOT provided the truck ADT counts for major arterials in Green Bay. The calibration procedure involved 7 runs of the model, which included adjustments to external stations as well as centroids. Calibration runs were terminated when the model overestimated the link volumes, on average, by only 1%. Because of the larger number of calibration runs, the forecasts for Green Bay are unlikely to be as strong as the forecasts from the Fox Cities.

In both the Fox Cities and Green Bay case studies the final product of a forecast is a truck trip table, not assigned volumes. The trip table would be combined with the trips for passenger vehicles before loading them to the network using equilibrium, capacity-restrained assignment methods.

Figure 9.5 Assigned Traffic Volumes in the Fox Cities Area with Size of Centroids Directly Related to Trip Attractions



■ 9.3 Site Impact Analysis: Services Plus, Green Bay, WI

9.3.1 Introduction and Description of Case Study Site

New industries or expansion of existing ones can add additional truck traffic both to nearby streets and to outlying streets. Adapting a previously developed regionwide freight forecasting model (e.g. Site Impact Strategy 3) is one way to determine a site's potential impact. This type of analysis can provide a reasonably precise mechanism for evaluating potential truck movements and enables tailored solutions to traffic problems. Chapter 5 describes a more generic approach to site analysis. This section illustrates how a truck traffic impact assessment can be done with minimal effort.

Services Plus is anticipating adding approximately 100,000 square feet to an existing facility in Green Bay. Their site is located in an industrial park immediately off the Green Bay beltway system (see Figure 9.6). The firm specializes in the repackaging of consumer products. The site is now approximately 200,000 square feet and presently has 110 trucks entering and leaving the facility per day. All the trucks are combination units of which 40% serve the local area and 60% serve regions outside the area. Planners have estimated that the expansion will add another 55 truck trips per day to the local traffic.

Although not particularly large, this site was selected for the case study because it would demonstrate travel paths over a variety of facilities (i.e., arterials, freeways, and collectors) and a variety of destinations (external and internal), thereby indicating the features of this particular method of traffic impact analysis. In addition, the site was selected from Green Bay because a freight forecasting model for this urban area had already been prepared (see Section 9.2) and would provide yet another illustration of the value of a good freight forecasting database.[3]

9.3.2 Steps in Adapting A Model for Site Impact Analysis

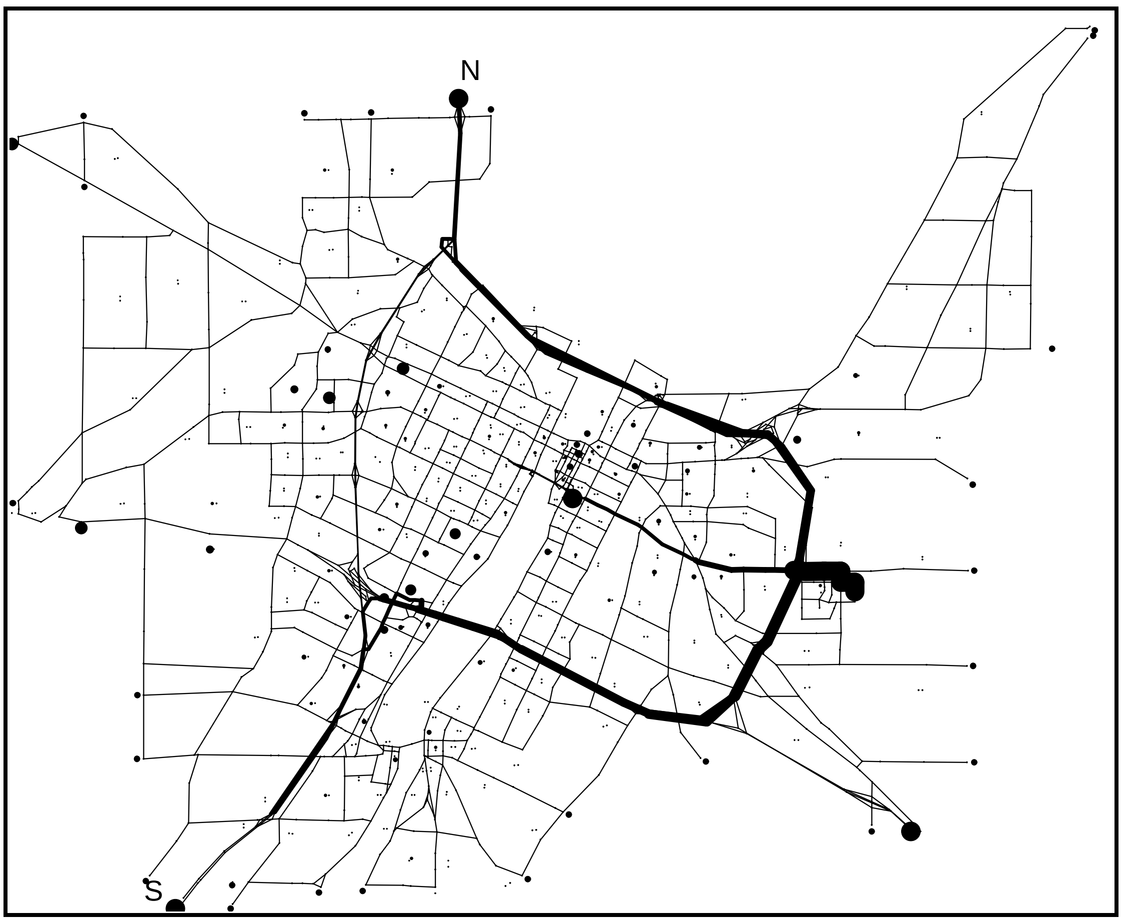
Normally a network is needed for site impact analysis (see Chapter 5, Section 5.3). The network shows the site in some detail including many of the surrounding streets. In the case of Services Plus, it was only necessary to add the streets of its industrial park to the existing regionwide network and to change some data at centroids and external stations. Had a regionwide network not been available, a subarea focused network (see Section 7.8) would have been drawn instead. A subarea focused network would have had fewer links, nodes and centroids, but it would have required the same quality of employment data. Below are the steps of the process.

Step 1 - Network Additions. The individual streets in Services Plus' industrial park were added. There were only 31 new links and 23 new nodes, including 1 new

[3] Very little effort was required to adapt the regionwide network for site impact purposes; the whole analysis (exclusive of reporting and graphics) took about 16 hours of work.

centroid. The locations of the nodes could be easily measured from a road map without resorting to digitizing. Speeds for the new links were assumed to be similar to local streets (e.g. 25 mph). One arterial link was adjusted to a slightly higher speed to better approximate preferred paths of travel. This adjustment was made after a preliminary run showing traffic diverting to a local street instead of to an arterial. This routing of traffic was related to the selection of all-or-nothing traffic assignment and the use of intersections without delays. The remainder of the links had attributes that were unchanged from the calibrated Green Bay regionwide network.

Figure 9.6 Services Plus Site (Middle Right)



Note: Figure 9.6 shows the impacts of *Services Plus* on the whole Green Bay network, with the nodes sized in proportion to trip attractions and the links sized in proportion to truck volumes from the site.

Step 2 - Setting of Productions and Attractiveness Values. The travel forecasting software needed data on productions and attractiveness values (replacing trip attractions), not origins and destinations. Eventually, the software would turn half the productions into origins and the other half into destinations. The same would be done to attractions, once they have been ascertained from the attractiveness values. A singly-constrained gravity model was selected for trip distribution, whereby only the production-end constraints will be satisfied. A singly-constrained gravity model is the same as presented in Chapter 4, except there is no attempt to match attraction totals through the iterative process. This form of the gravity model can be used to estimate the number of trip attractions at off-site zones, given a measure of attractiveness.

Two trip purposes were established: internal-to-internal and internal-to-external. To indicate only the trips generated by Services Plus, the productions and attractiveness values were modified drastically from the regionwide network. The site's centroid contained internal-to-internal trip productions and internal-to-external trip productions, based on the firm's estimates of 40% internal and 60% external shipments. The attractivness values were all placed on off-site centroids and at external stations. External stations only had attractiveness values for the internal-to-external trip purpose, while off-site centroids only received attractiveness values for the internal-to-internal trip purpose. In each case trip attractiveness values were set equal to the number of trip attractions in the regionwide model for the heavy vehicle trip purpose. For example the trip attractiveness value for the external station labeled N in Figure 9.6 was 1548 and the attractiveness value for the external station labeled S was 1361. As can be readily observed, these attractiveness values bear little relation to the number of trip ends expected from Services Plus.

Step 3 - Parameter Settings and Base-Case Run. The model was forced not to balance productions and attractions. An exponential friction factor function with a coefficient of 0.03 was used within the gravity model for trip distribution, as recommended in Section 4.4. Services Plus was unable to identify any consistent peaking characteristics in its operation, so time of day parameters were set assuming a 9-hour work day, 8 a.m. to 5 p.m. Thus, 1/9 of all trips were assumed to occur in each of those hours. Equal numbers of trips were assigned in each direction in each hour. That is, half of the trips had the site as their destination, while the other half had the site as their origin. Both full-day and single-hour analyses could be performed.

Step 4 - Assignment of Additional Trips. Knowing the existing square footage of the facility and the existing truck trips generated, a custom trip rate could be developed for this site. Had this been an entirely new site, a trip rate would have been adopted from a similar facility. There was no need to perform a new model run with increased trip productions. Since all-or-nothing assignment was used in the base case, it was only necessary to factor up the previously obtained link loadings.

Essentially, these four steps (with little modification) could be used in the evaluation of most other sites.

9.3.3 Analysis of Results

As seen in Figure 9.6, the site's traffic will be directed to the Green Bay beltway system and to a limited number of interior streets, mainly leading to industrial locations in the center of Green Bay. Although the overall impact on Green Bay's streets is small, the impact will be greatest near the entrance of the facility and on entrances to, and exits from, the freeway.

■ 9.4 Summary

The applications in the case study cities illustrate the overall ease of adding a true freight component to an urban travel forecast. The freight forecast can piggyback on passenger vehicle forecasts by adopting, nearly intact, the passenger traffic network and by using the same employment data with little modification. However, freight-specific inputs are still required. For regionwide applications these inputs include an external-to-external trip table, truck counts on freeways and major arterials, and employment information for the largest generators. The case studies also illustrate how the need for extensive local survey data can be largely avoided by making good use of default parameters contained in this manual. The default parameters permit the creation of a solid, first-cut truck forecast that can be improved over time as more information becomes available.

Appendix A

Glossary of Terms

Appendix A

■ Glossary of Terms

Primary source: For-Hire Trucking Industry Size Study

Part 1. Classification Definitions of Motor Carriers

Truckload - motor carriers operating with loads, whose weight is either in excess of 10,000 lbs or whose load allows no other load to be carried.

Less-Than-Truckload - motor carriers operating with loads, whose weight is less than 10,000 lbs and whose load allows other loads to be carried. This excludes package carriers, such as Federal Express, UPS, and US Postal Service.

Package - motor carriers operating with loads consisting primarily of small packages less than 150 lbs each.

Personnel - the freight carrying operations of motor carriers operating primarily as transporters of personnel, such as bus and coach lines, excluding emergency vehicles.

Non-Goods - motor carriers operating special equipment vehicles not engaged in the transportation of goods or personnel. This segment includes utilities and construction equipment.

International - movement of goods across a border without any processing or value added to the shipment.

Line Haul - transportation of goods greater than 250 miles from origin to destination, for one motor carrier.

Regional - transportation of goods more than 50 miles but less than 250 miles from origination to destination for one carrier.

Local - transportation of goods less than 50 miles from origination to destination for one carrier.

Off-Highway - primary use of vehicle is off-highway, i.e. construction and agriculture.

For Hire - motor carrier offering transportation services to the general public.

Owner-Operator - An owner of one or more power units who also operates at least one of those power units and who offers hauling services under contract or trip lease.

Regulated - motor carriers operating with ICC authority and whose primary business is for-hire carriage.

Not Regulated - motor carriers operating without ICC authority.

Combined - motor carriers operating as for-hire but without clear distinction as to which segment is their primary focus.

Household Goods - motor carriers whose primary business is the transportation of previously-owned household goods or office furniture for purposes of relocation.

Government - motor carriers owned by government, including state and local. This category also includes the Postal Service.

Private - all other motor carrier types including utilities and airlines.

Part 2. General Freight and Motor Carrier Terminology

CLASS I MOTOR CARRIER - For-Hire motor carrier receiving annual gross operating revenues of $5 million or more from motor carrier operations. Prior to 1980, the revenue classification level was $3 million.

CLASS II MOTOR CARRIER - For-Hire motor carrier receiving annual gross operating revenues of $1 million to $4,999,999 from motor carrier operations. Prior to 1980, the revenue classification level was $500 000 to $2,999,999.

CLASS III MOTOR CARRIER - For-Hire motor carrier receiving annual gross operating revenues of less than $1 million from motor carrier operations. Prior to 1980, the revenue classification level was $500,000 or less.

CLASS I-VIII TRUCK - Truck with following gross vehicle weight (GVW):

Class	GVW
I	6,000 lbs. or less
II	6,000 - 10,000 lbs.
III	10,000 - 14,000 lbs.
IV	14,001 - 16,000 lbs.
V	16,001 - 19,500 lbs.
VI	19,501 - 26,000 lbs.
VII	26,001 - 33,000 lbs.
VIII	33,001 or more lbs.

COFC - Container on (rail) flat car. A form of intermodal movement of freight.

COMBINATION VEHICLE - An equipment configuration that includes separate power unit (tractor) and at least one trailer.

COMMERCIAL TRAILER - A trailer used to handle freight in the transportation of goods for others; excludes house trailers, light farm trailers and car trailers.

DOLLY - An auxiliary axle assembly having a fifth wheel used for purpose of converting a semitrailer to a full trailer.

DOMESTIC INTERCITY TRUCKING - Trucking operations within the territory of the United States, including intra-Hawaiian and intra-Alaskan, that carry freight beyond the local areas and commercial zones.

DOUBLE - A combination of two trailers pulled by a power unit. Usually refers to a power unit pulling two 28' trailers. See also ROCKY MOUNTAIN DOUBLE and TURNPIKE DOUBLE.

EXPENSES - The cost of doing business, generally excludes current obligations on long term debt.

FIFTH WHEEL - A device used to connect a semi-trailer and tractor.

FREIGHT - Any commodity being transported.

FREIGHT FORWARDER - An individual or company that accepts less-than-truckload (LTL) or less-than-carload (LCL) shipments from shippers and combines them into carload or truckload lots. Designated as a common carrier under the Interstate Commerce Act.

FREIGHT TRAFFIC - Commodities transported.

GENERAL FREIGHT CARRIER - A for-hire carrier that handles a wide variety of commodities, typically in LTL quantities and generally involves the use of terminal facilities to break and consolidate shipments.

GROSS DOMESTIC PRODUCT - A measure of the money value of the goods and services becoming available to the nation from economic activity within the United States.

GROSS VEHICLE WEIGHT (GVW) - The maximum allowable fully laden weight of the vehicle and its payload. The most common classification scheme, used by manufacturers and by states, often for both trucks and tractors.

HEAVY DUTY TRUCK - Truck with a gross vehicle weight generally in excess of 19,500 pounds (class 6-8). Other minimum weights are used by various laws or government agencies.

HIGHWAY USER FEE OR TAX - A charge levied on persons or organizations based on the use of public roads. Funds collected are usually applied toward highway construction, reconstruction and maintenance. Examples include vehicle registration fees, fuel taxes, and weight-distance taxes.

ICC - See INTERSTATE COMMERCE COMMISSION

ICC AUTHORIZED OR REGULATED MOTOR CARRIERS - A for-hire carrier licensed and regulated by the Interstate Commerce Commission to carry freight.

INTERCITY TRUCKING - Trucking operations that carry freight beyond the local areas and commercial zones.

INTERMODAL TRANSPORTATION - Transportation movement involving more than one mode, e.g., rail-motor, motor-air, or rail-water.

INTERSTATE COMMERCE COMMISSION (ICC) - The federal body charged with enforcing Acts of Congress affecting interstate commerce.

ISTEA - Intermodal Surface Transportation Efficiency Act of 1991.

LCV - Longer combination vehicle.

LESS THAN TRUCKLOAD (LTL) - A quantity of freight less than that required for the application of a truckload rate. Usually less than 10,000 pounds.

LTL - See LESS THAN TRUCKLOAD

MODAL SHARE - The percentage of total freight moved by a particular type of transportation.

NATION'S FREIGHT BILL - The amount spent annually on freight transportation by the nation's shippers; also represents the total revenue of all carriers operating in the nation.

NET PROFIT MARGIN - A measure of profitability based on the ratio of net income to total operating revenues.

NON-REGULATED TRUCKING - A carrier that is exempt from economic regulation, e.g., exempt agricultural shipments and private trucking operations.

OPERATING EXPENSES - The costs of handling traffic, including both direct costs, e.g., driver wages and fuel; and indirect costs, e.g., computer expenses and advertising; but excludes interest expense.

OPERATING RATIO - A measure of profitability based on operating expenses as a percentage of gross revenues.

PIGGYBACK - The transportation of highway trailers or removable trailer bodies on rail cars specifically equipped for the service. It is essentially a joint carrier movement in which the motor carrier forms a pickup and delivery operation to a rail terminal, as well as a delivery operation at the terminating rail head.

POWER UNITS - The control and pulling vehicle for trailers or semi-trailers.

REGULATED MOTOR CARRIER - A for-hire carrier subject to economic and operational regulation by the Interstate Commerce Commission.

REVENUE - Monies paid to carriers as compensation for the movement of freight.

ROCKY MOUNTAIN DOUBLE - A combination vehicle consisting of a tractor, a 45 to 48 foot semitrailer and a shorter 28 foot semitrailer.

SIC CODE - See STANDARD INDUSTRIAL CLASSIFICATION CODE.

SPECIALIZED CARRIER - A trucking company franchised to transport articles that, because of size, shape, weight, or other inherent characteristics, require special equipment for loading, unloading or transporting.

STANDARD INDUSTRIAL CLASSIFICATION (SIC) CODE - A classification of establishments by type of activity in which they are engaged: for the purpose of facilitating the collection, tabulation, presentation and analysis of data relating to establishments, e.g., SIC 42 Motor Freight Transportation and Warehousing; SIC 421 Trucking, Local and Long Distance.

STATE OF DOMICILE - The state in which the carrier maintains its headquarters.

STRAIGHT TRUCK - A vehicle with the cargo body and tractor mounted on the same chassis.

THIRD STRUCTURE TAX - Any tax on road users other than registration fees or fuel taxes. See, for example, ton-mile tax and weight-distance tax.

TOFC - Trailer on (rail) flat car. A form of piggyback movement of freight.

TON-MILE - The movement of one ton of freight a distance of one mile. Ton-miles are computed by multiplying the weight in tons of each shipment transported by the distance hauled.

TON-MILE TAX - A tax calculated by measuring the weight of each truck for each trip. The gross weight is assigned a tax rate that is multiplied by the miles of travel.

TRACTOR SEMITRAILER - A combination vehicle consisting of a power unit (tractor) and a semitrailer.

TRAILER - A vehicle designed without motive power, to be drawn by another vehicle.

TRUCK - A motor vehicle designed to carry an entire load. It may consist of a chassis and body; a chassis, cab and body; or it may be of integral construction so that the body and chassis form a single unit.

TRUCK TONNAGE - The weight of freight in tons transported by truck.

TRUCKLOAD (TL) - Quantity of freight required to fill a truck. When used in connection with freight rates, the quantity of freight necessary to qualify a shipment for a truckload rate. Usually in excess of 10,000 pounds.

TURNPIKE DOUBLE - A combination vehicle consisting of a tractor and two trailers of 45 to 48 feet.

TWIN TRAILER - A short semitrailer (under 29') designed to be operated as part of a combination vehicle with a tandem trailer of similar length.

VEHICLE-MILE - A measurement of the total miles traveled by all vehicles in an area. Generally applied to intercity movements only.

WEIGHT-DISTANCE TAX - A tax basing the fee per mile on the registered gross weight of the vehicle. Total tax liability is calculated by multiplying this rate times miles traveled.

Appendix B

Selected References

Appendix B

Selected References

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Appendix C

Standard Industrial Classification (SIC) Codes

Appendix C

■ Standard Industrial Classification (SIC) Codes

SIC	DESCRIPTION
	AGRICULTURE, FORESTRY & FISHERY
1,2,7	Agriculture and Agricultural Services
8	Forestry
9	Fishing, Hunting, Trapping
	MINING
10	Metal Mining
11	Anthracite Mining
12	Lignite & Coal Mining
13	Oil & Gas Extraction
14	Non-metallic Mining
	CONSTRUCTION
15	General. Building Construction
16	Heavy Construction
17	Specialty Trade Contracting
19	Ordinance
	MANUFACTURING
20	Processed Foods and Kindred Products
21	Tobacco Products
22	Textile Mill Products
23	Clothing/Apparel and Other Textile Products
24	Lumber and Wood Products
25	Furniture and Fixtures
26	Paper and Allied Products
27	Printing and Publishing Materials
28	Chemicals and Allied Products
29	Petroleum and Coal Products
30	Rubber /Miscellaneous Plastic Products
31	Leather and Leather Products
32	Stone, Clay and Glass Products

33	Primary Metal Industries
34	Fabricated Metal Products
35	Industrial Machinery and Equipment
36	Electronic and Other Electric Equipment
37	Transportation Equipment (Motor Vehicles and Equipment)
38	Instruments and Related Products
39	Miscellaneous Manufacturing Industries
	TRANSPORTATION, COMMUNICATIONS AND UTILITIES
40	Railroads
41	Local Buses
42	Truck Transportation
43	U.S. Postal Service
44	Water Transportation
45	Air Transportation
46	Pipeline Transport
47	Transport Services
48	Communications Services
49	Electric, Gas, Water, & Sanitary Services
	WHOLESALE TRADE
50	Wholesale Durables
51	Wholesale Nondurables
	RETAIL TRADE
52	Building Materials
53	General Merchandise
54	Food Store
55	Automobile Dealers
56	Apparel Stores
57	Furniture Appliances
58	Eating Places
59	Miscellaneous Retail (Drugs, Liquor, etc.)
	FINANCE, INSURANCE & REAL ESTATE
60	Banking
61	Credit Agencies
62	Security Brokers
63	Insurance Carriers
64	Insurance Agents
65	Real Estate
67	Holdings & Investment Offices

	SERVICES
70	Hotels and Other Lodging Places
72	Personal Services
73	Business Services (Advertising, Building Service, Personnel Supply, Computer and Data Processing)
75	Auto Repair, Services and Garages
76	Miscellaneous Repair Shops
78	Motion Pictures (i.e. Video Tape Rental)
79	Amusement and Recreation Services
80	Health Services (i.e. Nursing/Personal Care Facilities, Private Hospitals, Health Practitioner Office)
81	Legal Services
82	Educational Services
83	Social Services
84	Museums
86	Membership Organizations
87	Engineering, Management and Services not elsewhere classified
88	Private Households
89	Industries not elsewhere classified

Appendix D

Trip Generation Summary Tables

Appendix D

■ Trip Generation Summary Tables

The following tables contain the detailed daily trip generation rates for each location, land use type, and truck classification. The tables are grouped into the following four sections:

D-1) Trip generation rates per employee;

D-2) Trip generation rates per 1,000 square feet of office space;

D-3) Trip generation rates per acre; and

D-4) Trip generation regression formulas.

Within each of these sections, trip generation rates are summarized according to the following land use types (SIC numbers enclosed in parentheses-- See Appendix C):

a) Agriculture, Mining and Construction (1-19);

b) Manufacturing, Transportation/Communications/Utilities, and Wholesale Trade (20-51);

c) Retail Trade (52-59);

d) Offices and Services (60-88); and

e) Unclassified (89)

Note that some of the trip generation rates shown in the table, specifically those obtained from the Puget Sound Region (i.e., Washington State counties) are expressed in truckload equivalents (TLE's). Rates expressed in TLE's not only include freight transportationby trucks but also freight moved by other modes including rail and waterways (which has been converted into "equivalent" truckloads).

D-1 Trip Generation Rates Per Employee

D-1a. Trip Generation Summary - Daily Commercial Vehicle Trips Per Employee for Agriculture, Construction & Mining Industries (SIC 1-19)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
King County, Washington	Mining (10-14)					213.835	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Kitsap County, Washington	Mining (10-14)					108.295	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Pierce County, Washington	Mining (10-14)					306.395	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Snohomish County, Washington	Mining (10-14)					409.525	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Median	**SIC (10-14)**					**260.115**		Truck Load Equivalent (TLE)
Average	**SIC (10-14)**					**259.513**		Truck Load Equivalent (TLE)
Minimum	**SIC (10-14)**					**108.295**		Truck Load Equivalent (TLE)
Maximum	**SIC (10-14)**					**409.525**		Truck Load Equivalent (TLE)
King County, Washington	Construction (15-19)					11.770	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Kitsap County, Washington	Construction (15-19)					12.120	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Pierce County, Washington	Construction (15-19)					10.355	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Snohomish County, Washington	Construction (15-19)					11.730	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Median	**SIC (15-19)**					**11.750**		Truck Load Equivalent (TLE)
Average	**SIC (15-19)**					**11.494**		Truck Load Equivalent (TLE)
Minimum	**SIC (15-19)**					**10.355**		Truck Load Equivalent (TLE)
Maximum	**SIC (15-19)**					**12.120**		Truck Load Equivalent (TLE)

D-1b.Trip Generation Summary - Daily Commercial Vehicle Trips Per Employee for Manufacturing, Transportation/Communications/Utilities and Wholesale Trade (SIC 20-51)

Location	**Land Use Type (SIC)**	**4-Tire Commercial Vehicles**	**Single Unit**	**Combination Unit**	**All 6+ Tire Commercial Vehicles**	**All Commercial Vehicles**	**Date**	**Notes/Comments**
Phoenix, Arizona (pop. 1.7 million)	Manufacturing (20-39)	0.641	0.100	0.050	0.150	0.791	1992	See note 2 and 5.
Knoxville, Tennessee (pop. 450,000)	Truck Transportation (42)	0.050	0.160	0.465	0.625	0.675	1979	
Modesto, California (pop. 216,000)	Truck Transportation (42)	0.060	0.193	0.562	0.755	0.815	1979	
Rochester, New York (pop. 1,040,000)	Truck Transportation (42)					0.575	1979	
Saginaw, Michigan (pop. 235,000)	Truck Transportation (42)					0.955	1979	
Phoenix, Arizona (pop. 1.7 million)	Transportation, Communic. and Utilities (40-49)	0.763	0.106	0.075	0.181	0.944	1992	See note 2 and 5.
Knoxville, Tennessee (pop. 450,000)	Wholesale Operations (50-51)					0.195	1979	
Modesto, California (pop. 216,000)	Wholesale Operations (50-51)	0.075	0.136	0.129	0.265	0.340	1979	
Rochester, New York (pop. 1,040,000)	Wholesale Operations (50-51)	0.048	0.088	0.084	0.172	0.220	1979	
Saginaw, Michigan (pop. 235,000)	Wholesale Operations (50-51)	0.031	0.056	0.053	0.109	0.140	1979	
Median	**SIC (20-51)**	**0.060**	**0.106**	**0.084**	**0.181**	**0.625**		Truck Trips
Average	**SIC (20-51)**	**0.238**	**0.120**	**0.203**	**0.322**	**0.565**		Truck Trips
Minimum	**SIC (20-51)**	**0.031**	**0.056**	**0.050**	**0.109**	**0.140**		Truck Trips
Maximum	**SIC (20-51)**	**0.763**	**0.193**	**0.562**	**0.755**	**0.955**		Truck Trips

D-1b.Trip Generation Summary - Daily Commercial Vehicle Trips Per Employee for Manufacturing, Transportation/Communications/Utilities and Wholesale Trade (SIC 20-51)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
King County, Washington	Manufacturing (20-39)					5.580	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Kitsap County, Washington	Manufacturing (20-39)					3.525	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Pierce County, Washington	Manufacturing (20-39)					4.240	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Snohomish County, Washington	Manufacturing (20-39)					5.205	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Median	**SIC (20-39)**					**4.723**		Truck Load Equivalents (TLE's)
Average	**SIC (20-39)**					**4.638**		Truck Load Equivalents (TLE's)
Minimum	**SIC (20-39)**					**3.525**		Truck Load Equivalents (TLE's)
Maximum	**SIC (20-39)**					**5.580**		Truck Load Equivalents (TLE's)
King County, Washington	Transportation & Public Utilities (40-49)					0.005	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Kitsap County, Washington	Transportation & Public Utilities (40-49)					0.005	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Pierce County, Washington	Transportation & Public Utilities (40-49)					0.005	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Snohomish County, Washington	Transportation & Public Utilities (40-49)					0.008	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Median	**SIC (40-49)**					**0.005**		Truck Load Equivalents (TLE's)
Average	**SIC (40-49)**					**0.006**		Truck Load Equivalents (TLE's)
Minimum	**SIC (40-49)**					**0.005**		Truck Load Equivalents (TLE's)
Maximum	**SIC (40-49)**					**0.008**		Truck Load Equivalents (TLE's)

D-1b.Trip Generation Summary - Daily Commercial Vehicle Trips Per Employee for Manufacturing, Transportation/Communications/Utilities and Wholesale Trade (SIC 20-51)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
King County, Washington	Wholesale Trade (50-51)					9.790	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Kitsap County, Washington	Wholesale Trade (50-51)					18.980	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Pierce County, Washington	Wholesale Trade (50-51)					11.010	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Snohomish County, Washington	Wholesale Trade (50-51)					14.130	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Median	**SIC (50-51)**					**12.570**		Truck Load Equivalents (TLE's)
Average	**SIC (50-51)**					**13.478**		Truck Load Equivalents (TLE's)
Minimum	**SIC (50-51)**					**9.790**		Truck Load Equivalents (TLE's)
Maximum	**SIC (50-51)**					**18.980**		Truck Load Equivalents (TLE's)

D-1c. Trip Generation Summary - Daily Commercial Vehicle Trips Per Employee for Retail Trade (SIC 52-59)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Knoxville, Tennessee (pop. 450,000)	Retail - Downtown (52-59)	0.075	0.032	0.009	0.040	0.115	1979	
Modesto, California (pop. 216,000)	Retail Trade (52-59)	0.215	0.091	0.025	0.116	0.330	1979	
Phoenix, Arizona (pop. 1.7 million)	Retail - Downtown (52-59)	0.591	0.133	0.037	0.169	0.760	1992	See note 2 and 5.
Rochester, New York (pop. 1,040,000)	Retail - Downtown (52-59)	0.039	0.017	0.005	0.021	0.060	1979	
Saginaw, Michigan (pop. 235,000)	Retail - Downtown (52-59)					0.150	1979	
Median	**SIC (52-59)**	**0.145**	**0.061**	**0.017**	**0.078**	**0.150**		Truck Trips
Average	**SIC (52-59)**	**0.230**	**0.068**	**0.019**	**0.087**	**0.283**		Truck Trips
Minimum	**SIC (52-59)**	**0.039**	**0.017**	**0.005**	**0.021**	**0.060**		Truck Trips
Maximum	**SIC (52-59)**	**0.591**	**0.133**	**0.037**	**0.169**	**0.760**		Truck Trips
King County, Washington	Retail Trade (52-59)					14.540	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Kitsap County, Washington	Retail Trade (52-59)					17.690	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Pierce County, Washington	Retail Trade (52-59)					17.040	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Snohomish County, Washington	Retail Trade (52-59)					17.770	1994	See note 4. Rates are truck load equivalents (TLEs) and include all modes (truck, rail, air, etc.)
Median	**SIC (52-59)**					**17.365**		Truck Load Equivalents (TLE's)
Average	**SIC (52-59)**					**16.760**		Truck Load Equivalents (TLE's)
Minimum	**SIC (52-59)**					**14.540**		Truck Load Equivalents (TLE's)
Maximum	**SIC (52-59)**					**17.770**		Truck Load Equivalents (TLE's)

D-1d. Trip Generation Summary - Daily Commercial Vehicle Trips Per Employee for Offices and Services (SIC 60-88)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Phoenix, Arizona (pop. 1.7 million)	Office and Services (60-87)	0.309	0.021	0.003	0.024	0.334	1992	See note 2 and 5.
Phoenix, Arizona (pop. 1.7 million)	Medical & Government (80)		0.006	0.024	0.030	0.325	1992	See note 2 and 5.
Median	**SIC (60-88)**	**0.309**	**0.014**	**0.014**	**0.027**	**0.329**		Truck Trips
Average	**SIC (60-88)**	**0.309**	**0.014**	**0.014**	**0.027**	**0.329**		Truck Trips
Minimum	**SIC (60-88)**	**0.309**	**0.006**	**0.003**	**0.024**	**0.325**		Truck Trips
Maximum	**SIC (60-88)**	**0.309**	**0.021**	**0.024**	**0.030**	**0.334**		Truck Trips

D-1e. Trip Generation Summary - Daily Commercial Vehicle Trips Per Employee for Other Land Use Types (Unclassified - SIC 89)

Location	Land Use Type	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Phoenix, Arizona (pop. 1.7 million)	Group Quarter Households		7.523		7.523	7.523	1992	See note 2 and 5.
Phoenix, Arizona (pop. 1.7 million)	Resident Households	0.040		0.003	0.003	0.043	1992	See note 2 and 5. Rates per unit household.
Phoenix, Arizona (pop. 1.7 million)	Residential - Total Households					0.236	1992	See note 2 and 5. Rates per unit household.
Washington D.C. (pop. 3.5 million)	Government Warehouse and Garage	0.074	0.072	0.084	0.155	0.229	1977	See note 1. Washington D.C. government warehouse and garages averaged to get trip generation rates.
Washington D.C. (pop. 3.5 million)	Government Office					0.006	1977	See note 1. Washington D.C. government offices averaged to get trip generation rates.

D-2 Trip Generation Rates Per 1,000 Square Feet (TSF) of Office Space

D-2b. Trip Generation Summary - Daily Commercial Vehicle Trips Per 1,000 Square Feet (TSF) of Building Space for Manufacturing, Transportation/ Communications/Utilities and Wholesale Trade (SIC 20-51)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Australia	Manufacturing (20-39)	0.092	0.046	0.090	0.136	0.228	1989	Summed various trucks to get total truck trips/TSF. See note 6.
Australia	Warehouse (20-39)	0.047	0.090	0.090	0.180	0.227	1989	Summed various trucks to get total truck trips/TSF. See note 6.
Boston, Massachusetts (pop. 4.6 million)	Manufacturing (20-39)				0.350		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	Warehouse (20-39)				0.440		1992	Summed various trucks to get total truck trips/TSF.
Fontana, California (pop. greater than 100,000)	Industrial - Heavy (20-39)			0.190		0.280	1994	See note 8.
Fontana, California (pop. greater than 100,000)	Industrial - Light (20-39)			0.135		0.300	1994	See note 8.
Fontana, California (pop. greater than 100,000)	Industrial Park (20-39)			0.075		0.180	1994	See note 8.
Fontana, California (pop. greater than 100,000)	Warehouse - Heavy (20-39)			0.135		0.185	1994	See note 8.
Fontana, California (pop. greater than 100,000)	Warehouse - Light (20-39)			0.105		0.185	1994	See note 8.
Median	**SIC (20-39)**	**0.070**	**0.068**	**0.105**	**0.265**	**0.227**		Truck Trips
Average	**SIC (20-39)**	**0.070**	**0.068**	**0.117**	**0.277**	**0.226**		Truck Trips
Minimum	**SIC (20-39)**	**0.047**	**0.046**	**0.075**	**0.136**	**0.180**		Truck Trips
Maximum	**SIC (20-39)**	**0.092**	**0.090**	**0.190**	**0.440**	**0.300**		Truck Trips

D-2b. Trip Generation Summary - Daily Commercial Vehicle Trips Per 1,000 Square Feet (TSF) of Building Space for Manufacturing, Transportation/ Communications/Utilities and Wholesale Trade (SIC 20-51)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Australia	Truck Transportation (42)	0.920	0.700	1.800	2.500	3.420	1989	Summed various trucks to get total truck trips/TSF. See note 6.
Fontana, California (pop. greater than 100,000)	Truck Transportation (42)			0.895		4.370	1994	See note 8.
Knoxville, Tennessee (pop. 450,000)	Truck Transportation (42)	0.118	0.573	1.669	2.242	2.360	1979	
Modesto, California (pop. 216,000)	Truck Transportation (42)	0.054	0.264	0.767	1.031	1.085	1979	
Rochester, New York (pop. 1,040,000)	Truck Transportation (42)	0.053	0.255	0.742	0.998	1.050	1979	
Saginaw, Michigan (pop. 235,000)	Truck Transportation (42)	0.135	0.655	1.905	2.560	2.695	1979	
Median	**SIC (42)**	**0.118**	**0.573**	**1.282**	**2.242**	**2.528**		Truck Trips
Average	**SIC (42)**	**0.256**	**0.489**	**1.296**	**1.866**	**2.497**		Truck Trips
Minimum	**SIC (42)**	**0.053**	**0.255**	**0.742**	**0.998**	**1.050**		Truck Trips
Maximum	**SIC (42)**	**0.920**	**0.700**	**1.905**	**2.560**	**4.370**		Truck Trips
Knoxville, Tennessee (pop. 450,000)	Wholesale Trade (50-51)	0.032	0.058	0.055	0.113	0.145	1979	
Modesto, California (pop. 216,000)	Wholesale Trade (50-51)	0.106	0.192	0.182	0.374	0.480	1979	
Rochester, New York (pop. 1,040,000)	Wholesale Trade (50-51)	0.044	0.080	0.076	0.156	0.200	1979	
Saginaw, Michigan (pop. 235,000)	Wholesale Trade (50-51)	0.015	0.028	0.027	0.055	0.070	1979	
Median	**SIC (50-51)**	**0.038**	**0.069**	**0.066**	**0.135**	**0.173**		Truck Trips
Average	**SIC (50-51)**	**0.049**	**0.090**	**0.085**	**0.175**	**0.224**		Truck Trips
Minimum	**SIC (50-51)**	**0.015**	**0.028**	**0.027**	**0.055**	**0.070**		Truck Trips
Maximum	**SIC (50-51)**	**0.106**	**0.192**	**0.182**	**0.374**	**0.480**		Truck Trips

D-2c. Trip Generation Summary - Daily Commercial Vehicle Trips Per 1,000 Square Feet (TSF) of Building Space for Retail Trade (52-59)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Australia	Retail Trade - Other (52-59)	0.830	0.190	0.000	0.190	1.020	1989	Summed various trucks to get total truck trips/TSF. See note 6.
Australia	Retailing - Regional Center (52-59)	0.650	0.280	0.460	0.740	1.390	1989	Summed various trucks to get total truck trips/TSF. See note 6.
Baltimore, Maryland - Suburban Area	Retail Trade - Soft (52-59)					2.000	1987	See note 5.
Boston, Massachusetts (pop. 4.6 million)	Retail - Major (52-59)	0.005			0.075	0.080	1992	Summed various trucks to get total truck trips/TSF. See note 7.
Boston, Massachusetts (pop. 4.6 million)	Retail - Major (52-59)				0.300		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	Retail - Storefront (52-59)	0.283			0.114	0.397	1992	Summed various trucks to get total truck trips/TSF. See note 7.
Boston, Massachusetts (pop. 4.6 million)	Retail - Storefront (52-59)				0.170		1992	Summed various trucks to get total truck trips/TSF.
Knoxville, Tennessee (pop. 450,000)	Retail - Downtown (52-59)	0.062	0.026	0.007	0.033	0.095	1979	
Modesto, California (pop. 216,000)	Retail - Downtown (52-59)	0.413	0.175	0.048	0.222	0.635	1979	
Rochester, New York (pop. 1,040,000)	Retail - Downtown (52-59)	0.065	0.028	0.008	0.035	0.100	1979	
Saginaw, Michigan (pop. 235,000)	Retail - Downtown (52-59)	0.078	0.033	0.009	0.042	0.120	1979	
Boston, Massachusetts (pop. 4.6 million)	Retail - Convenience (53,59)				0.440		1992	Summed various trucks to get total truck trips/TSF.
Australia	Retail - Local Supermarket (54)	0.506	0.230	0.090	0.320	0.826	1989	Summed various trucks to get total truck trips/TSF. See note 6.

D-2c. Trip Generation Summary - Daily Commercial Vehicle Trips Per 1,000 Square Feet (TSF) of Building Space for Retail Trade (52-59)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Australia	Retail - Major Supermarket (54)	0.280	0.190	0.090	0.280	0.560	1989	Summed various trucks to get total truck trips/TSF. See note 6.
Baltimore, Maryland - Suburban Area	Foods - Prepared (54)					3.900	1987	See note 5. Converted from one way (trip ends) to total trips.
Australia	Retail Trade - Department Store (56)	0.320	0.460	0.046	0.506	0.826	1989	Summed various trucks to get total truck trips/TSF. See note 6.
Boston, Massachusetts (pop. 4.6 million)	Food - Fast (58)				0.770		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	Restaurant / Club (58)				0.770		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	Restaurants (58)	0.715			0.495	1.209	1992	Summed various trucks to get total truck trips/TSF. See note 7.
Baltimore, Maryland - Suburban Area	Variety / Pharmacy (59)					0.600	1987	See note 5.
Median	**SIC (52-59)**	**0.301**	**0.190**	**0.046**	**0.280**	**0.635**		Truck Trips
Average	**SIC (52-59)**	**0.350**	**0.179**	**0.084**	**0.324**	**0.917**		Truck Trips
Minimum	**SIC (52-59)**	**0.005**	**0.026**	**0.000**	**0.033**	**0.080**		Truck Trips
Maximum	**SIC (52-59)**	**0.830**	**0.460**	**0.460**	**0.770**	**3.900**		Truck Trips

D-2d. Trip Generation Summary - Daily Commercial Vehicle Trips Per 1,000 Square Feet (TSF) of Building Space for Office and Services (SIC 60-88)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Baltimore, Maryland - Suburban Area	Office Buildings (60-67)					0.200	1987	See note 5.
Boston, Massachusetts (pop. 4.6 million)	Office (60-67)	0.022			0.037	0.059	1992	Summed various trucks to get total truck trips/TSF. See note 7.
Boston, Massachusetts (pop. 4.6 million)	Office (60-67)				0.110		1992	Summed various trucks to get total truck trips/TSF. Converted from one-way (arrivals) to two way (total trips).
Boston, Massachusetts (pop. 4.6 million)	Hotel (70)	0.012			0.022	0.034	1992	Summed various trucks to get total truck trips/TSF. See note 7.
Boston, Massachusetts (pop. 4.6 million)	Hotel (70)				0.040		1992	Summed various trucks to get total truck trips/TSF.
Baltimore, Maryland - Suburban Area	Personal Services (72)					2.300	1987	See note 5.
Boston, Massachusetts (pop. 4.6 million)	Theater (78)				0.006		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	Recreation - Outdoor (79)				0.006		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	Office - Medical (80)				0.110		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	Hospital (80)	0.005			0.004	0.009	1992	Summed various trucks to get total truck trips/TSF. See note 7.
Boston, Massachusetts (pop. 4.6 million)	Hospital (80)				0.014		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	Laboratory (80)				0.110		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	School (82)				0.019	0.019	1992	Summed various trucks to get total truck trips/TSF. See note 7.
Boston, Massachusetts (pop. 4.6 million)	School - Public (82)				0.010		1992	Summed various trucks to get total truck trips/TSF.

D-2d. Trip Generation Summary - Daily Commercial Vehicle Trips Per 1,000 Square Feet (TSF) of Building Space for Office and Services (SIC 60-88)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Boston, Massachusetts (pop. 4.6 million)	School - College (82)				0.015		1992	Summed various trucks to get total truck trips/TSF.
Boston, Massachusetts (pop. 4.6 million)	Library (82)				0.050		1992	Summed various trucks to get total truck trips/TSF.
Median	**SIC (60-88)**	**0.012**			**0.020**	**0.046**		Truck Trips
Average	**SIC (60-88)**	**0.013**			**0.039**	**0.437**		Truck Trips
Minimum	**SIC (60-88)**	**0.005**			**0.004**	**0.009**		Truck Trips
Maximum	**SIC (60-88)**	**0.022**			**0.110**	**2.300**		Truck Trips

D-2e. Trip Generation Summary - Daily Commercial Vehicle Trips Per 1,000 Square Feet (TSF) of Building Space for Other Land Uses (Unclassified - SIC 89)

Location	Land Use Type	4-Tire Commercial Vehicles	Single Unit	Combination Unit	All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
Washington D.C. (pop. 3.5 million)	Government Warehouse and Garage	0.022	0.021	0.025	0.047	0.069	1977	See note 1. Washington D.C. goverment warehouses and garages averaged to get trip generation rate.
Australia	Industry (Light)/High Tech	1.210	0.230	0.046	0.276	1.486	1989	Summed various trucks to get total truck trips/TSF. See note 6.
Boston, Massachusetts (pop. 4.6 million)	Residential				0.011		1992	Summed various trucks to get total truck trips/TSF.
Washington D.C. (pop. 3.5 million)	Government Office	0.011	0.008	0.003	0.011	0.022	1977	See note 1. Washington DC government offices averaged to get trip generation rates.

D-3 Trip Generation Rates Per Acre

D-3a. Trip Generation Summary - Daily Commercial Vehicle Trips Per Acre for Agriculture, Mining and Construction (SIC 1-19)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
			Single Unit	Combination Unit				
Columbus, Ohio (pop. 810,000)	Agriculture and Vacant (1,2,7)	0.005		0.000	0.000	0.005	1964	Summed various trucks to get total truck trips/acre. See note 9.
Racine, Wisconsin (pop. 136,952)	Agriculture and Related (1-9)	0.005		0.000	0.000	0.005	1972	Summed various trucks to get total truck trips/acre. See note 10.
Kenosha, Wisconsin (pop. 99,664)	Agriculture and Related (1-9)	0.010		0.000	0.000	0.010	1972	Summed various trucks to get total truck trips/acre. See note 10.
Columbus, Ohio (pop. 810,000)	Mining (10-14)		0.005			0.005	1964	Summed various trucks to get total truck trips/acre. See note 9.
Median	**SIC (1-14)**	**0.005**	**0.005**	**0.000**	**0.000**	**0.005**		Truck Trips
Average	**SIC (1-14)**	**0.007**	**0.005**	**0.000**	**0.000**	**0.006**		Truck Trips
Minimum	**SIC (1-14)**	**0.005**	**0.005**	**0.000**	**0.000**	**0.005**		Truck Trips
Maximum	**SIC (1-14)**	**0.010**	**0.005**	**0.000**	**0.000**	**0.010**		Truck Trips

D-3b. Trip Generation Summary - Daily Commercial Vehicle Trips Per Acre for Manufacturing, Transportation/Communications/Utilities and Wholesale Trade (SIC 20-51)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
			Single Unit	Combination Unit				
Chicago, Illinois (pop. 8 million)	Manufacturing (20-39)					3.600	1979	
Richmond, Virginia	Manufacturing (20-39)					2.800	1979	
Baton Rouge, Louisiana	Manufacturing (20-39)					1.300	1979	
Columbia, SC	Manufacturing (20-39)					1.500	1979	
Monroe, Louisiana	Manufacturing (20-39)					5.900	1979	
Little Rock , Arkansas	Manufacturing (20-39)					0.400		
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Manufacturing (20-39)					1.805	1981	
Flint, Michigan (pop. 470,000)	Manufacturing (20-39)	5.185	1.030	1.080	2.110	7.295	1966	Summed various trucks to get total truck trips/acre.
Racine, Wisconsin (pop. 136,952)	Manufacturing - non-durable (20-23,26-31)	0.970	1.000	0.075	1.075	2.045	1972	Summed various trucks to get total truck trips/acre. See note 10.
Kenosha, Wisconsin (pop. 99,664)	Manufacturing - non-durable (20-23,26-31)	0.280	1.700	0.050	1.750	2.030	1972	Summed various trucks to get total truck trips/acre. See note 10.
Racine, Wisconsin (pop. 136,952)	Manuf. - durable & extractive (24,25,32-39)	6.405	4.375	0.180	4.555	10.960	1972	Summed various trucks to get total truck trips/acre. See note 10.
Kenosha, Wisconsin (pop. 99,664)	Manuf. - durable & extractive (24,25,32-39)	9.245	8.350	4.425	12.775	22.020	1972	Summed various trucks to get total truck trips/acre. See note 10.

D-3b. Trip Generation Summary - Daily Commercial Vehicle Trips Per Acre for Manufacturing, Transportation/Communications/Utilities and Wholesale Trade (SIC 20-51)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
			Single Unit	Combination Unit				
Nashville, Tennessee	Industrial (35)					2.500	1975	
Columbus, Ohio (pop. 810,000)	Industrial (35)	1.380	1.470	0.565	2.035	3.415	1964	Summed various trucks to get total truck trips/acre. See note 9.
Median	**SIC (20-39)**	**3.283**	**1.585**	**0.373**	**2.073**	**2.650**		Truck Trips
Average	**SIC (20-39)**	**3.911**	**2.988**	**1.063**	**4.050**	**4.826**		Truck Trips
Minimum	**SIC (20-39)**	**0.280**	**1.000**	**0.050**	**1.075**	**0.400**		Truck Trips
Maximum	**SIC (20-39)**	**9.245**	**8.350**	**4.425**	**12.775**	**22.020**		Truck Trips
Chicago, Illinois (pop. 8 million)	Transportation, Communication, Utilities (40-49)					1.150	1975	See note 5.
Nashville, Tennessee	Transportation, Communication, Utilities (40-49)					0.950		
Columbus, Ohio (pop. 810,000)	Transportation, Communication, Utilities (40-49)	0.345	0.420	0.305	0.725	1.070	1964	Summed various trucks to get total truck trips/acre. See note 9.
Flint, Michigan (pop. 470,000)	Transportation, Communication, Utilities (40-49)	0.320	0.140	0.370	0.510	0.830	1966	Summed various trucks to get total truck trips/acre.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Transportation, Communication, Utilities (40-49)					0.58	1981	See note 5.
Kenosha, Wisconsin (pop. 99,664)	Transportation and Utilities (40-47,49)	0.080	0.055	0.050	0.105	0.185	1972	Summed various trucks to get total truck trips/acre. See note 10.
Racine, Wisconsin (pop. 136,952)	Transportation and Utilities (40-47,49)	0.135	0.095	0.010	0.105	0.240	1972	Summed various trucks to get total truck trips/acre. See note 10.
Fontana, California (pop. greater than 100,000)	Truck Transportation (42)					17.905	1994	

D-3b. Trip Generation Summary - Daily Commercial Vehicle Trips Per Acre for Manufacturing, Transportation/Communications/Utilities and Wholesale Trade (SIC 20-51)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
			Single Unit	Combination Unit				
Richmond, Virginia	Transportation - Warehouse (47)					0.900	1979	
Baton Rouge, Louisiana	Transportation - Warehouse (47)					4.000	1979	
Columbia, SC	Transportation - Warehouse (47)					2.300	1979	
Monroe, Louisiana	Transportation - Warehouse (47)					2.500	1979	
Flint, Michigan (pop. 470,000)	Wholesale Trade (50-51)	9.525	3.785	1.700	5.485	15.010	1966	Summed various trucks to get total truck trips/acre.
Median	**SIC (40-51)**	**0.320**	**0.140**	**0.305**	**0.510**	**1.070**		Truck Trips
Average	**SIC (40-51)**	**2.081**	**0.899**	**0.487**	**1.386**	**3.663**		Truck Trips
Minimum	**SIC (40-51)**	**0.080**	**0.055**	**0.010**	**0.105**	**0.185**		Truck Trips
Maximum	**SIC (40-51)**	**9.525**	**3.785**	**1.700**	**5.485**	**17.905**		Truck Trips

D-3c. Trip Generation Summary - Daily Commercial Vehicle Trips Per Acre for Retail Trade (SIC 52-59)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
			Single Unit	Combination Unit				
Flint, Michigan (pop. 470,000)	Retail (52-59)	5.925	2.800	0.565	3.365	9.290	1966	Summed various trucks to get total truck trips/acre.
Median	**SIC (52-59)**	**5.925**	**2.800**	**0.565**	**3.365**	**9.290**		Truck Trips
Average	**SIC (52-59)**	**5.925**	**2.800**	**0.565**	**3.365**	**9.290**		Truck Trips
Minimum	**SIC (52-59)**	**5.925**	**2.800**	**0.565**	**3.365**	**9.290**		Truck Trips
Maximum	**SIC (52-59)**	**5.925**	**2.800**	**0.565**	**3.365**	**9.290**		Truck Trips

D-3d. Trip Generation Summary - Daily Commercial Vehicle Trips Per Acre for Office and Services (SIC 60-88)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
			Single Unit	Combination Unit				
Flint, Michigan (pop. 470,000)	Services (70-89)	2.464	0.595	0.090	0.685	3.149	1966	Summed various trucks to get total truck trips/acre.
Flint, Michigan (pop. 470,000)	Cultural, Rec., Entertainment (79)	0.155	0.050	0.005	0.055	0.210		
Racine, Wisconsin (pop. 136,952)	Recreation (79)	0.015			0.010	0.025	1972	Summed various trucks to get total truck trips/acre. See note 10.
Kenosha, Wisconsin (pop. 99,664)	Recreation (79)					0.005	1972	Summed various trucks to get total truck trips/acre. See note 10.
Columbus, Ohio (pop. 810,000)	Recreation, Open Space (79)	0.015	0.150	0.115	0.265	0.280	1964	Summed various trucks to get total truck trips/acre. See note 9.
Richmond, Virginia	Services - Schools, Govt. (82)					4.000	1979	
Baton Rouge, Louisiana	Services - Schools, Govt. (82)					2.600	1979	
Columbia, SC	Services - Schools, Govt. (82)					2.300	1979	
Monroe, Louisiana	Services - Schools, Govt. (82)					5.200	1979	
Median	**SIC (70-88)**	**0.085**	**0.150**	**0.090**	**0.160**	**2.300**		Truck Trips
Average	**SIC (70-88)**	**0.662**	**0.265**	**0.070**	**0.254**	**1.974**		Truck Trips
Minimum	**SIC (70-88)**	**0.015**	**0.050**	**0.005**	**0.010**	**0.005**		Truck Trips
Maximum	**SIC (70-88)**	**2.464**	**0.595**	**0.115**	**0.685**	**5.200**		Truck Trips

D-3e. Trip Generation Summary - Daily Commercial Vehicle Trips Per Acre for Other Land Uses (Unclassified - SIC 89; or Combination of Various SIC's)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
			Single Unit	Combination Unit				
Kenosha, Wisconsin (pop. 99,664)	Commercial Wholesale and Storage	0.970	0.500	0.020	1.520	2.490	1972	Summed various trucks to get total truck trips/acre. See note 10.
Racine, Wisconsin (pop. 136,952)	Commercial Wholesale and Storage	1.345	1.695	0.065	1.760	3.105	1972	Summed various trucks to get total truck trips/acre. See note 10.
Richmond, Virginia	Retail-Wholesale (50-59)					10.300	1979	
Baton Rouge, Louisiana	Retail-Wholesale (50-59)					33.600	1979	
Little Rock, Arkansas	Retail-Wholesale (50-59)					16.000	1979	
Columbia, SC	Retail-Wholesale (50-59)					20.300	1979	
Monroe, Louisiana	Retail-Wholesale (50-59)					35.000	1979	
Chicago, Illinois (pop. 8 million)	Commercial					14.250	1975	See note 5.
Columbus, Ohio (pop. 810,000)	Commercial	5.965	4.290	0.640	4.930	10.895	1964	Summed various trucks to get total truck trips/acre. See note 9.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Commercial					7.125	1981	See note 5.
Kenosha, Wisconsin (pop. 99,664)	Commercial Retail & Services (52-59)	8.465	11.085	0.275	11.360	19.825	1972	Summed various trucks to get total truck trips/acre. See note 10.
Racine, Wisconsin (pop. 136,952)	Commercial Retail & Services (52-59)	9.535	11.465	0.065	11.530	21.065	1972	Summed various trucks to get total truck trips/acre. See note 10.
Kenosha, Wisconsin (pop. 99,664)	Institutional and Government Service	0.675	0.170		0.170	0.845	1972	Summed various trucks to get total truck trips/acre. See note 10.
Racine, Wisconsin (pop. 136,952)	Institutional and Government Service	1.110	0.410		0.410	1.520	1972	Summed various trucks to get total truck trips/acre. See note 10.

D-3e. Trip Generation Summary - Daily Commercial Vehicle Trips Per Acre for Other Land Uses (Unclassified - SIC 89; or Combination of Various SIC's)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
			Single Unit	Combination Unit				
Columbus, Ohio (pop. 810,000)	Residential	0.220	0.190	0.055	0.245	0.465	1964	Summed various trucks to get total truck trips/acre. See note 9.
Flint, Michigan (pop. 470,000)	Residential	0.840	0.100	0.045	0.145	0.985	1966	Summed various trucks to get total truck trips/acre.
Kenosha, Wisconsin (pop. 99,664)	Residential	0.600	0.260		0.260	0.860	1972	Summed various trucks to get total truck trips/acre. See note 10.
Racine, Wisconsin (pop. 136,952)	Residential	0.465	0.180		0.180	0.645	1972	Summed various trucks to get total truck trips/acre. See note 10.
Chicago, Illinois (pop. 8 million)	Residential					0.100	1975	See note 5.
Nashville, Tennessee	Residential					0.900		
Richmond, Virginia	Residential					1.400	1979	
Baton Rouge, Louisiana	Residential					2.000	1979	
Columbia, SC	Residential					1.200	1979	
Monroe, Louisiana	Residential					1.700	1979	
Little Rock , Arkansas	Residential					1.000		
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Residential					0.060	1981	See note 5.
Chicago, Illinois (pop. 8 million)	Automobile Parking					0.500	1975	
Chicago, Illinois (pop. 8 million)	Public Buildings					0.400	1975	See note 5.

D-3e. Trip Generation Summary - Daily Commercial Vehicle Trips Per Acre for Other Land Uses (Unclassified - SIC 89; or Combination of Various SIC's)

Location	Land Use Type (SIC)	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	Date	Notes/Comments
			Single Unit	Combination Unit				
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Public Buildings					0.200	1981	See note 5.
Columbus, Ohio (pop. 810,000)	Public Facilities	0.260	0.245	0.065	0.310	0.570	1964	Summed various trucks to get total truck trips/acre. See note 9.
Nashville, Tennessee	Public Land and Buildings					0.500		
Chicago, Illinois (pop. 8 million)	Public Open Space					0.300	1975	See note 5.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Public Open Space					0.015	1981	See note 5.
Chicago, Illinois (pop. 8 million)	Highways - Streets					0.150	1975	See note 5.
Racine, Wisconsin (pop. 136,952)	Open Land and Water Areas	0.015	0.080		0.080	0.095	1972	Summed various trucks to get total truck trips/acre. See note 10.
Kenosha, Wisconsin (pop. 99,664)	Open Land and Water Areas					0.003	1972	
Columbus, Ohio (pop. 810,000)	Open Land and Water Areas	0.140	0.100	0.025	0.125	0.265	1964	Summed various trucks to get total truck trips/acre. See note 9.
Flint, Michigan (pop. 470,000)	Resource Production & Extraction	0.020	0.005		0.005	0.025	1966	Summed various trucks to get total truck trips/acre.
Chicago, Illinois (pop. 8 million)	Undeveloped					0.010	1975	See note 5.
Flint, Michigan (pop. 470,000)	Undeveloped	0.005				0.005	1966	Summed various trucks to get total truck trips/acre.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Undeveloped					0.004	1981	See note 5.

D-4 Trip Generation Regression Equations

D-4a. Trip Generation Summary - Regression Formulas for Daily Commercial Vehicle Trips for Agriculture, Mining and Construction (1-19)

Location	Land Use Type (SIC)	Date	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	R^2	Notes/Comments
				Single Unit	Combination Unit				
Leake and Gan (unknown), London??	Road Haul Contractors (17)	1973					1.69 + (1.73 * N) - (.02 * N^2)	0.58	N = Total non-office floor area in 1000 sq. ft. See note 4.

D-4b. Trip Generation Summary - Regression Formulas for Daily Commercial Vehicle Trips for Manufacturing, Transportation/ Communications/Utilities and Wholesale Trade (20-51)

Location	Land Use Type (SIC)	Date	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	R^2	Notes/Comments
				Single Unit	Combination Unit				
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Manufacturing (20-39)	1981	163.4 + (95.16*MANL)	933.5 + (31.01*MANL)	255.8 + (28.2*MANL)		1.69 + (1.73*N) - (.02*N^2)	0.07 to 0.48	MANL = Manufacturing land in the district. See note 5.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Manufacturing (20-39)	1981	253.8 + (2.1*MANEMP)	257.6 + (5.11*MANEMP)	271.6 + (2.3*MANEMP)	529.2 + (7.41*MANEMP)	730.6 + (9.7*MANEMP)	0.25 to 0.58	MANEMP = Employment at manufacturing sites. See note 5.
Starkie, London - Industrial Suburb	Manufacturing and Engineering (20-39)	1967					26.96 + (0.0377*E)	0.24	E = Employment. See note 4.
Starkie, London - Industrial Suburb	Manufacturing and Engineering (20-39)	1967					19.44 + (0.0003*FA)	0.36	FA = Floor area. See note 4.
Fontana, California (pop. greater than 100,000)	Industrial - Heavy (20-39)	1994			78 - (0.652*TSF)		127.3 - (1.09*TSF)		TSF = Building area in thousands of gross sq. ft. See note 8.
Fontana, California (pop. greater than 100,000)	Industrial - Light (20-39)	1994			3.39 + (0.0877*TSF)		13.94 + (0.148*TSF)	0.98	TSF = Building area in thousands of gross sq. ft. See note 8.
Fontana, California (pop. greater than 100,000)	Industrial Park (20-39)	1994			-0.93 + (0.16*TSF)		24.87 + (0.208*TSF)	0.3	TSF = Building area in thousands of gross sq. ft. See note 8.
Fontana, California (pop. greater than 100,000)	Warehouse - Heavy (20-39)	1994			37.75 + (0.2249*TSF)		57.65.3 + (0.2891*TSF)		TSF = Building area in thousands of gross sq. ft. See note 8.
Fontana, California (pop. greater than 100,000)	Warehouse - Light (20-39)	1994			11.43 + (0.1406*TSF)		30.44 + (0.1785*TSF)	0.6	TSF = Building area in thousands of gross sq. ft. See note 8.
Leake and Gan (unknown), London??	Industrial (Other) Materials and Mach. (20-39)	1973					5.29 + (22.9*S) - (2.4*S^2)	0.32	S = Site area in acres. See note 4.

D-4b. Trip Generation Summary - Regression Formulas for Daily Commercial Vehicle Trips for Manufacturing, Transportation/ Communications/Utilities and Wholesale Trade (20-51)

Location	Land Use Type (SIC)	Date	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	R^2	Notes/Comments
				Single Unit	Combination Unit				
Columbus, Ohio (pop. 1.1 million)	Industry-Oriented (35)	1980					16.2 + (0.28*INE) + (0.18*CTUE)	0.26	INE = Industrial non-manufacturing employment; CTUE = Communication, transportation, and utility employment. See note 5.
Flint, Michigan (pop. 593,000)	Industry-Oriented (35)	1980					37.6 + (0.2*OE) + (0.13*ME)	0.73	OE = Other employment; ME = Manufacturing employment. See note 5.
Saginaw, Michigan (pop. 236,000)	Industry-Oriented (35)	1980					6.12 + (0.36*TCE) + (0.09*TE)	0.64	TCE = Transportation and communications empl.; TE = Total empl. See note 5.
Fontana, California (pop. greater than 100,000)	Truck Sales and Leasing (37)	1994			-2.8 + (1.89*TSF)		-189.4 - (1.53*TSF)	0.21	TSF = Building area in thousands of gross sq. ft. See note 8.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Transportation, Communications, Utilities (40-49)	1981	279.3 + (7.77*TCUEMP)		390.4 + (10.5*TCUEMP)		1384.1 + (10.3*TCUEMP)	0.21 to 0.65	TCUEMP = Employment at transportation, communications, utilities. See note 5.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Transportation, Communications, Utilities (40-49)	1981		540.6 + (11.51*TCUL)				0.16	TCUL = Transportation, communications, utilities land in the district. See note 5.
Fontana, California (pop. greater than 100,000)	Truck Transportation (42)	1994			-72 + (38.2*TSF)		-108 + (50.6*TSF)	0.1	TSF = Building area in thousands of gross sq. ft. See note 8.
Nashville, Tennessee (pop. 770,000)	Truck Transportation (42)	1990					(2.0552*TE) - 3.4407	0.726	TE = Number of terminal employees.
Leake and Gan (unknown), London??	Wholesale Dist. - Food, Drink (51)	1973					-1.88 + (1.75*N)	0.81	N = Total non-office floor area in 1000 sq. ft. See note 4.

D-4c. Trip Generation Summary - Regression Formulas for Daily Commercial Vehicle Trips for Retail Trade (SIC 52-59)

Location	Land Use Type (SIC)	Date	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	R^2	Notes/Comments
				Single Unit	Combination Unit				
Leake and Gan (unknown), London??	Builders and Agriculture Supplies (52)	1973					$1.69 + (1.73*N) - (0.02*N^2)$	0.83	F = Total floor area in 1000 sq. ft. See note 4.
Gastonia, North Carolina (pop. 166,000)	Goods (52-59)	1980					50.1 + (1.1*RE) + (0.33*LIDU)	0.37	RE = Retail employment; LIDU = Low-income dwelling units. See note 5.

D-4d. Trip Generation Summary - Regression Formulas for Daily Commercial Vehicle Trips for Office and Services (SIC 60-88)

Location	Land Use Type (SIC)	Date	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	R^2	Notes/Comments
				Single Unit	Combination Unit				
Gastonia, North Carolina (pop. 166,000)	Service (70-89)	1980					1.69 + (1.73*N) - (0.02*N^2)	0.27	HE = Highway employment; TE = Total employment. See note 5.

D-4e. Trip Generation Summary - Regression Formulas for Daily Commercial Vehicle Trips for Other Land Uses (Unclassified - SIC 89)

Location	Land Use Type (SIC)	Date	4-Tire Commercial Vehicles	6+ Tire Commercial Vehicles		All 6+ Tire Commercial Vehicles	All Commercial Vehicles	R^2	Notes/Comments
				Single Unit	Combination Unit				
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Commercial	1981			515.7 + (18.9*COML)		1.69 + (1.73*N) - $(0.02*N^2)$	0.17 to 0.22	COML = Commercial land in the district. See note 5.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Commercial	1981	1,112.2 + (9.76*COMEMP)	2,492.1 + (3.6*COMEMP)	305.7 + (2.2*COMEMP)		2,252.7 + (23.7*COMEMP)	0.18 to 0.50	COMEMP = Employment at commercial sites. See note 5.
Columbus, Ohio (pop. 1.1 million)	Commercial Oriented	1980					54.6 + (0.51*INE) + (0.18*CGE)	0.35	INE = Industrial non-manufacturing employment; CGE = Commercial and government employment. See note 5.
Flint, Michigan (pop. 593,000)	Commercial Oriented	1980					73.3 + (0.59*CE) + (0.36*TDU)	0.47	CE = Commercial employment; TDU = Total dwelling units. See note 5.
Saginaw, Michigan (pop. 236,000)	Commercial Oriented	1980					11.9 + (0.38*TDU) + (0.37*TE)	0.65	TDU = Total dwelling units; CE = Commercial employment. See note 5.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Residential (88)	1981	762.7 + (5.43*DU)				416.7 + (16*DU)	0.21 to 0.37	DU = Dwelling units. See note 5.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Residential (88)	1981	-188.8 + (35.38*RESL) + (2.86*DU)				1078.6 + (56.5*RESL) + (11.7*DU)	0.54 to 0.55	RESL = Residential land in the district; DU = Dwelling units. See note 5.
NE Illinois/NW Indiana - Eight Counties (pop. over 8 million)	Public Buildings	1981	196.5 + (20.92*PB)				112.6 + (73.6*PB)	0.17 to 0.43	PB = Public buildings in the district. See note 5.

NOTES (Trip Generation Summary Tables)

1. Commercial vehicles distributed accordingly:
   - Auto/pickup/truck/van = 4-tire commercial vehicles.
   - Single unit truck = 6+ tire single unit.
   - Semi-trailer = 6+ tire combination unit.
2. Commercial vehicles distributed accordingly:
   - 0-8,000 lb commercial vehicles = 4-tire commercial vehicles.
   - 8,000-28,000 lb commercial vehicles = 6+ tire single unit.
   - 28,000+ lb commercial vehicle = 6+ tire combination unit.
3. Commercial vehicles distributed accordingly:
   - 2-axle commercial vehicle = 4-tire commercial vehicles.
   - 3-axle commercial vehicle = 6+ tire single unit truck.
   - 4+ axle commercial vehicle = 6+ tire combination unit.
4. Assuming trip rate includes all commercial vehicles.
5. No time period indicated; assumed daily.
6. Commercial vehicles distributed accordingly:
   - Courier vans plus light rigid trucks = 4-tire commercial vehicles.
   - Heavy rigid trucks = 6+ tire single unit truck.
   - Articulated trucks = 6+ tire combination unit.
7. Light commercial vehicles (4-wheeled trucks and vans) = 4-tire commercial vehicles.
8. 4+ axle trucks = 6+ tire combination unit.
9. Commercial vehicles distributed accordingly:
   - Light trucks (panel and pickup) = 4-tire commercial vehicles.
   - Medium trucks (all other commercial trucks except combination) = 6+ tire single unit truck.
10. Light [under 8000 lb except farm (under 10,000 lb)] = 4-tire commercial vehicles.

Appendix E

Internal Versus External Truck Trips

Appendix E

■ Internal Versus External Truck Trips

The following table contains a summary of the percentages of internal versus external truck trips as a percentage of total commercial vehicle trips for various locations. Median and average values of external-external (through) trips have been calculated using the numbers shown in the Table.

For the San Francisco Bay Area data, internal-internal trips are subdivided into garage-based trips and linked trips. Garage-based trips are those trips where the truck travels from its origin to its destination and returns to its origin. Linked trips involve departure from the origin and travel to several destinations before returning to the point of origin. Internal-internal port trips are either garage-based trips or linked trips whose origin or destination is the Port of Oakland.

E-1. Internal Versus External Truck Trips As Percentage of Total Commercial Vehicle Trips

Location	Trip Type	6+ Tire Combination Unit	Total Commercial Vehicles	Date	Notes/Comments
San Francisco Bay Area	Internal-Internal (linked)	8.3%	50.0%	1993	See notes 1, 2, and 3.
	Internal-Internal (garage-based)	5.3%	34.0%	1993	See notes 1, 2, and 3.
	Internal-Internal (port)	1.3%	2.0%	1993	See notes 1, 2, and 3.
	Internal-External	8.2%	14.0%	1993	See notes 1, 2, and 3.
	Internal-External (Port)	0.0%	0.0%	1993	See notes 1, 2, and 3.
	External-External (Through)	0.8%	1.0%	1993	See notes 1, 2, and 3.
Puget Sound Region	Longhaul (>250 mi)		9.5%	1994	See note 4.
	Shorthaul (<250 mi)		29.0%	1994	See note 4.
	Local		48.5%	1994	See note 4.
	Through		13.0%	1994	See note 4.
Lancaster County, Pennsylvania	External-External (Through)		50.0%	1994	See note 5.
	External-Internal		20.0%	1994	See note 5.
	Internal-External		30.0%	1994	See note 5.
York County, Pennsylvania	External-External (Through)		36.0%	1994	See note 5.
	External-Internal		43.0%	1994	See note 5.
	Internal-External		22.0%	1994	See note 5.
I-235, Polk County, Iowa	Through		11.0%	1991	See note 6.
Yuma Metropolitan Area, Arizona	External-External (Through)		7.0%	1990	See note 7.
Port Authority of New York and New Jersey (toll bridges/tunnel crossings)	Through		7.0%	1991	See note 8.
Average Through (External-External) Truck Trips			**17.86%**		
Median Through (External-External) Truck Trips			**11.00%**		
Minimum Through (External-External) Truck Trips			**1.00%**		
Maximum Through (External-External) Truck Trips			**50.00%**		

Notes:
1. Percentages based on number of trips.
2. Values available for 2-axle, 3-axle, and 4- or more-axle trucks. Assumed 4- or more-axle trucks = 6+ Combination Commercial Vehicles.
3. Schlappi, Marshall, and Itamura. "Truck Travel in the San Francisco Bay Area." Transportation Research Board 72nd Annual Meeting. January 1993.
4. Transmode Consultants, Inc. "Analysis of Freight Movements in the Puget Sound Region." Puget Sound Regional Council. October 1994.
5. Skelly and Loy, Inc. "PA 372 Origin-Destination Survey Final Report." For Lancaster and York County Planning Commissions. August 1994.
6. Wilbur Smith Associates. "I-235 Alternatives Analysis and Environmental Impact Statement," Technical Memorandum Number 1. For Iowa DOT.
7. Yuma Metropolitan Planning Organization. "1990 Origin-Destination Survey." 1990.
8. Percentage based on eastbound truck traffic at the region's 6 crossings.

Appendix F

Time-of-Day Characteristics

Appendix F

■ Time-of-Day Characteristics

The following pages contain detailed time-of-day characteristics of truck trips in various locations. Time-of-day characteristics summary tables are provided both as percentage of total daily truck trips (Table F-1) and as percentage of total hourly vehicle trips on the roadway (Table F-2). The median hourly distributions are shown in Tables F-1a and F-2a.

F-1. Time of Day Characteristics - (Hourly Truck Trips As Percentage of Total Daily Truck Trips)

Location	Land Use Type (SIC)	Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks	Date	Notes/Comments
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	12-1 A.M.	0.0	0.0	0.1	0.1	0.1	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	12-1 A.M.	0.0	0.0	0.6	0.6	0.6	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	12-1 A.M.	0.0	0.0	0.0	0.0	0.0	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		12-1 A.M.	0.0	0.0	0.0	0.0	0.0	1992	See Note 2.
Triad Region, North Carolina		12-1 A.M.					0.0	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		12-1 A.M.				1.4		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.0	0.0	0.1	0.1	0.0		
		Average	0.0	0.0	0.2	0.4	0.1		
		Minimum	0.0	0.0	0.0	0.0	0.0		
		Maximum	0.0	0.0	0.6	1.4	0.6		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	1-2 A.M.	0.0	0.0	0.2	0.2	0.2	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	1-2 A.M.	0.0	0.0	1.3	1.3	1.3	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	1-2 A.M.	0.0	0.0	0.0	0.0	0.0	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		1-2 A.M.	0.0	0.0	0.0	0.0	0.0	1992	See Note 2.
Triad Region, North Carolina		1-2 A.M.					0.4	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		1-2 A.M.				1.3		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.0	0.0	0.1	0.2	0.2		
		Average	0.0	0.0	0.4	0.6	0.4		
		Minimum	0.0	0.0	0.0	0.0	0.0		
		Maximum	0.0	0.0	1.3	1.3	1.3		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	2-3 A.M.	0.0	0.1	0.2	0.3	0.3	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	2-3 A.M.	0.0	0.0	1.5	1.5	1.5	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	2-3 A.M.	0.0	0.0	0.0	0.0	0.0	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		2-3 A.M.	0.3	0.5	0.3	0.8	1.1	1992	See Note 2.
Triad Region, North Carolina		2-3 A.M.					0.2	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		2-3 A.M.				1.3		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.0	0.1	0.3	0.8	0.3		
		Average	0.1	0.2	0.5	0.8	0.6		
		Minimum	0.0	0.0	0.0	0.0	0.0		
		Maximum	0.3	0.5	1.5	1.5	1.5		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	3-4 A.M.	0.1	0.3	0.3	0.6	0.7	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	3-4 A.M.	0.0	0.0	1.4	1.4	1.4	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	3-4 A.M.	0.0	0.0	0.0	0.0	0.0	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		3-4 A.M.	0.0	0.0	0.0	0.0	0.0	1992	See Note 2.
Triad Region, North Carolina		3-4 A.M.					0.3	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		3-4 A.M.				1.4		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.0	0.0	0.2	0.6	0.3		
		Average	0.0	0.1	0.4	0.7	0.5		
		Minimum	0.0	0.0	0.0	0.0	0.0		
		Maximum	0.1	0.3	1.4	1.4	1.4		

Time of Day Characteristics - Summary

Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks
12-1 A.M.	0.00	0.00	0.18	0.42	0.14
1-2 A.M.	0.00	0.00	0.38	0.56	0.38
2-3 A.M.	0.08	0.15	0.50	0.78	0.62
3-4 A.M.	0.03	0.08	0.43	0.68	0.48
4-5 A.M.	0.20	0.25	0.95	1.32	1.16
5-6 A.M.	0.65	0.55	1.55	2.26	2.30
6-7 A.M.	0.78	0.75	1.93	3.02	2.98
7-8 A.M.	0.80	1.53	2.90	4.64	5.62
8-9 A.M.	1.88	2.33	4.18	6.34	8.58
9-10 A.M.	3.28	2.75	4.43	7.04	10.53
10-11 A.M.	3.30	2.88	3.95	6.86	10.80
11-12 A.M.	3.33	2.78	3.73	6.64	10.37
12-1 P.M.	3.05	2.00	3.68	5.94	9.47
1-2 P.M.	2.75	2.15	3.55	5.96	9.10
2-3 P.M.	1.98	2.08	3.03	5.48	7.98
3-4 P.M.	1.85	1.75	2.33	4.60	6.48
4-5 P.M.	1.75	1.33	2.45	4.20	5.37
5-6 P.M.	1.43	1.30	1.70	3.36	3.97
6-7 P.M.	0.58	0.55	1.40	2.32	2.15
7-8 P.M.	0.40	0.20	1.00	1.60	1.36
8-9 P.M.	0.28	0.10	0.68	1.14	0.88
9-10 P.M.	0.30	0.08	0.48	0.86	0.70
10-11 P.M.	0.03	0.05	0.48	0.80	0.46
11-12 P.M.	0.00	0.00	0.00	0.80	0.30

Time of Day Characteristics - Summary

Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks
12-1 A.M.	0.00	0.00	0.05	0.10	0.00
1-2 A.M.	0.00	0.00	0.10	0.20	0.20
2-3 A.M.	0.00	0.05	0.25	0.80	0.30
3-4 A.M.	0.00	0.00	0.15	0.60	0.30
4-5 A.M.	0.10	0.20	1.15	1.50	1.50
5-6 A.M.	0.60	0.55	1.85	2.90	1.60
6-7 A.M.	0.45	0.70	2.25	4.10	2.20
7-8 A.M.	0.95	1.10	3.40	5.10	5.25
8-9 A.M.	1.35	2.15	4.65	6.00	9.00
9-10 A.M.	2.05	2.85	4.70	7.10	10.65
10-11 A.M.	1.95	2.95	4.30	7.00	10.70
11-12 A.M.	2.20	3.20	4.15	7.20	11.15
12-1 P.M.	2.75	1.95	3.60	6.00	10.45
1-2 P.M.	3.00	2.25	3.30	5.70	9.55
2-3 P.M.	1.55	2.05	3.30	5.40	8.55
3-4 P.M.	1.40	1.70	2.55	4.40	6.00
4-5 P.M.	0.95	1.40	1.70	3.80	5.10
5-6 P.M.	1.10	1.05	0.80	2.70	3.40
6-7 P.M.	0.55	0.40	0.75	1.50	1.35
7-8 P.M.	0.35	0.20	0.50	0.90	0.90
8-9 P.M.	0.30	0.05	0.40	0.60	0.60
9-10 P.M.	0.10	0.05	0.05	0.30	0.30
10-11 P.M.	0.00	0.05	0.05	0.20	0.20
11-12 P.M.	0.00	0.00	0.00	0.80	0.30

F-1. Time of Day Characteristics - (Hourly Truck Trips As Percentage of Total Daily Truck Trips)

Location	Land Use Type (SIC)	Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks	Date	Notes/Comments
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	4-5 A.M.	0.2	0.4	1.4	1.8	2.0	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	4-5 A.M.	0.0	0.0	1.5	1.5	1.5	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	4-5 A.M.	0.0	0.0	0.0	0.0	0.0	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		4-5 A.M.	0.6	0.6	0.9	1.5	2.1	1992	See Note 2.
Triad Region, North Carolina		4-5 A.M.					0.2	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		4-5 A.M.				1.8		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.1	0.2	1.2	1.5	1.5		
		Average	0.2	0.3	1.0	1.3	1.2		
		Minimum	0.0	0.0	0.0	0.0	0.0		
		Maximum	0.6	0.6	1.5	1.8	2.1		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	5-6 A.M.	1.2	1.0	2.2	3.2	4.4	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	5-6 A.M.	0.0	0.1	1.5	1.6	1.6	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	5-6 A.M.	0.0	0.0	0.0	0.0	0.0	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		5-6 A.M.	1.4	1.1	2.5	3.6	5.0	1992	See Note 2.
Triad Region, North Carolina		5-6 A.M.					0.5	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		5-6 A.M.				2.9		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.6	0.6	1.9	2.9	1.6		
		Average	0.7	0.6	1.6	2.3	2.3		
		Minimum	0.0	0.0	0.0	0.0	0.0		
		Maximum	1.4	1.1	2.5	3.6	5.0		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	6-7 A.M.	2.2	1.5	2.6	4.1	6.3	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	6-7 A.M.	0.0	0.3	1.9	2.2	2.2	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	6-7 A.M.	0.1	0.1	0.1	0.2	0.3	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		6-7 A.M.	0.8	1.1	3.1	4.2	5.0	1992	See Note 2.
Triad Region, North Carolina		6-7 A.M.					1.1	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		6-7 A.M.				4.4		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.5	0.7	2.3	4.1	2.2		
		Average	0.8	0.8	1.9	3.0	3.0		
		Minimum	0.0	0.1	0.1	0.2	0.3		
		Maximum	2.2	1.5	3.1	4.4	6.3		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	7-8 A.M.	1.2	3.1	4.2	7.3	8.5	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	7-8 A.M.	0.1	0.9	3.0	3.9	4.0	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	7-8 A.M.	1.0	0.8	0.6	1.4	2.4	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		7-8 A.M.					8.3	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		7-8 A.M.	0.9	1.3	3.8	5.1	6.0	1992	See Note 2.
Triad Region, North Carolina		7-8 A.M.					4.5	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		7-8 A.M.				5.5		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	1.0	1.1	3.4	5.1	5.3		
		Average	0.8	1.5	2.9	4.6	5.6		
		Minimum	0.1	0.8	0.6	1.4	2.4		
		Maximum	1.2	3.1	4.2	7.3	8.5		

Time of Day Characteristics - Summary

Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks

Time of Day Characteristics - Summary

Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks

F-1. Time of Day Characteristics - (Hourly Truck Trips As Percentage of Total Daily Truck Trips)

			Percent of Total Daily Truck Trips						
		Time	4-Tire	6+ Tire Commercial Vehicles		All 6+	All		
Location	Land Use Type (SIC)	Period	Trucks	Single Unit	Combination Unit	Tire Trucks	Trucks	Date	Notes/Comments
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	8-9 A.M.	1.0	3.4	5.3	8.7	9.7	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	8-9 A.M.	1.7	2.3	5.4	7.7	9.4	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	8-9 A.M.	3.8	1.6	2.0	3.6	7.4	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		8-9 A.M.					9.3	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		8-9 A.M.	1.0	2.0	4.0	6.0	7.0	1992	See Note 2.
Triad Region, North Carolina		8-9 A.M.					8.7	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		8-9 A.M.				5.7		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	1.4	2.2	4.7	6.0	9.0		
		Average	1.9	2.3	4.2	6.3	8.6		
		Minimum	1.0	1.6	2.0	3.6	7.0		
		Maximum	3.8	3.4	5.4	8.7	9.7		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	9-10 A.M.	1.9	2.8	4.5	7.3	9.2	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	9-10 A.M.	2.2	3.1	5.7	8.8	11.0	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	9-10 A.M.	7.1	2.9	2.6	5.5	12.6	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		9-10 A.M.					10.3	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		9-10 A.M.	1.9	2.2	4.9	7.1	9.0	1992	See Note 2.
Triad Region, North Carolina		9-10 A.M.					11.1	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		9-10 A.M.				6.5		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	2.1	2.9	4.7	7.1	10.7		
		Average	3.3	2.8	4.4	7.0	10.5		
		Minimum	1.9	2.2	2.6	5.5	9.0		
		Maximum	7.1	3.1	5.7	8.8	12.6		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	10-11 A.M.	2.2	3.5	3.8	7.3	9.5	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	10-11 A.M.	1.0	1.8	5.0	6.8	7.8	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	10-11 A.M.	8.3	3.8	2.2	6.0	14.3	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		10-11 A.M.					12.4	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		10-11 A.M.	1.7	2.4	4.8	7.2	8.9	1992	See Note 2.
Triad Region, North Carolina		10-11 A.M.					11.9	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		10-11 A.M.				7.0		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	2.0	3.0	4.3	7.0	10.7		
		Average	3.3	2.9	4.0	6.9	10.8		
		Minimum	1.0	1.8	2.2	6.0	7.8		
		Maximum	8.3	3.8	5.0	7.3	14.3		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	11-12 A.M.	1.7	2.9	4.4	7.3	9.0	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	11-12 A.M.	0.5	1.0	3.9	4.9	5.4	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	11-12 A.M.	8.4	3.7	1.8	5.5	13.9	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		11-12 A.M.					11.6	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		11-12 A.M.	2.7	3.5	4.8	8.3	11.0	1992	See Note 2.
Triad Region, North Carolina		11-12 A.M.					11.3	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		11-12 A.M.				7.2		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	2.2	3.2	4.2	7.2	11.2		
		Average	3.3	2.8	3.7	6.6	10.4		
		Minimum	0.5	1.0	1.8	4.9	5.4		
		Maximum	8.4	3.7	4.8	8.3	13.9		

Time of Day Characteristics - Summary

	Percent of Total Daily Truck Trips				
	4-Tire	6+ Tire Commercial Vehicles		All 6+	All
Time Period	Trucks	Single Unit	Combination Unit	Tire Trucks	Trucks

Time of Day Characteristics - Summary

	Percent of Total Daily Truck Trips				
	4-Tire	6+ Tire Commercial Vehicles		All 6+	All
Time Period	Trucks	Single Unit	Combination Unit	Tire Trucks	Trucks

F-1. Time of Day Characteristics - (Hourly Truck Trips As Percentage of Total Daily Truck Trips)

			Percent of Total Daily Truck Trips						
		Time	4-Tire	6+ Tire Commercial Vehicles		All 6+	All		
Location	Land Use Type (SIC)	Period	Trucks	Single Unit	Combination Unit	Tire Trucks	Trucks	Date	Notes/Comments
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	12-1 P.M.	1.2	2.0	4.0	6.0	7.2	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	12-1 P.M.	0.4	0.7	3.2	3.9	4.3	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	12-1 P.M.	6.3	1.9	2.2	4.1	10.4	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		12-1 P.M.					11.4	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		12-1 P.M.	4.3	3.4	5.3	8.7	13.0	1992	See Note 2.
Triad Region, North Carolina		12-1 P.M.					10.5	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		12-1 P.M.				7.0		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	2.8	2.0	3.6	6.0	10.5		
		Average	3.1	2.0	3.7	5.9	9.5		
		Minimum	0.4	0.7	2.2	3.9	4.3		
		Maximum	6.3	3.4	5.3	8.7	13.0		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	1-2 P.M.	1.6	2.0	3.7	5.7	7.3	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	1-2 P.M.	0.4	0.7	2.9	3.6	4.0	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	1-2 P.M.	4.4	3.4	1.7	5.1	9.5	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		1-2 P.M.					11.2	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		1-2 P.M.	4.6	2.5	5.9	8.4	13.0	1992	See Note 2.
Triad Region, North Carolina		1-2 P.M.					9.6	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		1-2 P.M.				7.0		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	3.0	2.3	3.3	5.7	9.6		
		Average	2.8	2.2	3.6	6.0	9.1		
		Minimum	0.4	0.7	1.7	3.6	4.0		
		Maximum	4.6	3.4	5.9	8.4	13.0		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	2-3 P.M.	1.6	2.4	3.7	6.1	7.7	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	2-3 P.M.	0.5	0.7	2.9	3.6	4.1	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	2-3 P.M.	4.3	3.5	1.8	5.3	9.6	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		2-3 P.M.					9.4	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		2-3 P.M.	1.5	1.7	3.7	5.4	6.9	1992	See Note 2.
Triad Region, North Carolina		2-3 P.M.					10.2	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		2-3 P.M.				7.0		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	1.6	2.1	3.3	5.4	8.6		
		Average	2.0	2.1	3.0	5.5	8.0		
		Minimum	0.5	0.7	1.8	3.6	4.1		
		Maximum	4.3	3.5	3.7	7.0	10.2		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	3-4 P.M.	1.3	2.2	2.8	5.0	6.3	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	3-4 P.M.	0.6	1.2	3.2	4.4	5.0	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	3-4 P.M.	4.0	2.4	1.0	3.4	7.4	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		3-4 P.M.					5.7	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		3-4 P.M.	1.5	1.2	2.3	3.5	5.0	1992	See Note 2.
Triad Region, North Carolina		3-4 P.M.					9.5	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		3-4 P.M.				6.7		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	1.4	1.7	2.6	4.4	6.0		
		Average	1.9	1.8	2.3	4.6	6.5		
		Minimum	0.6	1.2	1.0	3.4	5.0		
		Maximum	4.0	2.4	3.2	6.7	9.5		

Time of Day Characteristics - Summary

	Percent of Total Daily Truck Trips				
	4-Tire	6+ Tire Commercial Vehicles		All 6+	All
Time Period	Trucks	Single Unit	Combination Unit	Tire Trucks	Trucks

Time of Day Characteristics - Summary

	Percent of Total Daily Truck Trips				
	4-Tire	6+ Tire Commercial Vehicles		All 6+	All
Time Period	Trucks	Single Unit	Combination Unit	Tire Trucks	Trucks

F-1. Time of Day Characteristics - (Hourly Truck Trips As Percentage of Total Daily Truck Trips)

Location	Land Use Type (SIC)	Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks	Date	Notes/Comments
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	4-5 P.M.	1.0	1.9	1.9	3.8	4.8	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	4-5 P.M.	0.7	1.1	6.0	7.1	7.8	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	4-5 P.M.	4.4	1.7	0.4	2.1	6.5	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		4-5 P.M.					4.7	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		4-5 P.M.	0.9	0.6	1.5	2.1	3.0	1992	See Note 2.
Triad Region, North Carolina		4-5 P.M.					5.4	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		4-5 P.M.				5.9		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	1.0	1.4	1.7	3.8	5.1		
		Average	1.8	1.3	2.5	4.2	5.4		
		Minimum	0.7	0.6	0.4	2.1	3.0		
		Maximum	4.4	1.9	6.0	7.1	7.8		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	5-6 P.M.	0.4	1.5	1.2	2.7	3.1	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	5-6 P.M.	1.0	2.7	5.1	7.8	8.8	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	5-6 P.M.	3.1	0.6	0.1	0.7	3.8	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		5-6 P.M.					3.7	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		5-6 P.M.	1.2	0.4	0.4	0.8	2.0	1992	See Note 2.
Triad Region, North Carolina		5-6 P.M.					2.4	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		5-6 P.M.				4.8		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	1.1	1.1	0.8	2.7	3.4		
		Average	1.4	1.3	1.7	3.4	4.0		
		Minimum	0.4	0.4	0.1	0.7	2.0		
		Maximum	3.1	2.7	5.1	7.8	8.8		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	6-7 P.M.	0.1	0.5	1.0	1.5	1.6	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	6-7 P.M.	1.1	1.3	4.0	5.3	6.4	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	6-7 P.M.	0.8	0.1	0.1	0.2	1.0	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		6-7 P.M.					2.0	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		6-7 P.M.	0.3	0.3	0.5	0.8	1.1	1992	See Note 2.
Triad Region, North Carolina		6-7 P.M.					0.8	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		6-7 P.M.				3.8		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.6	0.4	0.8	1.5	1.4		
		Average	0.6	0.6	1.4	2.3	2.2		
		Minimum	0.1	0.1	0.1	0.2	0.8		
		Maximum	1.1	1.3	4.0	5.3	6.4		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	7-8 P.M.	0.0	0.4	0.5	0.9	0.9	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	7-8 P.M.	0.9	0.3	3.0	3.3	4.2	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	7-8 P.M.	0.2	0.1	0.0	0.1	0.3	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		7-8 P.M.	0.5	0.0	0.5	0.5	1.0	1992	See Note 2.
Triad Region, North Carolina		7-8 P.M.					0.4	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		7-8 P.M.				3.2		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.4	0.2	0.5	0.9	0.9		
		Average	0.4	0.2	1.0	1.6	1.4		
		Minimum	0.0	0.0	0.0	0.1	0.3		
		Maximum	0.9	0.4	3.0	3.3	4.2		

Time of Day Characteristics - Summary

Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks

Time of Day Characteristics - Summary

Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks

F-1. Time of Day Characteristics - (Hourly Truck Trips As Percentage of Total Daily Truck Trips)

Location	Land Use Type (SIC)	Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks	Date	Notes/Comments
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	8-9 P.M.	0.0	0.3	0.3	0.6	0.6	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	8-9 P.M.	0.5	0.1	1.9	2.0	2.5	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	8-9 P.M.	0.1	0.0	0.0	0.0	0.1	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		8-9 P.M.	0.5	0.0	0.5	0.5	1.0	1992	See Note 2.
Triad Region, North Carolina		8-9 P.M.					0.2	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		8-9 P.M.				2.6		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.3	0.1	0.4	0.6	0.6		
		Average	0.3	0.1	0.7	1.1	0.9		
		Minimum	0.0	0.0	0.0	0.0	0.1		
		Maximum	0.5	0.3	1.9	2.6	2.5		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	9-10 P.M.	0.0	0.2	0.1	0.3	0.3	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	9-10 P.M.	0.1	0.1	1.8	1.9	2.0	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	9-10 P.M.	0.1	0.0	0.0	0.0	0.1	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		9-10 P.M.	1.0	0.0	0.0	0.0	1.0	1992	See Note 2.
Triad Region, North Carolina		9-10 P.M.					0.1	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		9-10 P.M.				2.1		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.1	0.1	0.1	0.3	0.3		
		Average	0.3	0.1	0.5	0.9	0.7		
		Minimum	0.0	0.0	0.0	0.0	0.1		
		Maximum	1.0	0.2	1.8	2.1	2.0		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	10-11 P.M.	0.0	0.1	0.1	0.2	0.2	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	10-11 P.M.	0.0	0.0	1.8	1.8	1.8	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	10-11 P.M.	0.1	0.1	0.0	0.1	0.2	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		10-11 P.M.	0.0	0.0	0.0	0.0	0.0	1992	See Note 2.
Triad Region, North Carolina		10-11 P.M.					0.1	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		10-11 P.M.				1.9		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.0	0.1	0.1	0.2	0.2		
		Average	0.0	0.1	0.5	0.8	0.5		
		Minimum	0.0	0.0	0.0	0.0	0.0		
		Maximum	0.1	0.1	1.8	1.9	1.8		
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	11-12 P.M.	0.0	0.0	0.1	0.1	0.1	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	11-12 P.M.	0.0	0.0	1.4	1.4	1.4	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	11-12 P.M.	0.1	0.1	0.0	0.1	0.2	1979	See Note 1.
Phoenix Metropolitan Area (pop. 1.7 million)		11-12 P.M.	0.0	0.0	0.0	0.0	0.0	1992	See Note 2.
Triad Region, North Carolina		11-12 P.M.					0.6	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		11-12 P.M.				1.6		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI		Median	0.0	0.0	0.0	0.8	0.3		
		Average	0.0	0.0	0.0	0.8	0.3		
		Minimum	0.0	0.0	0.0	0.0	0.0		
		Maximum	0.0	0.0	0.0	1.6	0.6		

Time of Day Characteristics - Summary

Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks

Time of Day Characteristics - Summary

Time Period	Percent of Total Daily Truck Trips: 4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks

F-1. Time of Day Characteristics - (Hourly Truck Trips As Percentage of Total Daily Truck Trips)

			Percent of Total Daily Truck Trips						
		Time	4-Tire	6+ Tire Commercial Vehicles		All 6+	All		
Location	Land Use Type (SIC)	Period	Trucks	Single Unit	Combination Unit	Tire Trucks	Trucks	Date	Notes/Comments
4 Urban Areas (Pop. 25,000 to 750,000)*	Wholesale Trade (50-51)	Total Daily	18.9	32.5	48.6	81.1	100.0	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Truck Transp. (42)	Total Daily	11.7	18.4	69.9	88.3	100.0	1979	See Note 1.
4 Urban Areas (Pop. 25,000 to 750,000)*	Downtown Retail (52-59)	Total Daily	56.6	26.8	16.6	43.4	100.0	1979	See Note 1.
Central Artery/Tunnel Area (Boston, MA)		Total Daily	0.0	0.0	0.0	0.0	100.0	1993	See Note 5.
Phoenix Metropolitan Area (pop. 1.7 million)		Total Daily	27.6	24.8	49.7	74.5	102.1	1992	See Note 2.
Triad Region, North Carolina		Total Daily					100.0	1995	See Note 3.
San Francisco Bay Area (pop. 6.2 million)		Total Daily				100.0		1992	See Note 4.
* Knoxville, TN; Modesto, CA; Rochester, NY; and Saginaw, MI									

Time of Day Characteristics - Summary

	Percent of Total Daily Truck Trips				
	4-Tire	6+ Tire Commercial Vehicles		All 6+	All
Time Period	Trucks	Single Unit	Combination Unit	Tire Trucks	Trucks

Time of Day Characteristics - Summary

	Percent of Total Daily Truck Trips				
	4-Tire	6+ Tire Commercial Vehicles		All 6+	All
Time Period	Trucks	Single Unit	Combination Unit	Tire Trucks	Trucks

Table F-1a. Median Hourly Distribution of Truck Travel (As Percentage of Total Daily Truck Trips)

Time Period	4-Tire Trucks	6+ Tire Commercial Vehicles: Single Unit	6+ Tire Commercial Vehicles: Combination Unit	All 6+ Tire Trucks	All Trucks
12-1 A.M.	0.0	0.0	0.1	0.1	0.0
1-2 A.M.	0.0	0.0	0.1	0.2	0.2
2-3 A.M.	0.0	0.1	0.3	0.8	0.3
3-4 A.M.	0.0	0.0	0.2	0.6	0.3
4-5 A.M.	0.1	0.2	1.2	1.5	1.5
5-6 A.M.	0.6	0.6	1.9	2.9	1.6
6-7 A.M.	0.5	0.7	2.3	4.1	2.2
7-8 A.M.	1.0	1.1	**3.4**	**5.1**	5.3
8-9 A.M.	**1.4**	**2.2**	**4.7**	**6.0**	**9.0**
9-10 A.M.	**2.1**	**2.9**	**4.7**	**7.1**	**10.7**
10-11 A.M.	**2.0**	**3.0**	**4.3**	**7.0**	**10.7**
11-12 A.M.	**2.2**	**3.2**	**4.2**	**7.2**	**11.2**
12-1 P.M.	**2.8**	**2.0**	**3.6**	**6.0**	**10.5**
1-2 P.M.	**3.0**	**2.3**	**3.3**	**5.7**	**9.6**
2-3 P.M.	**1.6**	**2.1**	**3.3**	**5.4**	**8.6**
3-4 P.M.	**1.4**	**1.7**	2.6	4.4	**6.0**
4-5 P.M.	1.0	1.4	1.7	3.8	5.1
5-6 P.M.	1.1	1.1	0.8	2.7	3.4
6-7 P.M.	0.6	0.4	0.8	1.5	1.4
7-8 P.M.	0.4	0.2	0.5	0.9	0.9
8-9 P.M.	0.3	0.1	0.4	0.6	0.6
9-10 P.M.	0.1	0.1	0.1	0.3	0.3
10-11 P.M.	0.0	0.1	0.1	0.2	0.2
11-12 P.M.	0.0	0.0	0.0	0.8	0.3

Note:

The peak 8-hour hourly distributions of truck travel are identified by bold type.

F-2. Time of Day Characteristics - (Hourly Truck Trips as Percentage of Total Hourly Vehicle Trips)

Location	Time Period	Percent of Total Vehicles on Roadway			Date	Notes/Comments
		4-Tire Trucks	All 6+ Tire Trucks	All Trucks		
Central Artery/Tunnel Area (Boston, MA)	8-9 A.M.	7.3	8.0	15.3	1993	See Note 1.
Columbia Corridor - Portland, OR	8-9 A.M.			25.6	1994	See Note 2.
Downtown Boston (MA)	8-9 A.M.			7.8	1993	Hourly Average: 7-10 a.m.
Back Bay/Prudential/Copley (Boston, MA)	8-9 A.M.			4.0	1993	Hourly Average: 7-10 a.m.
South End (Boston, MA)	8-9 A.M.			11.6	1993	Hourly Average: 7-10 a.m.
Back Bay/Prudential/Copley (Boston, MA)	8-9 A.M.			4.0	1993	Hourly Average: 7-10 a.m.
East Boston (MA)	8-9 A.M.			6.9	1993	Hourly Average: 7-10 a.m.
South Boston (MA)	8-9 A.M.			16.2	1993	Hourly Average: 7-10 a.m.
South End (Boston, MA)	8-9 A.M.			11.6	1993	Hourly Average: 7-10 a.m.
	Median	7.3	8.0	11.6		
	Average	7.3	8.0	11.4		
	Minimum	7.3	8.0	4.0		
	Maximum	7.3	8.0	25.6		
Central Artery/Tunnel Area (Boston, MA)	9-10 A.M.	8.2	9.1	17.3	1993	See Note 1.
Columbia Corridor - Portland, OR	9-10 A.M.			27.9	1994	See Note 2.
Downtown Boston (MA)	9-10 A.M.			7.8	1993	Hourly Average: 7-10 a.m.
Back Bay/Prudential/Copley (Boston, MA)	9-10 A.M.			4.0	1993	Hourly Average: 7-10 a.m.
South End (Boston, MA)	9-10 A.M.			11.6	1993	Hourly Average: 7-10 a.m.
Back Bay/Prudential/Copley (Boston, MA)	9-10 A.M.			4.0	1993	Hourly Average: 7-10 a.m.
East Boston (MA)	9-10 A.M.			6.9	1993	Hourly Average: 7-10 a.m.
South Boston (MA)	9-10 A.M.			16.2	1993	Hourly Average: 7-10 a.m.
South End (Boston, MA)	9-10 A.M.			11.6	1993	Hourly Average: 7-10 a.m.
	Median	8.2	9.1	11.6		
	Average	8.2	9.1	11.9		
	Minimum	8.2	9.1	4.0		
	Maximum	8.2	9.1	27.9		
Central Artery/Tunnel Area (Boston, MA)	10-11 A.M.	10.0	10.6	20.6	1993	See Note 1.
Columbia Corridor - Portland, OR	10-11 A.M.			25.1	1994	See Note 2.
South End (Boston, MA)	10-11 A.M.			5.3	1993	Hourly Average: 10 a.m. - 3 p.m.
East Boston (MA)	10-11 A.M.			6.1	1993	Hourly Average: 10 a.m. - 3 p.m.
Charlestown (Boston, MA)	10-11 A.M.			7.2	1993	Hourly Average: 10 a.m. - 3 p.m.
East Cambridge/Somerville (Boston, MA)	10-11 A.M.			6.4	1993	Hourly Average: 10 a.m. - 3 p.m.
South Boston (MA)	10-11 A.M.			20.4	1993	Hourly Average: 10 a.m. - 3 p.m.
	Median	10.0	10.6	7.2		
	Average	10.0	10.6	13.0		
	Minimum	10.0	10.6	5.3		
	Maximum	10.0	10.6	25.1		

F-2. Time of Day Characteristics - (Hourly Truck Trips as Percentage of Total Hourly Vehicle Trips)

Location	Time Period	Percent of Total Vehicles on Roadway			Date	Notes/Comments
		4-Tire Trucks	All 6+ Tire Trucks	All Trucks		
Central Artery/Tunnel Area (Boston, MA)	11-12 A.M.	11.9	12.6	24.5	1993	See Note 1.
Columbia Corridor - Portland, OR	11-12 A.M.			22.2	1994	See Note 2.
South End (Boston, MA)	11-12 A.M.			5.3	1993	Hourly Average: 10 a.m. - 3 p.m.
East Boston (MA)	11-12 A.M.			6.1	1993	Hourly Average: 10 a.m. - 3 p.m.
Charlestown (Boston, MA)	11-12 A.M.			7.2	1993	Hourly Average: 10 a.m. - 3 p.m.
East Cambridge/Somerville (Boston, MA)	11-12 A.M.			6.4	1993	Hourly Average: 10 a.m. - 3 p.m.
South Boston (MA)	11-12 A.M.			20.4	1993	Hourly Average: 10 a.m. - 3 p.m.
	Median	11.9	12.6	7.2		
	Average	11.9	12.6	13.2		
	Minimum	11.9	12.6	5.3		
	Maximum	11.9	12.6	24.5		
Central Artery/Tunnel Area (Boston, MA)	12-1 P.M.	13.6	11.6	25.2	1993	See Note 1.
Columbia Corridor - Portland, OR	12-1 P.M.			19.6	1994	See Note 2.
South End (Boston, MA)	12-1 P.M.			5.3	1993	Hourly Average: 10 a.m. - 3 p.m.
East Boston (MA)	12-1 P.M.			6.1	1993	Hourly Average: 10 a.m. - 3 p.m.
Charlestown (Boston, MA)	12-1 P.M.			7.2	1993	Hourly Average: 10 a.m. - 3 p.m.
East Cambridge/Somerville (Boston, MA)	12-1 P.M.			6.4	1993	Hourly Average: 10 a.m. - 3 p.m.
South Boston (MA)	12-1 P.M.			20.4	1993	Hourly Average: 10 a.m. - 3 p.m.
	Median	13.6	11.6	7.2		
	Average	13.6	11.6	12.9		
	Minimum	13.6	11.6	5.3		
	Maximum	13.6	11.6	25.2		
Central Artery/Tunnel Area (Boston, MA)	1-2 P.M.	11.3	10.4	21.7	1993	See Note 1.
Columbia Corridor - Portland, OR	1-2 P.M.			21.4	1994	See Note 2.
South End (Boston, MA)	1-2 P.M.			5.3	1993	Hourly Average: 10 a.m. - 3 p.m.
East Boston (MA)	1-2 P.M.			6.1	1993	Hourly Average: 10 a.m. - 3 p.m.
Charlestown (Boston, MA)	1-2 P.M.			7.2	1993	Hourly Average: 10 a.m. - 3 p.m.
East Cambridge/Somerville (Boston, MA)	1-2 P.M.			6.4	1993	Hourly Average: 10 a.m. - 3 p.m.
South Boston (MA)	1-2 P.M.			20.4	1993	Hourly Average: 10 a.m. - 3 p.m.
	Median	11.3	10.4	7.2		
	Average	11.3	10.4	12.6		
	Minimum	11.3	10.4	5.3		
	Maximum	11.3	10.4	21.7		
Central Artery/Tunnel Area (Boston, MA)	2-3 P.M.	11.0	10.6	21.6	1993	See Note 1.
Columbia Corridor - Portland, OR	2-3 P.M.			20.1	1994	See Note 2.
South End (Boston, MA)	2-3 P.M.			5.3	1993	Hourly Average: 10 a.m. - 3 p.m.
East Boston (MA)	2-3 P.M.			6.1	1993	Hourly Average: 10 a.m. - 3 p.m.
Charlestown (Boston, MA)	2-3 P.M.			7.2	1993	Hourly Average: 10 a.m. - 3 p.m.
East Cambridge/Somerville (Boston, MA)	2-3 P.M.			6.4	1993	Hourly Average: 10 a.m. - 3 p.m.

F-2. Time of Day Characteristics - (Hourly Truck Trips as Percentage of Total Hourly Vehicle Trips)

Location	Time Period	Percent of Total Vehicles on Roadway			Date	Notes/Comments
		4-Tire Trucks	All 6+ Tire Trucks	All Trucks		
South Boston (MA)	2-3 P.M.			20.4	1993	Hourly Average: 10 a.m. - 3 p.m.
	Median	11.0	10.6	7.2		
	Average	11.0	10.6	12.4		
	Minimum	11.0	10.6	5.3		
	Maximum	11.0	10.6	21.6		
Central Artery/Tunnel Area (Boston, MA)	3-4 P.M.	10.5	10.5	21.0	1993	See Note 1.
Columbia Corridor - Portland, OR	3-4 P.M.			14.3	1994	See Note 2.
South End (Boston, MA)	3-4 P.M.			5.1	1993	Hourly Average: 3 p.m. - 6 p.m.
East Boston (MA)	3-4 P.M.			3.7	1993	Hourly Average: 3 p.m. - 6 p.m.
South Boston (MA)	3-4 P.M.			8.0	1993	Hourly Average: 3 p.m. - 6 p.m.
	Median	10.5	10.5	8.0		
	Average	10.5	10.5	10.4		
	Minimum	10.5	10.5	3.7		
	Maximum	10.5	10.5	21.0		
Central Artery/Tunnel Area (Boston, MA)	4-5 P.M.	8.0	7.6	15.6	1993	See Note 1.
Columbia Corridor - Portland, OR	4-5 P.M.			11.8	1994	See Note 2.
South End (Boston, MA)	4-5 P.M.			5.1	1993	Hourly Average: 3 p.m. - 6 p.m.
East Boston (MA)	4-5 P.M.			3.7	1993	Hourly Average: 3 p.m. - 6 p.m.
South Boston (MA)	4-5 P.M.			8.0	1993	Hourly Average: 3 p.m. - 6 p.m.
	Median	8.0	7.6	8.0		
	Average	8.0	7.6	8.8		
	Minimum	8.0	7.6	3.7		
	Maximum	8.0	7.6	15.6		
Central Artery/Tunnel Area (Boston, MA)	5-6 P.M.	4.6	5.0	4.8	1993	See Note 1.
Columbia Corridor - Portland, OR	5-6 P.M.			10.9	1994	See Note 2.
South End (Boston, MA)	5-6 P.M.			5.1	1993	Hourly Average: 3 p.m. - 6 p.m.
East Boston (MA)	5-6 P.M.			3.7	1993	Hourly Average: 3 p.m. - 6 p.m.
South Boston (MA)	5-6 P.M.			8.0	1993	Hourly Average: 3 p.m. - 6 p.m.
	Median	4.6	5.0	5.1		
	Average	4.6	5.0	6.5		
	Minimum	4.6	5.0	3.7		
	Maximum	4.6	5.0	10.9		
Central Artery/Tunnel Area (Boston, MA)	6-7 P.M.	3.4	3.3	6.7	1993	See Note 1.

Notes:

1. Values represent an average of 3 highway locations and 4 local streets. Commercial vehicles distributed accordingly:
   - Light trucks = 4-tire trucks.
   - Medium and heavy trucks = 6+ tire trucks.
2. Source: City of Portland, Office of Transportation. "Columbia Corridor Transportation Study." Technical Report 2: Truck Routing Model. April 1994. p.13.

F-1a. Notes on Time of Day Characteristics

Notes:
1. Source: Chatterjee, Wegmann, Brogan, Phiu-Nual. "Estimating Truck Traffic for Analyzing UGM Problems and Opportunities." ITE Journal. May 1979.
2. Source: Ruiter, Earl. Development of an Urban Truck Travel Model for the Phoenix Metropolitan Area, Final Report. Arizona Department of Transportation; Prepared by Cambridge Systematics, Inc. February 1992.
   Commercial vehicles distributed as follows:
   - 0-8,000 lb commercial vehicles = 4-tire commercial vehicles.
   - 8,000-28,000 lb commercial vehicles = 6+ tire single unit.
   - 28,000+ lb commercial vehicle = 6+ tire combination unit.
3. Source: State of North Carolina Department of Transportation. "Triad Regional Study, Draft Report on Commercial Vehicle Survey." Commercial Vehicle Pretest Results. January 1995.
4. Source: Schlappi, Marshall, and Itamura. "Truck Travel in the San Francisco Bay Area." Transportation Research Board 72nd Annual Meeting, Paper No. 930477. January 1993. p. 8.
5. Values represent an average of 3 highway locations and 4 local streets. Commercial vehicles distributed accordingly:
   - Light trucks = 4-tire trucks.
   - Medium and heavy trucks = 6+ tire trucks.

Time of Day Characteristics - Summary
Average Values - As a Percent of Total Daily Truck Trips

Time of Day Characteristics - Summary
Median Values - As a Percent of Total Daily Truck Trips

Table F-2a. Median Hourly Distribution of Truck Travel (As Percentage of Total Hourly Vehicle Trips)

Time Period	4-Tire Trucks	All 6+ Tire Trucks	All Trucks
8-9 A.M.	7.3	8.0	11.6
9-10 A.M.	8.2	9.1	11.6
10-11 A.M.	10.0	10.6	7.2
11-12 A.M.	11.9	12.6	7.2
12-1 P.M.	13.6	11.6	7.2
1-2 P.M.	11.3	10.4	7.2
2-3 P.M.	11.0	10.6	7.2
3-4 P.M.	10.5	10.5	8.0
4-5 P.M.	8.0	7.6	8.0
5-6 P.M.	4.6	5.0	5.1
6-7 P.M.	3.4	3.3	6.7

Appendix G

Guide to State Data Centers

Appendix G

■ Guide to State Data Centers

XXXX in the following listings refers to the year in the title that will change with each new issue of the abstract.

Alabama
University of Alabama,
Center for Business and Economic Research
P.O. Box 870221, Tuscaloosa 35487
205-348-6191

Economic Abstract of Alabama, XXXX. 600pp.

Alaska
Department of Commerce and
Economic Development,
Division of Economic Development,
P.O. Box 110804, Juneau 99811
907-465-2017

Arizona
University of Arizona,
Economic and Business Research, College of Business and Public Administration,
McClelland Hall 204
Tucson, Arizona 85721-0001
602-621-2155 - FAX 602-621-2150

Arizona Statistical Abstract: A 1993 Data Handbook. 616pp.
Arizona Economic Indicators. 52pp. (Biannual.)
Arizona's Economy. 20pp. (Quarterly newsletter and data.)

Arkansas
University of Arkansas at Little Rock, Economic Research, Library 512,
Little Rock 72204

Arkansas State and County Economic Data. 18pp. (Revised annually.)
University of Arkansas at Little Rock, Census State Data Center, Library 512,
Little Rock 72204
501-569-8530

Arkansas Statistical Abstract. 600pp. (Revised biennially.)

California
Department of Finance,
915 L Street, 8th Floor

Sacramento 95814
916-322-2263

California Statistical Abstract, XXXX. 210pp.

Pacific Data Resources, P.O. Box 1922,
Santa Barbara, CA 93116-1922
800-422-2546

California Almanac, 6th ed. Biennial. 275pp.

Colorado
University of Colorado, Business Research
Division, Campus Box 420, Boulder 80309
303-492-8227

Statistical Abstract of Colorado, XXXX. 609pp.

Connecticut
Connecticut Department of
Economic Development
865 Brook Street, Rocky Hill 06067-3405
1-800-392-2122

Connecticut Market Data, XXXX-XXXX
Approx. 87pp. No charge for single copy.

Delaware
Delaware Development Office, P.O. Box 1401
99 Kings Highway, Dover 19903
302-739-4271

Delaware Data Book, XXXX. 141pp.
University of Delaware Bureau of Economic Research,
College of Business and Economics, Newark 19716-2730
302-832-8401

Delaware Economic Report XXXX-XXXX. 200pp. Annual

District of Columbia
Office of Planning, Data Management Division, Presidential Bldg., Suite 500
415 12th St.
N.W. Washington, DC 20004
202-727-6533

Population Estimates and Housing Units, Annual.
Office of Policy and Evaluation, Executive Office of the Mayor, 1 Judiciary Square,
Suite 1000, 441 4th St., N.W., Washington 20001
202-727-4016
Indices - A Statistical Index to DC Services, Dec XXXX. Annual. 366pp.

Florida
University of Florida, Bureau of Economic and Business Research, Gainsville 32611-2017
904-392-0171

Florida Statistical Abstract, XXXX. 26th ed. 760pp.
National Data Consultants, P.O. Box 6381, Athens, Georgia 30604

706-548-8460

Florida County Perspectives: XXXX. Annual. 110pp.

Georgia
University of Georgia, Selig Center for Economic Growth, Terry College of Business, Athens 30602-6269
706-542-4085

Georgia Statistical Abstract, 1992-93. XXXX. 535pp.
University of Georgia, College of Agriculture and Environmental Sciences, Cooperative Extension Service, Athens 30602
706-542-8938

The Georgia County Guide. XXXX. 12th ed. Annual. 197pp.
Office of Planning and Budget,
254 Washington St., S.W.,
Atlanta 30334-8501
404-656-0911

Georgia Descriptions in Data. XXXX-XXXX. 249pp.

Hawaii
Hawaii State Department of Business, and Economic Development & Tourism, Research and Economic Analysis Division, Statistics Branch, P.O. Box 2359, Honolulu 96804.
Inquiries 808-586-2481: Copies 808-586-2424

The State of Hawaii Data Book 1992; A Statistical Abstract, 26th ed. XXXX. 618pp.

Idaho
Department of Commerce,
700 West State St., Boise 83720
208-334-2470

County Profiles of Idaho, XXXX

Idaho Community Profiles, XXXX.
Idaho Facts, XXXX.
Idaho Facts Data Book, XXXX.
Profile of Rural Idaho, XXXX
University of Idaho, Center for Business Development and Research,
Moscow 83844-3227
208-885-6611

Idaho Statistical Abstract, XXXX. 415pp.
(Out of print.)

Illinois
University of Illinois, Bureau of Economic and Business Research
428 Commerce West
1206 South 6th St., Champaign 61820
217-333-2330

Illinois Statistical Abstract. XXXX. 812 pp.

Indiana
Indiana University, Indiana Business Research Center, School of Business,

801 W. Michigan BS4015 Indianapolis 46202-5151
317-274-2204

Indiana Factbook, XXXX. 413pp.

Iowa
Iowa Department of Economic Development Research Bureau
200 East Grand Avenue
Des Moines 50309

1993 Statistical Profile of Iowa.

Kansas
University of Kansas, Institute for Public Policy and Business Research,
607 Blake Hall, Lawrence 66045-2960
913-864-3701

Kansas Statistical Abstract, 1991-92. 27th ed. XXXX.

Kentucky
Department of Existing Business and Industry, Capital Plaza Office Tower,
Frankfort 40601
502-564-4886

Kentucky Deskbook of Economic Statistics. 29th ed. XXXX.

Louisiana
University of New Orleans, Division of Business and Economic Research,
New Orleans 70148
504-286-6248

Statistical Abstract of Louisiana. 8th ed., XXXX

Maine
Maine Department of Economic and Community Development,
State House Station 59, Augusta 04333
207-287-3153

Maine: A Statistical Summary. (Updated periodically.)

Maryland
Department of Economic and Employment Development
217 E. Redwood St., Baltimore 21202
Inquiries 410-333-6953;
Copies 410-333-6955

Maryland Statistical Abstract. XXXX-XX. 274pp. (Biennial.)

Massachusetts
Massachusetts Institute for Social and Economic Research,
128 Thompson Hall, University of Massachusetts at Amherst 01003
413-545-3460 FAX 413-545-3686

Projected Total Population and Age Distribution for 1995 and 2000; Massachusetts Cities and Towns. March, XXXX. 62pp.

Michigan

Wayne State University, Bureau of Business Research, School of Business Administration, Detroit 48202

Michigan Statistical Abstract, 20th ed. XXXX-XX. 629pp.

Minnesota
Department of Trade and Economic Development, Business Development and Analysis Division,
900 American Center Building, St. Paul 55101
612-296-8283

Compare Minnesota: An Economic and Statistical Factbook. XXXX-XX. 165pp.
Economic Report to the Governor: State of Minnesota, XXXX. 148pp.
Office of State Demographer, Minnesota Planing, 300 Centennial Bldg., St. Paul 55155
612-296-2557

Minnesota Population and Household Estimates, XXXX. 74pp. Available on diskette in Lotus, dBASE or ASCII files.

Mississippi
Mississippi State University, College of Business and Industry, Division of Research, Mississippi State 39762
601-325-3817

Mississippi Statistical Abstract, XXXX. 750pp.

Missouri
University of Missouri, Business and Public Administration Research Center,
Columbia 65211
314-882-4805

Statistical Abstract for Missouri, XXXX. Biennial. 350pp.

Montana
Montana Department of Commerce, Census and Economic Information Center,
1424 9th Ave., Helena 59620
406-444-2896

Montana County Database. (Separate county and state reports; will be available by subject section as well as complete reports by county and state, updated periodically, available in paper, microfiche, and diskette.)

Nebraska
Department of Economic Development, Division of Research, Box 94666,
Lincoln 68509
402-471-3779

Nebraska Statistical Handbook. XXXX-XXXX. 300pp.

Nevada
Department of Administration, Planning Division, Capitol Complex,
Carson City 89710
702-687-4065

Nevada Statistical Abstract. XXXX. Biennial. 405pp.

New Hampshire
Office of State Planning,
2 1/2 Beacon St., Concord 03301
603-271-2155

Current Estimates and Trends in New Hampshire's Housing Supply. Update, XXXX. 32pp.
Selected Economic Characteristics of New Hampshire's Municipalities. 12pp.
(Other series available on population estimates and projections, and taxation.)

New Jersey
New Jersey State Data Center, NJ Department of Labor, CN 388, Trenton 08625-0388
609-984-2593
New Jersey Statistical Factbook. XXXX. 115pp.

New Jersey Source Book, XXXX. 156pp.

New Mexico
University of New Mexico, Bureau of Business and Economic Research,
1920 Lomas N.E. Albuquerque 87131-6021
505-277-2216

New Mexico Statistical Abstract. 215pp.
County Profiles. (Occasionally.)

New York
Energy Association of New York, 111 Washington Avenue, Suite 601, Albany 12210
518-449-3440

New York at a Glance, 230pp.
Nelson Rockefeller Institute of Government,
411 State Street, Albany 12203-1003
518-443-5522

New York State Statistical Yearbook, XXXX
18th ed., 544pp.

North Carolina
Office of Governor
Office of State Planning, 116 West Jones St., Raleigh 27603-8003
919-733-4131

Statistical Abstract of North Carolina Counties, XXXX. 6th edition.

North Dakota
University of North Dakota, Bureau of Business and Economic Research,
Grand Forks 58202
701-777-3365

The Statistical Abstract of North Dakota. XXXX. 700 pp.
North Dakota Department of Economic Development and Finance,
1833 E. Bismarck Expressway, Bismarck 58504
701-221-5300

North Dakota Economic Data Book. XXXX. 100pp.

Ohio

Department of Development, Office of Statistical Research, P.O. Box 1001, Columbus 43266-0101
614-466-2115

Products and Services. (Updated continuously.)
The Ohio State University, School of Public Policy and Management
1775 College Road, Columbus 43210-1399
614-292-8698

Benchmark Ohio, XXXX. Biennial. 300pp.

Oklahoma
University of Oklahoma, Center for Economic and Management Research,
307 West Brooks Street, Room 4, Norman 73019
405-325-2931

Statistical Abstract of Oklahoma, XXXX. Annual.626pp.

Oregon
Secretary of State, Room 136, State Capitol, Salem 93710

Oregon Blue Book, XXXX-XX. Biennial. 441pp. $12.

Pennsylvania
Pennsylvania State Data Center, Institute of State and Regional Affairs, Penn State Harrisburg, 777 West Harrisburg Pike, Middleton Pennsylvania 17057-4898.

Pennsylvania Statistical Abstract, XXXX. 30th ed., 249pp.

Rhode Island
Department of Economic Development,
7 Jackson Walkway, Providence 02903
401-277-2601

Rhode Island Basic Economic Statistics. XXXX. Population summary,
Annual and Monthly Economic Trends.

South Carolina
Budget and Control Board, Division of Research and Statistical Services,
R.C. Dennis Building, Room 425, Columbia 29201
803-734-3780

South Carolina Statistical Abstract, XXXX. 422pp.

South Dakota
University of South Dakota, State Data Center, Vermillion 57069
605-677-5287

Selected Social and Economic Characteristics, 550pp.
1992 South Dakota Community Abstracts, 400pp.

Tennessee
University of Tennessee, Center for Business and Economic Research,
Knoxville 37996-4170
615-974-5441

Tennessee Statistical Abstract, XXXX-XX. 14th ed., 800pp. (Annual.)

Texas
Dallas Morning News, Communications Center, P.O. Box 655237, Dallas 75265
214-977-8261

Texas Almanac, XXXX-XXXX. 672pp.

University of Texas, Bureau of Business Research, Austin 78712
512-471-5180

Texas Fact Book, XXXX. 6th ed. 250pp.

Utah
University of Utah, Bureau of Economic and Business Research, 401 Kendall D. Garff Building, Salt Lake City 84112
801-581-6333

Statistical Abstract of Utah. XXXX. (Triennial.)
Utah Foundation, 10 West 100 South 323, Salt Lake City 84101-1544
801-364-1837

Statistical Review of Government in Utah. XXXX. 135pp.

Vermont
Office of Policy and Information, Department of Employment and Training.
Montpelier 05601
802-828-4202 ext. 323.

Demographic and Economic Profiles. Annual.

Virginia
University of Virginia, Center for Public Service, Dynamics Building, 4th Floor,
2015 Ivy Road, Charlottesville 22903
804-924-3921

Virginia Statistical Abstract. Biennial. XXXX. 850pp.

Washington
Washington State Office of Financial Management, Forecasting Division
P.O. Box 43113 Olympia, WA 98504-3113
206-753-5617

Washington State Data Book. Biennial. XXXX. 306pp.
Population Trends for Washington State. Annual. 128pp.

West Virginia
West Virginia Chamber of Commerce, P.O. Box 2789, Charleston 25330
304-342-1115

West Virginia: Economic-Statistical Profile. XXXX-XX. Biennial. 750pp.

West Virginia Research League, Inc.
405 Capitol Street, Suite 414,
Charleston 25301
304-346-9451

Economic Indicators. XXXX. 110pp.
The 1992 Statistical Handbook. 94pp.

Wisconsin
Wisconsin Legislative Reference Bureau,
P.O. Box 2037, Madison 53701-2037
608-266-0341

XXXX-XXXX Wisconsin Blue Book. 1,000pp. Biennial.

Wyoming
Department of Administration and Information, Division of Economic Analysis.
327 E. Emerson Building, Cheyenne 82002
307-777-7504

Wyoming Data Handbook, XXXX. 310pp.

Puerto Rico
Planning Board, Area of Economic and Social Planning, Bureau of Economic Analysis and Bureau of Statistics, Santurce 00940
809-722-2070

Economic Report to the Governor, XXXX. (In Spanish.)
Historic Series of Employment, Unemployment and Labor Force, XXXX. (In Spanish.)
Social Statistics Abstract, XXXX. (In Spanish.)
Socioeconomic Indicators by Municipios, XXXX. (In Spanish.)
Economical Forecasts for Fiscal Years 1993 and 1994. (In Spanish.)
Income Product, XXXX. (In Spanish.)
National Accounts of Puerto Rico, XXXX. (In Spanish.)

Appendix H

Guide to State Trucking Associations

Appendix H

■ Guide to State Trucking Associations

Note: This list of state associations is extracted from "TruckSource 1994" and is used with their permission. "TruckSource" is updated annually, includes additional listings, and is available from the American Trucking Association.

Alabama Trucking Association
660 Adams Avenue
Montgomery, AL 36104
Phone: (205) 834-3983
Fax: (205) 262-6504

Alaska Trucking Association
3443 Minnesota Drive
Anchorage, AK 99503
Phone: (907) 276-1149
Fax: (907) 274-1946

Arizona Motor Transport Association
2111 W. McDowell Road
Phoenix, AZ 85009
Phone: (602) 252-7559
Fax: (602) 253-1848

Arkansas Motor Carriers Association, Inc.
P.O. Box 2798
Little Rock, AR 72203
Phone: (501) 372-3462
Fax: (501) 376-1810

California Trucking Association
1251 Beacon Blvd.
West Sacramento, CA 95691
Phone: (916) 373-3500
Fax: (916) 371-7346

Colorado Motor Carriers Association
4060 Elati Street
Denver, CO 80216
Phone: (303) 433-3375
Fax: (303) 477-6977

Conneticut: Motor Transport Association of Connecticut, Inc.
60 Forest Street
Hartford, CT 06105
Phone: (203) 520-4455
Fax: (203) 520-4567

Delaware Motor Transport Association, Inc.
1203-D College Park Drive, Suite104
Dover, DE 19901
Phone: (302) 678-5306
Fax: (302) 678-2113

Florida Trucking Association, Inc.
350 E. College Avenue
Tallahassee, FL 32301
Phone: (904) 222-9900
Fax: (904) 222-9363

Georgia Motor Trucking Association
500 Piedmont Avenue, NE
Atlanta, GA 30308
Phone: (404) 876-4313
Fax: (404) 874-9765

Hawaii Transportation Association
2850 Paa Street, Suite
204 Honolulu, HI 96820
Phone: (808) 833-6628
Fax: (808) 833-8486

Idaho Motor Transport Association, Inc.
P.O. Box 4549
Boise, ID 83711-4549
Phone: (208) 342-3521
Fax: (208) 343-8397

Illinois Transportation Associations, Inc.
2000 Fifth Avenue
River Grove, IL 60171
Phone: (708) 452-3500
Fax: (708) 452-3508

Indiana Motor Truck Association, Inc.
1 North Capitol Avenue, Suite 460
Indianapolis, IN 46204
Phone: (317) 630-4682
Fax: (317) 638-5380

Iowa Motor Truck Association, Inc.
600 East Court, Suite D
Des Moines, IA 50309
Phone: (515) 244-5193
Fax: (515) 244-2204

Kansas Motor Carriers Association
P.O. Box 1673
2900 S. Topeka Blvd.
Topeka, KS 66601
Phone: (913) 267-1641
Fax: (913) 266-6551

Kentucky Motor Transport Association, Inc.
134 Walnut Street
Frankfort, KY 40601
Phone: (502) 6954055
Fax: (502) 695-9026

Louisiana Motor Transport Association
P.O. Box 80278
4838 Bennington Avenue (70808)
Baton Rouge, LA 70898
Phone: (504) 928-5682
Fax: (504) 928-0500

Maine Motor Transport Association, Inc.
P.O. Box 857
524 Western Avenue Augusta, ME 04330
Phone: (207) 623-4128
Fax: (207) 623-4096

Maryland Motor Truck Association
3000 Washington Blvd.
Baltimore, MD 21230
Phone: (301) 644-4600
Fax: (301) 644-2537

Massachusetts Motor Transportation Association, Inc.
80 Blanchard Road
Burlington, MA 01803
Phone: (617) 270-6880
Fax: (617) 229-0458

Michigan Trucking Association, Inc.
5800 Executive Drive
Lansing, MI 48911
Phone: (517) 393-2053
Fax: (517) 393-1120

Minnesota Trucking Association
1821 University Avenue
134 N. Griggs-Midway Bldg.
Street Paul, MN 55104-2994
Phone: (612) 646-7351
Fax: (612) 641-8995

Mississippi Trucking Association
767 N. President Street
Jackson, MS 39202
Phone: (601) 354-0616
Fax: (601) 354-4371

Missouri Motor Carriers Association
227B Jefferson Street
Jefferson City, MO 65101
Phone: (314) 634-3388
Fax: (314) 6344197

Montana Motor Carriers Association, Inc.
P.O. Box 1714
Helena, MT 59624-1714
Phone: (406) 442-6600
Fax: (406) 443-4281

Nebraska Motor Carriers Association
1701 K Street
Lincoln, NE 68508
Phone: (402) 476-8504
Fax: (402) 476-0579

Nevada Motor Transport Association
255 Glendale Avenue, Suite 6
Sparks, NV 89431
Phone: (702) 331-6884
Fax: (702) 331-6887

New Hampshire Motor Transport Association
4 Park Street
Concord, NH 03301
Phone: (603) 224-7337
Fax: (603) 225-9361

New Jersey Motor Truck Association
160 Tices Lane
East Brunswick, NJ 08816
Phone: (908) 254-5000
Fax: (908) 613-1745

.

New Mexico Motor Carriers' Association
4809 Jefferson Street, NE
Albuquerque, NM 87109
Phone: (505) 884-5575
Fax: (505) 884-3661

New York State Motor Truck Association
1736 Western Avenue
Albany, NY 12203-4413
Phone: (518) 464-5065
Fax: (518) 464-5069

North Carolina Trucking Association, Inc.
P.O. Box 2977
19 W. Martin Street
Raleigh, NC 27602
Phone: (919) 834-0387
Fax: (919) 832-0390

North Dakota Motor Carriers Association, Inc.
1031 E. Interstate Avenue
P.O. Box 874
Bismarck, ND 58502
Phone: (701) 223-2700
Fax: (701) 223-4324

Ohio Trucking Association
50 W. Broad Street, Suite 1111
Columbus, OH 43215
Phone: (614) 221-5375
Fax: (614) 221-3717

Oklahoma: Associated Motor Carriers of Oklahoma
P.O. Box 14620
7201 N. Classen Blvd.
Oklahoma City, OK 73113
Phone: (405) 843-9488
Fax: (405) 843-7310

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Oregon Trucking Associations, Inc.
5940 N. Basin Avenue
Portland, OR 97217

Phone: (503) 289-6888
Fax: (503) 289-6672

Pennsylvania Motor Truck Association
P.O. Box 128
Camp Hill, PA 17110-0128
Phone: (717) 761-7122
Fax: (717) 761-8434

Rhode Island Trucking Association
1240 Pawtucket Avenue
Rumford, RI 02916
Phone: (401) 438-0410
Fax: (401) 438-2072

South Carolina Trucking Association, Inc.
P.O. Box 50166
Columbia, SC 29250
Phone: (803) 799-4306
Fax: (803) 254-7148

South Dakota Trucking Association
P.O. Box 89008
Sioux Falls, SD 57105
Phone: (605) 334-8871
Fax: (605) 334-1938

Tennessee Trucking Association
P.O. Box 190538
Nashville, TN 37219-0538
Phone: (615) 255-0558
Fax: (615) 244-0495

Texas Motor Transportation Association, Inc.
P.O. Box 1669
700 East 11th Street
Austin, TX 78767
Phone: 512) 478-2541
Fax: (512) 474-6494

Utah Motor Transport Association
975 West 2100 South
Salt Lake City, UT 84119
Phone: (801) 973-9370
Fax: (801) 973-8515

Vermont Truck & Bus Association, Inc.
P.O. Box 271
Barre, VT 05641

Phone: (802) 479-1778
Fax: (802) 479-1395

Virginia Trucking Association
104 W. Franklin Street
Lexington Tower, Suite D
Richmond, VA 23220
Phone: (804) 649-9311
Fax: (804) 788-4218

Washington D.C. Area Trucking Association
2200 Mill Road
Alexandria, VA 22314
Phone: (703) 838-1840
Fax: (703) 836-6070

Washington Trucking Associations, Inc.
4101 4th Avenue, South
Seattle, WA 98134
Phone: (206) 682-0250
Fax: (206) 622-0565

West Virginia Motor Truck Association, Inc.
P.O. Box 5187, Capitol Station
Charleston, WV 25361
Phone: (304) 345-2800
Fax: (304) 345-0308

Wisconsin Motor Carriers Association
562 Grand Canyon Drive
P.O. Box 44849
Madison, WI 53744-4849
Phone: (608) 833-8200
Fax: (608) 833-2875

Wyoming Trucking Association
555 North Poplar Street
Casper, WY 82601
Phone: (307) 234-1579
Fax: (307) 234-7082

Appendix I

Bureau of Census Regional Offices

Appendix I

■ Bureau of Census Regional Offices

Information specialists in these cities can answer questions about the availability and uses of the County Business Patterns and other economic data collected by the Census Bureau.

Atlanta, GA (404) 730-3832
101 Marietta St., NW
Suite 3200 ZIP 30303-2700

Boston, MA (617) 424-0500
2 Copley Place, Suite 301
P.O. Box 9108 ZIP 02117-9108

Charlotte, NC (704) 844-6142
901 Center Park Drive
Suite 106 ZIP 28217-2935

Chicago, IL (708) 562-1350
2255 Enterprise Dr., Suite 5501
Westchester ZIP 60154-5800

Dallas, TX (214) 767-7500
6303 Harry Hines Blvd.
Suite 210 ZIP 75235-5269

Denver, CO (303) 969-6750
6900 West Jefferson Avenue
P.O. Box 272020 ZIP 80227-9020

Detroit, MI(313) 259-1158
1395 Brewery Park Blvd.
P.O. Box 33405 ZIP 48232-5405

Kansas City, KS (913) 551-6728
400 State Avenue
Suite 600 ZIP 66101-2410

Los Angeles, CA (818) 904-6393
15350 Sherman Way, Suite 300
Van Nuys ZIP 91406-4224

New York, NY (212) 264-3860
26 Federal Plaza
Room 37-130 ZIP 10278-0044

Philadelphia, PA (215) 597-4920
105 South 7th Street
1st Floor ZIP 19106-3395

Seattle, WA (206) 728-5300
101 Stewart Street
Suite 500 ZIP 98101-1098

Appendix J

National Trade Associations

Appendix J

■ National Trade Associations

Note: This partial listing of national freight associations is extracted from "TruckSource 1994" and is used with their permission. "TruckSource" is updated annually, includes additional listings, and is available from the American Trucking Association.

Air Transport Association of America
1301 Pennsylvania Avenue, NW Suite 1100 Washington, DC 20004
Phone: (202) 626-4000
Fax: (202) 626-4181
Represents airlines engaged in transporting persons, goods, and mail by aircraft between fixed terminals on regular schedules.

American Institute for Shippers' Associations
P.O. Box 33457
Washington, DC 20033
Phone: (202) 628-0933
Fax: (202) 296-1370
Association of shippers that consolidate and distribute freight on a non-profit basis for the purpose of securing the benefits of volume rates and are interested in the continued existence of cooperative shipping.

American Movers Conference
1611 Duke Street
Alexandria, VA 22314
Phone: (703) 683-7410
Fax: (703) 683-8208
Represents local, intrastate, interstate and international movers who transport household goods, office and institutional equipment, and high value products.

American Petroleum Institute
1220 L Street, NW
Washington, DC 20005
Phone: (202) 682-8000 Fax: (202) 682-8232
Represents producers, refiners, marketers,and transporters of gasoline, crude oil, lubricating oils, and natural gas.

American Trucking Associations
2200 Mill Road
Alexandria, VA 22314
Phone: (703) 838-1700 (703) 838-1754 or
(800) ATA-LINE (Customer Service) (703) 838-1880 (Information Center)
Motor carriers, suppliers, state associations and national conferences of trucking companies working together to promote increased safety, competitiveness, and productivity in the motor transportation industry, through influence on state and national transportation policy.

American Warehousemen's Association
1300 West Higgins
Suite 111
Park Ridge, IL 60068
Phone: (708) 292-1891 Fax: (708) 292-1896
Represents the warehousing industry at the national level and fosters social change and advancement through education and exchange of industry information.

American Waterways Operators, Inc.
1600 Wilson Blvd., Suite 1000
Arlington, VA 22209
Phone: (703) 841-9300
Fax: (703) 841-0389
Represents coastal and inland operators of towboats, tugboats and barges; also shipyards that build, repair or maintain such vessels.

Association of American Railroads
50 F Street
NW Washington, DC 20001
Phone: (202) 639-2555 Fax: (202) 639-2558
Coordinating and research agency of the American freight railway industry.

Council of Independent Truckers of New Jersey
P.O. Box 786
Piscataway, NJ 08854
Phone: (908) 968-1005
Owner-operator association.

Film, Air & Package Carriers Conference, Inc.
2200 Mill Road
Alexandria, VA 22314
Phone: (703) 838-1887 Fax: (703) 549-6196
Represents carriers of film or packaged cargo of 100-1,000 pounds requiring express delivery.

Forest Products Traffic Association
22 N. 2nd Street, Suite 302
Memphis, TN 38103
Phone: (901) 526-7625 Fax: (901) 529-8225
Professional transportation analysts whose chief interest lies in transportation and distribution of logs, lumber and related wood products.

Household Goods Carriers' Bureau
1611 Duke Street
Alexandria, VA 22314-3482
Phone: (703) 683-7410 Fax: (703) 683-7527
Membership is composed of movers certified by the U.S. Interstate Commerce Commission to transport household goods and other property in interstate commerce.

Household Goods Forwarders Association of America
2111 Eisenhower Avenue, Suite 404 Alexandria, VA 22314
Phone: (703) 684-3780
Fax: (703) 684-3784
Carriers engaged in the movement of household goods by the door-to-door container method.

Independent Truck Owner/Operator Association
P.O. Box 621
Stoughton, MA 02072
Phone: (617) 828-7200 or (800) 628-4866
Comprised of owner-operators, merchant vendors, truck dealers,fuel stops, and truck stops, dedicated to ensuring the survival of the small, independent truck owner-operator.

Intermodal Association of North America
6410 Kenilworth Avenue, Suite 108
Riverdale, MD 20737 ,
Phone: (301) 474-8700 Fax: (301) 836-6070
Represents companies involved in intermodal freight transportation domestically and/or internationally within North America.

Intermodal Council
2200 Mill Road
Alexandria, VA 22314
Phone: (703) 838-1918 Fax: (703) 836-6070
American Trucking Associations member council representing companies engaged in internodal freight transportation. Focus is on issues or concerns of significant import to the intermodal freight transportation industry.

International Association of Refrigerated Warehouses
7315 Wisconsin Avenue, Suite 1200 N. Bethesda, MD 20814
Phone: (301) 652-5674
Fax: (301) 652-7269
Represents public refrigerated warehouses storing all types of perishable foods and other perishable products. Associate members are industrial suppliers.

Interstate Truckload Carriers Conference
2200 Mill Road
Alexandria, VA 22314
Phone: (703) 838-1950
Fax: (703) 836-6610
Represents the truckload motor carrier industry.

National Automobile Transporters Association
902 Buhl Building
535 Griswold
Detroit, Ml 48226
Phone: (313) 965-6533
Fax: (313) 965-6950
A representation affirms specializing in the transportation by truck of automobiles, trucks,and other motor vehicles.

National Defense Transportation Association
50 South Picket Street, Suite 220
Alexandria, VA 22304-3008
Phone: (703) 751-5011 Fax: (703) 823-8761
Professional armed service/civilian organization for men and women of the armed forces, federal government and private industry who are active in the field of transportation.

National Motor Freight Traffic Association, Inc.
2200 Mill Road
Alexandria, VA 22314
Phone: (703) 838-1868
Fax: (703) 683-1094
Serves as the agency by which thousands of participating motor common carriers nationwide can discharge their legal obligations to establish, publish and maintain a tariff of classifications of property transported by truck.

National Perishable Logistics Association
P.O. Box 3021
Oak Park, IL 60303
Phone: (708) 524-1020
Fax: (708) 524-1064
Represents motor carriers and industrial companies whose primary interest is the regulated transportation of perishable commodities.

National Private Truck Council
1320 Braddock Pl. #720
Alexandria, VA 22314
Phone: (703) 683-1300
Fax: (703) 683-1217
Represents manufacturers, processors, shippers, distributors, and jobbers who operate their own truck fleets and transport their own goods.

National-American Wholesale Grocers' Association
201 Park Washington Court
Falls Church, VA 22046
Phone: (703)
Provides technical assistance and research to wholesale grocers and food service distributors.

North American Traffic Report: Airports Council International- North America,
1775 K Street, NW, Suite 500, Washington, DC 20006,
Phone: (202) 293-8500,
Fax: (202) 331-1362. Price $25 members, $95 non-members. *Covers airport activity statistics ranking over 130 airports in North America in terms of passengers, cargo and operations.*

United Fresh Fruit & Vegetable Association
727 North Washington Street
Alexandria, VA 22314
Phone: (703) 836-3410
Fax: (703) 836-7745
Represents growers, shippers, brokers, wholesalers, distributors, and retailers of fresh fruit and vegetables.

Appendix K

Freight Transportation Data Sources

Appendix K

■ Freight Transportation Data Sources

The key at the top of each page of this appendix categorizes the data in terms of perceived usefulness to the quick response freight modeling process. This is not meant to imply that data items categorized as "marginal" or "specialized" do not have very useful applications in other areas.

Appendix K is divided into four main parts related to their most appropriate application in the quick response freight modeling process:

- **Part 1** -- Baselines, forecasts, and growth factors
- **Part 2** -- Vehicle miles traveled (VMT) and networks
- **Part 3** -- Survey development and other
- **Part 4** -- Specialized data sources, organized as air, pipeline, rail, water, and multimodal and others.

MODE: Demographics, flows, etc.	GEOGRAPHY: National, state, county	USEFULNESS: Very useful	USE WITH MANUAL: Growth factor, base year statistics

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: County Business Patterns

CONTENT: The County Business Patterns (CBP) is an annual series of state and national publications presenting county-level data on number of establishments, total employment, and payroll on an establishment basis, with economic activity classification reflecting the principal activity at each individual locations. The data are derived from a universe of employees covered by Federal Insurance Contributions Act (FICA).

Data in the CBP represent the following types of employment covered by FICA:

- all covered wage and salary employment of private nonfarm employers and of nonprofit organizations;

- all employment of religious organizations covered under the elective provisions of FICA.

Data for employees of establishments totally exempt from FICA are excluded. These include the following types of employment: self-employed, government, domestic service, agricultural, foreign, and railroad employment jointly covered by Social Security and railroad retirement programs.

For activities such as construction, transportation, electric and gas, establishments are represented by those relatively permanent main or branch offices, terminals, stations, etc. Hence, the individual sites or systems of such dispersed activities (e.g., worksites) are not ordinarily considered to be establishments.

Note:data for industries with less than 100 employees in a given county are not shown in the printed reports, but are included on the CD-ROM and computer tape.

<u>County Business Patterns Addendum:</u>

Source of Data: Department of Commerce/Bureau of Economic Analysis

Attributes: Geographic Coverage of Data: US, states and counties, to zip code level by special request

Update frequency: annual

Sponsoring Organization: Department of Commerce, Bureau of Economic Analysis

Availability: Printed reports, tape, diskette, microfiche, CD-ROM

Entire US: Superintendent of Documents, PO Box 371954, Pittsburgh, PA 15250-7954, ph. 202-512-1800, fax (202) 512-2250. Price $245, stock number 803-049-00000-9.

Individual States: (county level) Prices vary from $2.50 to $15.00. Contact above for order information.

Internet:To county level by 4-digit SIC code - total employment, not by employment by size.

Sample//http://www.census.gov/>

Special request: Total establishments and establishments by employment size class by 4-digit SIC code by zip code. Minimum charge $300; total US $1000

Contact for additional information:
Carol Comisarow, Statistician
DOC - Economics Planning and Coordination Division
Phone: 301-457-2580

Also contact:
Customer Services Branch
Data Users Services Division
Bureau of the Census
Washington, DC 20233
Phone: 301-457-4100
<http://www.census.gov/>

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: National, state, metropolitan, county	USEFULNESS: Very useful	USE WITH MANUAL: Growth factor, base year statistics, forecast statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Regional Economic Information System (REIS)

Abstract: The REIS contains estimates of annual personal income by major source, per capita personal income, earnings by two-digit SIC industry, full- and part-time employment by one-digit SIC industry, regional economic profiles, transfer payments by major program, and farm income and expenses for states, metropolitan areas and counties. In addition, other information includes BEA estimates of quarterly personal income by state (1969-1992); Census Bureau data on intercounty flows for 1960, 1970 and 1980; BEA's latest gross state product estimates for 1977-1989; its projections to 2040 of income and employment for states and metropolitan areas; and total commuter's income flows, 1969-1991.

Source of Data: Department of Commerce/Bureau of Economic Analysis.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1969-1991
First Developed: 1991
Update Frequency: Annual
Number of Records: Not Available
File Size: 450MB
File Format: ASCII
Media: CD-ROM

Sponsoring Organization: Department of Commerce, Bureau of Economic Analysis, Regional Economic Measurement System

Availability: DOC/Bureau of Economic Analysis, Regional Economic Measurement Division, BE-55, Washington, DC 20230; telephone, (202)523-5360. Price, $35.

Contact for Additional Information: REIS Staff, DOC/Bureau of Economic Analysis
(202) 606-5360

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state, metropolitan, other	USEFULNESS: Very useful	USE WITH MANUAL: Growth factor, base year statistics, forecast statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: BEA Regional Projections to 2040; County Projections also available Publication

Abstract: This document illustrates estimates for 1973, 1979, 1983, 1988, and projections for 1195, 2000, 2005, 2010, 2020, and 2040 for total persons income, population, per capita personal income, and employment and earnings by industry for the U.S., BEA regions, states, metropolitan statistical areas, and BEA economic area. Volume 1 contains data on states, Volume 2 contains data on MSAs, and Volume 3 contains data on BEA Economic Areas.

Source of Data: Department of Commerce/Bureau of Economic Analysis.

Attributes:
Geographic Coverage of Data: U.S., States, MSAs, BEA Economic Areas
Time Span of Data Source: 1973-2040
First Developed: 1964
Update Frequency: Every 5 Years

Sponsoring Organization: Department of Commerce, Bureau of Economic Analysis, Regional Economic Analysis Division

Availability: Volume 1 - National Technical Information Service, Springfield, VA 22161; telephone, (301)487-4650. Price, $27; order number PB90-264532. Volumes 2 and 3 - Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20590; telephone,, (202)783-3238. Price, $17/Volume 2 order number 003-010-00211-5; $10/Volume 3, order number 003-010-00212-3. Disks: DOC/Bureau of Economic Analysis, Regional Economics Analysis Division, Washington, DC 20230; telephone, (202)523-0959. Prices vary. County Level: DOC/Bureau of Economic Analysis, Regional Economic Analysis Division, BE-61, Washington, DC 20230; telephone, (202)523-0959. Price, $260 (13 disks). Data also available for user-selected states at $20/disk.

Contact for Additional Information:
Duane Hackman
Data Manager
DOC/Bureau of Economic Analysis
(202)606-9218

Contact for Additional Information:
George Downey
Chief
DOC/Bureau of Economic Analysis, Projects Branch
(202)606-5341

MODE: Highway	GEOGRAPHY: National, state	USEFULNESS: Useful	USE WITH MANUAL: Growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Truck Weight Study Data Database

Abstract: This data base contains weigh-in-motion data from the states submitted in accordance with the Traffic Monitoring Guide. Summary files are produced for generating weight reports.

Source of Data: State Departments of Transportation submit data to FHWA in accordance with the Traffic Monitoring Guide.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1986-present
First Developed: 1989 (supersedes data base dating to 1930)
Update Frequency: Annual
Last Update: 1993
Number of Records: 40,000,000
File Size: 3GB
File Format: ASCII
Media: Read/Write Optical Disk

Significant Features and/or Limitations: Amount of data varies tremendously by state because some states submit data from continuously operating weigh-in-motion sites whereas others submit the minimum 48 hours of data from each weigh-in-motion site. Some states have not submitted weigh-in-, motion data because of various problems with the equipment, etc.

Sponsoring Organization: Department of Transportation, Federal Highway Administration, Office of Highway Information Management

Availability: DOT/FHWA, Office of Highway Information Management, HPM-30, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-0175. No cost to customer if magnetic or optical disks are supplied.

Contact for Additional Information:
Ralph Gillmann, Data Managers
DOT/FHWA, HPM-30
(202)366-0175

Perry Kent, Data Manager
DOT/FHWA, HPM-30
(202)366-0175

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: National, state	USEFULNESS: Useful	USE WITH MANUAL: Growth factor, base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Commodity Flow Survey: 1993

Abstract: The Commodity Flow Survey (CFS) is designed to provide data on the flow of goods and materials by mode of transport. The CFS is a continuation of statistics collected in the Commodity Transportation Survey from 1963 through 1977, and includes major improvements in methodology, sample size and scope. A sample of 200,000 domestic establishments randomly selected from a universe of about 900,000 establishments engaged in mining, manufacturing, wholesale, auxiliary establishments (warehouses) of multi-establishment companies, and some selected activities in retail and service was used. Each selected establishment will report a sample of approximately 30 outboard shipments for a two week period in each of the four calendar quarters of 1993. This will produce a total sample of about 20 million shipments. For each sampled shipment, zip code of origin and destination, 5-digit Standard Transportation Commodity Classification (STCC) code, weight, value, and modes of transport, will be provided. Check box information on whether the shipment was containerized, a hazardous material, or an export will also be obtained.

Source of Data: A sample of manufacturing wholesale establishments will complete questionnaire.

Attributes:
Geographic Coverage of Data: National, Stratified by State
Time Span of Data Source: 1993
First Developed: 1993
Update Frequency: Every Five Years
Number of Records: ~20 Million (Estimated)
File Size: TBD
File Format: TBD
Media: 9-track Tape, CD-ROM, Hardcopy

Significant Features and/or Limitations: The 1993 CFS will differ from previous surveys in greatly expanded coverage of intermodalism. Earlier surveys reported only the principal mode. The 1993 survey will report all modes used for the shipment (for-hire truck, private truck, rail, inland water, deep sea water, pipeline, air, parcel delivery or U.S. Postal Service, other mode, unknown). Route distance for each mode for each shipment will be imputed from a Mode-Distance Table developed by Oak Ridge National Laboratory. Distance, in turn, will be, used to compute ton-mileage by mode of transport.

Corresponding Printed Source: Commodity Flow Survey, 1993

Sponsoring Organization: Department of Transportation, Bureau of Transportation Statistics, Department of Commerce, Bureau of the Census

Performing Organization: Department of Commerce, Bureau of the Census, Oak Ridge National Laboratory

Availability: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)783-3238. Data not available until late 1995.

Contact for Additional Information
John Fowler
DOC/ Bureau of the Census, Business Division
(301)763-6087

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state, metropolitan	USEFULNESS: Useful	USE WITH MANUAL: Base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: 1992 Census of Transportation, Communications and Utilities Geographic Area Series Summary (UC92-A-1); other series also available: Series Establishment and Firm Size (Including Legal Form of Organization) (UC92-S-1) and Miscellaneous Subjects (UC92-S-2) Publication

Abstract: Presents data for establishments with payroll in transportation, communications, and utilities industries as defined in Division E of the 1987 Standard Industrial Classification (SIC) Manual, except for SIC Major Group 43, U.S. Postal Service. Presents general statistics on number of establishments, revenue, payroll, and employment. Data are also provided on revenue and employees per establishment, and on revenue and payroll per employee. Comparative statistics showing percent changes in revenue and payroll between 1987 and 1992 area also shown for some kind-of-business classifications.

Source of Data: 1992 Economic Census; 1992 Census of Transportation, Communications, and Utilities {transportation companies).

Attributes:
Geographic Coverage of Data: National, Stratified by State, Consolidated Metropolitan Statistical Areas, Primary Metropolitan Statistical Areas, Selected Metropolitan Statistical Areas
Time Span of Data Source: January 1, 1992-December 31, 1992
First Developed: In Progress
Update Frequency: Every Five Years
Last Update: 1989
Media: CD-ROM, Hardcopy

Significant Features and/or Limitations: Includes all establishments with one or more paid employees engaged in these classifications: SIC 41, local and suburban transit and interurban highway passenger transportation; SIC 42, motor freight transportation and warehousing; SIC 44, water, transportation; SIC 45, transportation by air; SIC 46, pipeline, except natural gas; SIC 47, transportation services; SIC 48, communications; SIC 49, electric, gas, and sanitary services. Also includes SIC 40, railroad transportation reported to the, Association of American Railroads; they were not in the 1992 Census of Transportation, Communications, and Utilities universe. Likewise, data reported to DOT's RSPA/Office of Airline Statistics were included in the tabulations for SIC 45, but were excluded from the universe. Excludes firms without paid employees and governmental organizations. Excludes auxiliaries for all industries except firms in SIC's 46 (pipeline, except natural gas); 481 and 482 (telephone, telegraph and other message

Sponsoring Organization: Department of Commerce, Bureau of the Census, Business Division

Availability: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)512-1800. Publication not available until February, 1995.

Contact for Additional Information
Dennis Shoemaker
Chief
DOC/Bureau of the Census, Utilities Census Branch
(301)457-2786; Fax, (301)457-4576

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state	USEFULNESS: Useful	USE WITH MANUAL: Growth factor

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Commercial Drivers Licenses

CONTENT: Number of Commercial Drivers Licenses issued. These data are updated continuously.

METHODOLOGY: A Commercial Drivers License (CDL) is required for all commercial drivers whose vehicle falls into one of the following categories:

- gross weight of more than 26,000 pounds, including a towed unit over 10,000 pounds;
- designed to haul more than 15 passengers, including the driver;
- requires placards under the Hazardous Materials Regulations.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National	USEFULNESS: Useful	USE WITH MANUAL: Base year statistics, forecast statistics

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Current Population Survey

CONTENT: The Bureau of Census conducts the survey each month for the Bureau of Labor Statistics and provides comprehensive data on the employed and unemployed, including such characteristics as age, sex, occupation, hours worked and industry.

METHODOLOGY: Data based on household interviews are obtained from the Current Population Survey (CPS), a sample survey of the population 16 years of age and over.

CPS employment data are estimated from a sample survey of about 60,000 households and 115,000 persons selected to represent the entire civilian noninstitutional population. The CPS estimates are designed to measure overall employment, unemployment, and those not in the labor force. The survey data are weighted to derive national estimates.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, metropolitan	USEFULNESS: Useful, specialized	USE WITH MANUAL: Base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Current Employment Statistics Publication

Abstract: This publication provides monthly employment data collected from payroll records of business establishments. Statistics on employment, hours, and earnings are published for industry groups in the transportation sector, with these data classified using the Standard Industrial Classification (SIC). Publication detail includes all 2-digit SIC detail (railroad transportation, local and interurban passenger transit, trucking and warehousing, water transportation, transportation by air, pipelines, transportation services) and selected 3- and 4-digit detail.

Source of Data: Monthly payroll records from a sample of business establishments. Employment data for Class I Railroads are provided by the ICC. Data collected via mail, computer automated telephone interviewing, and touchtone data entry.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Current Year
Update Frequency: Monthly

Sponsoring Organization: Department of Labor, Bureau of Labor Statistics

Availability: DOL/Inquiries and Correspondence Branch, Office of Publications, Bureau of Labor Statistics, Washington, DC 20212; telephone, (202)606-5902

Contact for Additional Information:
Lois Plunkert
Data Manager
BLS/Division of Monthly Industry Employment Statistics
(202) 606-6527

MODE: Highway	GEOGRAPHY: National, state	USEFULNESS: Marginal	USE WITH MANUAL: Base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Nationwide Truck Activity Survey (NTACS)

Abstract: The NTACS is a follow-on to the 1987 Truck Inventory and Use Survey (TIUS) designed to collect detailed information on travel characteristics of commercial motor vehicles. The survey provides detailed annual and daily activity for a probability sample of trucks responding to the TIUS. The data were collected for days selected at random over a 12-month period ending in October 1990. Among the truck, shipment, and location characteristics, the NTACS identifies shipments carried by the truck that were picked up or delivered to another mode. In addition, the survey provides information on temporal, geographic and other characteristics of truck use that are not collected in the TIUS.

Source of Data: Survey of a sample of all trucks reported carrying commodities over long distances in the 1987 TIUS, approximately half of the trucks that were reported as carrying commodities locally in the 1987 TIUS and a small portion of the remaining, 1987 TIUS respondents.

Attributes:
Geographic Coverage of Data: National, Regional
Time Span of Data Source: 1989-1990
First Developed: 1990
Update Frequency: TBD
Last Update: 1990
Number of Records: 22,044
File Size: 180 tracks, ASCII, 510 Tracks SAS
File Format: ASCII, SAS
Media: 9-track Tape, 6250 bpi; Hardcopy; CD-ROM

Significant Features and/or Limitations: Data limited to trucks 4-years old and older. NTACS suffered from a low response rate and data inconsistency problems. Where possible, the collected data were adjusted to compensate for and to decrease the extent of these problems.

Corresponding Printed Source: 1990 Nationwide Truck Activity and Commodity Survey, Selected Tabulations

Sponsoring Organization: Department of Transportation, Federal Highway Administration, Federal Railroad Administration, Office of the Secretary of Transportation

Performing Organization: Department of Commerce, Bureau of Census, Oak Ridge National Laboratory

Availability: Tape, Printed Source: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 5500A, MS6366, Oak Ridge, TN 37831-6366; telephone, (615)574-5957; fax, (615)574-3851, CD-ROM: Transportation Data Sampler - DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone, (202)366-3282; fax, (202)366-3640

Contact for Additional Information:
Stacy Davis, Data Manager, Jim March, Data Manager
Oak Ridge National Laboratory DOT/FHWA, HPP-12
(615)574-5957(202)366-9237

MODE: Highway	GEOGRAPHY: National, state	USEFULNESS: Marginal	USE WITH MANUAL: Base year statistics, growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Truck Inventory and Use Survey

Abstract: This data base provides detailed information collected from a 152,000 truck sample producing state universe estimates for the United States, including a national summary of the nation's truck population. Data include year of truck model, average weight, state of registration, major use, principal products carried, annual and lifetime miles, vehicle body type and size, axle arrangement, maintenance, area of operation, size class, leasing arrangements, miles per gallon, and hazardous materials carried.

Source of Data: Owners of private and commercial trucks registered in each state complete a mail survey.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1987 (Results of the state reports from the 1992 TIUS are expected to be released in Fall 1993 through Summer 1994. The U.S. summary report and microdata tape are expected to be released in Fall 1994.
First Developed: 1990
Update Frequency: Every Five Years
Last Update: 1985
Number of Records: 104,600 Logical Records; 424 Character Logical Record Length
File Size: ~44MB
File Format: Not Available
Media: Microdata File, Hardcopy

Significant Features and/or Limitations: Only source of comprehensive data collected for trucks that are classified by their physical and operational characteristics and that also provide microdata analysis from a public-use tape to data users of the transportation community. The records on, the microdata tape are modified to avoid disclosure of a sampled vehicle or operating company.
Sponsoring Organization: Department of Commerce, Bureau of the Census

Availability: Data File - DOC/Bureau of the Census, Customer Services, Washington, DC 20233; telephone, (301)763-4100. Printed Source - Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone (202)783-3238., Price, $1.50/Individual State Report; $9.50/U.S. Summary Report; $175/Microdata File. Data available for 1963, 1967, 1972, 1977, 1982, and 1987 surveys.

Contact for Additional Information:
Bill Bostic, Project Manager
DOC/Bureau of the Census
(301) 763-2735

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: National	USEFULNESS: Marginal	USE WITH MANUAL: Growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: 1982 Benchmark Input-Output Accounts of the United States Publication

Abstract: This publication shows the distribution of transportation service output (including rail, truck, water, air, pipeline, and other transportation services) to using industries and final purchasers. Among the using industries are transportation industries defined by mode. The commodities used as inputs by these transportation industries are also identified. These accounts also provide detailed information on the consumption of specified commodities. The input-output workfile that is available for benchmark years includes information for over 8,000 commodities.

Source of Data: Department of Commerce/Bureau of Economic Analysis.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1982
First Developed: 1958
Update Frequency: Every 5 Years
Media: Tape, Disk, Hardcopy

Sponsoring Organization: Department of Commerce, Bureau of Economic Analysis, Interindustry Economic Division

Availability: Tape, Disk: DOC/Bureau of Economic Analysis, Interindustry Economics Division, BE-51, Washington, DC 20230; telephone, (202)606-5585. Price varies by table requested., Printed Source: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)783-3238. Price, $19.

Contact for Additional Information:
Ann Lawson
Chief, DOC/Bureau of Economic Analysis, Interindustry Economics Division
(202) 606-5584

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state	USEFULNESS: Marginal	USE WITH MANUAL: Base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Annual Survey of Manufactures Publication

Abstract: This survey of manufactures was initiated in 1949 and has been conducted since that time for years not covered by the Census of Manufactures. The survey provides up-to-date statistics on the key measures of manufacturing activity for industry groups and individual industries, and for states by 3-digit industry groups. Approximately 55,000 plants from a total of 350,000 were surveyed. Included in the sample are all large manufacturing plants, that account for more than two-thirds of total employment of all manufacturing establishments in the U.S., and a sample of the more numerous medium- and small-sized establishments. This program is designed to provide estimates of general statistics (employment, payroll, hours worked, value added by manufacture, cost of materials, expenditure for new plant and equipment, value of manufacturers inventory, etc.) for industry groups and industries; general statistics for values of shipments for classes of products; fuels and electric energy data by industry groups, and labor cost.

Source of Data: Questionnaire is completed by manufacturing establishments with one or more paid employees.

Attributes:
Geographic Coverage of Data: National, Stratified by State
Time Span of Data Source: 1949-1991
First Developed: 1949
Last Update: 1991
Update Frequency: Annual
Media: CD-ROM, Printed Source

Sponsoring Organization: Department of Commerce, Bureau of the Census, Industry Division

Availability: Publications: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)512-1800. CD-ROM: DOC/Bureau of the Census, Customer Services, Washington, DC 20233; telephone, (301)457-4100.

Contact for Additional Information:
William Visnanski, Data Manager
DOC/Bureau of the Census, Industry Division
(301) 457-4141; Fax, (301) 457-2298

Judy Dodds, Data Manager - Food, Textiles, & Apparel
DOC/Bureau of the Census, Manufacturing and Construction Division
(301) 457-4651; Fax, (301) 458-4503

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state	USEFULNESS: Marginal	USE WITH MANUAL: Base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Occupational Employment Statistics Publication
Abstract: This publication provides employment statistics by detailed occupation within detailed industries. Statistics on the occupational profile of transportation employment are provided at the 2 and 3-digit SIC level of detail on a three year cycle.

Source of Data: Annual sample of 250,000 employer units conducted by State employment security agencies in cooperation with the Bureau of Labor Statistics. Sample is conducted using mail surveys, telephone follow-up, and personal interviews.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Current Year
Update Frequency: Annual

Sponsoring Organization: Department of Labor, Bureau of Labor Statistics, Office of Employment and Unemployment Statistics

Availability: DOL/Inquiries and Correspondence Branch, Office of Publications, Bureau of Labor Statistics, Washington, DC 20212; telephone, (202)606-5902

Contact for Additional Information:
Mike McElray
Data Manager
DOL/BLS/Occupational Employment Statistics
(202)606-6516; Fax, (202)606-6645

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state, metropolitan	USEFULNESS: Marginal	USE WITH MANUAL: Growth factor

DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Occupational Compensation Surveys Publication

Abstract: This publication presents occupational earnings estimates by metropolitan area for selected occupations. Among the occupations studied are four levels of local truck drivers, forklift operators, material handling laborers and warehouse specialists. Surveys combine data for most industries, but data are published separately for the transportation, communication, electric, gas and sanitary services industry division. Several occupational compensation surveys conducted biennially for the Employment Standards Administration of the Department of Labor relate to specific transportation industries: Alaskan Air Transportation, Deep Sea Freighters, and Deep Sea Tankers.

Source of Data: Large sample survey of business establishments representing all MSAs in the U.S. are conducted via personal interviews every three or four years, with data for interviewing years collected by combination of mail, telephone and personal, visits.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Annual
Update Frequency: Annual, Biennial

Sponsoring Organization: Department of Labor, Bureau of Labor Statistics, Division of Occupational Pay and Benefit Levels

Availability: DOL/Inquiries and Correspondence Branch, Office of Publications, Bureau of Labor Statistics, Washington, DC 20212; telephone, (202)606-5902

Contact for Additional Information:
Staff, Data Analysis
DOL/BLS, Division of Occupational Pay and Benefit Levels, OCSP Information (202)606-6219; Fax (202)606-7856.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state	USEFULNESS: Marginal	USE WITH MANUAL: Base year statistics

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Employment and Wages

CONTENT: The Employment and Wages database contains information on employment, wages and establishments, by industry, by state. The data represent the count of employment and wages for workers covered by State unemployment insurance programs (UI) and Federal civilian workers covered by the Unemployment Compensation for Federal Employees (UCFE) program.

The BLS aggregates the data to national levels, by State and by industry -- private sector data are shown at the 4-digit SIC level. Employment and Wages data are available quarterly.

AVAILABILITY: The Office of Employment and Unemployment Statistics at the BLS in Washington, D.C. maintains the database of employment and wages data. The BLS data can be copied onto diskettes using compression software. The BLS may have their employment and wages data available on CD-ROM and also on the Internet -- where databases can be downloaded via modem.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state	USEFULNESS: Marginal	USE WITH MANUAL: Base year statistics

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Employment and Earnings

CONTENT: The Employment and Earnings database contains information on industry employment, by state, and nationwide occupational employment. This data is published monthly.

METHODOLOGY: According to the BLS, Employment and Earnings (E&E) statistics are compiled from two places: household interviews and employer results.

Data based on household interviews are obtained from the Current Population Survey (CPS), a sample survey of the population 16 years of age and over. The Bureau of Census conducts the survey each month for the BLS and provides comprehensive data on the employed and unemployed, including such characteristics as occupation, hours and industry.

Data based on establishment records are compiled each month from questionnaires sent by the Bureau of Labor Statistics, in cooperation with state employment agencies. The Current Employment Statistics (CES) survey provides industry information on non-farm wage and salary employment, hours, and average weekly earnings.

State agencies mail the questionnaires, then collect and compile data and make employment estimates at the state level. National employment estimates are then made by the BLS.

The Employment and Earnings publication is prepared in the Office of Employment and Unemployment Statistics in collaboration with the Office of Publications and Special Studies.

AVAILABILITY: Data are available in printed publications and on computer files.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state, detailed Sub-areas, other	USEFULNESS: Marginal	USE WITH MANUAL: Base year statistics

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Occupational Employment Statistics

CONTENT: The Occupational Employment Statistics (OES) covers wage and salary employment by occupation for establishments in nonagricultural industries. The OES is an annual survey that provides employment by detailed occupation within detailed private industries, plus state and local governments.

METHODOLOGY: According to the BLS, the OES is a federal-state cooperative program. State employment agencies mail a BLS survey to a sample of about 250,000 employer units, the collect and compile the data. Employment estimates are based upon survey results adjusted to reflect total industry employment.

Statistics are derived for employment by occupation and industry for about 750 occupations (which include trucking activity occupations such as truck drivers, dispatchers and truck mechanics) and 400 industries. The states also conduct the SIC coding of establishments, with the occupational data shown separately.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state	USEFULNESS: Marginal	USE WITH MANUAL: Growth factor, base year statistics, forecast statistics

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Occupational Outlook Handbook

CONTENT: Current and projected occupational employment data include employees in private and government sectors, and estimates for self-employed persons (for total employment only and not at the industry level).

METHODOLOGY: According to the BLS, the employment estimates are derived from the BLS industry-employment matrix, which includes data for more than 500 detailed occupations and 250 detailed industries. The main sources of data used in the matrix are Current Employment Statistics (CES) estimates for total wage and salary jobs by industry, and Occupational Employment Statistics (OES) data for employment by occupation within detailed industries.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state, county	USEFULNESS: Marginal	USE WITH MANUAL: Base year statistics, establish sampling base for survey

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Payroll Reports

CONTENT: Payroll information reported to the states each month depicting employment, hours worked, establishment name, address, and type of business.

TYPOLOGY MAPPING: The payroll data are very detailed and provide state-and-county-level coverage of payroll data for all business establishments, but only within the SIC structure. As such, only for-hire carriers (SIC 4213) will be reflected as trucking operations in the data. Payroll data for private fleet operations will be represented in the particular company's SIC category.

AVAILABILITY: Data are available to government agencies only.

MODE: Highway	GEOGRAPHY: National, state, metropolitan, facility- airport, marine port, etc.	USEFULNESS: Very useful	USE WITH MANUAL: Network related

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Highway Performance Monitoring System (HPMS) Database

Abstract: This system includes universe data consisting of a small amount of information for all public road mileage in each state. Additional information on physical characteristics, condition, use, and performance for sample roadway sections within the state are included in the sample data. Sample data are statistically valid for each arterial and collect or functional system for rural, small urban, and urbanized areas. Areawide data, consisting of accident data, system length and travel by functional system, and travel activity by vehicle type are also reported in summary form. Accident data contains summary statistics on fatal and non-fatal injury accidents.

Source of Data: State inventory, sampling, and surveys are conducted by State Highway Agencies.

Attributes:
Geographic Coverage of Data: National, Puerto Rico, Limited Data from U.S. Territories
Time Span of Data Source: 1978, 1980-1992
First Developed: 1978
Update Frequency: Annual
Last Update: 1992
Number of Records: ~3.3 Million Universe/Year including 116,000 Sample Section Records/Year
File Size: ~568MB
File Format: ASCII, EBCDIC, LOTUS (areawide)
Media: 9-track Tape, Disk, Hardcopy

Significant Features and/or Limitations: Sample data only for collector through interstate functional systems.
Corresponding Printed Source: Highway Statistics (not inclusive of all data)
Sponsoring Organization: Department of Transportation, Federal Highway Administration, Office of Highway Information Management

Availability: DOT/FHWA, Office of Highway Information Management, HPM-20, 400 7th Street, SW, Washington, DC 20590; telephone (202)366-0175. Price $30-$150 and up for non-government agencies; price varies depending upon amount and coverage desired.

Contact for Additional Information:
Don Kestyn, Transportation Specialist
DOT/FHWA, HPM-20
(202)366-0175

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: National, state, metropolitan, facility-airport, marine port, etc.	USEFULNESS: Useful	USE WITH MANUAL: Network related

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: National Commodity Flow Network

Abstract: This data base includes information on highway, railroad, waterway, aviation, and pipeline networks with intermodal connections for use in calculating distances for the Commodity Flow Survey. Emphasis has been placed on topological accuracy rather than planimetric accuracy for use in network analysis such as minimum path calculations.

Source of Data: Public domain maps, digital line graphs from the U.S. Geological Survey.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1993
First Developed: 1993
Update Frequency: Annual
Last Update: 1993
Number of Records: TBD
File Size: TBD
File Format: ASCII
Media: CD-ROM

Significant Features and/or Limitations: These networks are based on 1:2,000,000 maps and are generally accurate to 1,000 meters.
Sponsoring Organization: Department of Transportation, Bureau of Transp. Statistics
Performing Organization: DOT/Research and Special Programs Administration, Volpe National Transportation Systems Center (RSPA/Volpe Center), Service Assessment Division, Oak Ridge National Laboratory

Availability: DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone (202)366-3282; fax (202)366-3640

Contact for Additional Information:
Staff, DOT/Bureau of Transportation Statistics
(202)366-3282

Bruce Spear
DOT/RSPA/Volpe Center, DTS-49
(617)494-2192

Mike Bronzini
Oak Ridge National Laboratory

(615)574-8267

MODE: Highway	GEOGRAPHY: National, state, metropolitan, County, Facility-airport, marine port, etc.	USEFULNESS: Useful	USE WITH MANUAL: Network related

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: National Highway Planning Network (NHPN)

Abstract: The NHPN is a data base of the major highways in the U.S. It is a foundation for analytic studies of highway performance, vehicle routing and scheduling problems, and mapping purposes. The network is based on the U.S. Geological Survey's 1:2,000,000 digital line graphs (DLG's). The DLG's have been enhanced through addition of transportation attributes such as number of lanes, degree of access control, median type, and FHWA's functional classification codes. Other enhancements include the digitation of some additional links and the correction of topological errors to create a true analytic network.

Source of Data: U.S. Geological Survey's digital line graphs and the States.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Real-Time
First Developed: 1985
Update Frequency: Continual
Number of Records: ~35,000
File Size: ~16 MB
File Format: ASCII
Media: Disk, Hardcopy, CD-ROM

Significant Features and/or Limitations: 1:2,000,000 accuracy insufficient for some types of analyses. This data base has been expanded upon by the Department of Defense, Military Traffic Management Command, Transportation Engineering Agency. See National Highway Planning Network Strategic, Highway Corridor Network (STRANET) and Connectors located in the MTMC profiles section.
Corresponding Printed Source: Description of the National Highway Planning Network
Sponsoring Organization: Department of Transportation, Federal Highway Administration, Highway Needs and Investment Branch
Performing Organization: Oak Ridge National Laboratory

Availability: Disk, Printed Source: DOT/FHWA, Highway Needs and Investment Branch, HPP-22, 400 7th Street, SW, Washington, DC 20590; telephone (202)366-9223. No charge for data, however, six high density floppy disks must be provided by the customer., CD-ROM: Transportation Data Sampler - DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone, (202)366-3282; fax (202)366-3640

Contact for Additional Information:
Stephen M. Lewis, Data Manager
FHWA, HPP-22

(202)366-9223

Bruce Patterson, Data Manager
Oakridge National Laboratory
(615)574-4419

MODE: Highway	GEOGRAPHY: National, state	USEFULNESS: Useful	USE WITH MANUAL: VMT related

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Monthly Traffic Volume Trends

Abstract: This data base contains information on vehicle miles of travel (VMT) generated by the Highway Performance Monitoring System. VMT is expanded from the previous year to give a current year estimate based on the change in traffic volumes at approximately 4,500 locations across the nation. The VMT estimates are generated by functional highway system within each state and the aggregate for national totals. A computer data base for the VMT has been created on the DOT central computers beginning with 1970. A new, expanded data base is generated on the current micro computer system beginning with 1991 VM2 (Traffic Volume Trends Report) data.

Source of Data: State Highway Agencies provide FHWA with traffic counts from automatic traffic data recorders buried in roadway surfaces.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1970-present
First Developed: 1935
Update Frequency: Monthly
Number of Records: Varies
File Size: Varies
File Format: dBASE
Media: Disk, Hardcopy

Significant Features and/or Limitations: Sample limited by statistic sampling and finances available. A computer data base for the VMT has been created on the DOT central computers beginning with 1970. A new, expanded data base is generated on the current micro computer system beginning with 1991 VM2 data.

Corresponding Printed Source: Traffic Volume Trends

Sponsoring Organization: Department of Transportation, Federal Highway Administration, Office of Highway Information Management

Availability: DOT/FHWA, Office of Highway Information Management, HPM-30, 400 7th Street, SW, Washington, DC 20590; telephone (202)366-5055. Price, monthly report is free; annual cost for monthly data base is $240.

Contact for Additional Information:
Kenneth H. Welty, Highway Engineer
DOT/FHWA, HPM-30
(202)366-5055

MODE: Highway	GEOGRAPHY: National, state	USEFULNESS: Marginal	USE WITH MANUAL: VMT related

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Vehicle Classification and Vehicle Miles Travelled (VCVMT) Database

Abstract: This data base is a compilation of vehicle classification type by highway functional classification by state. Depicts the vehicle type in each functional classification as a percentage of annual vehicle miles travelled (AVMT). One table is developed each year that contains data for all the states.

Source of Data: Data collected by each state.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1985-present
First Developed: 1985
Update Frequency: Annual
Last Update: 1991
Number of Records: 612
File Size: 471KB
File Format: LOTUS
Media: Disk, Hardcopy

Corresponding Printed Source: Highway Statistics

Sponsoring Organization: Department of Transportation, Federal Highway Administration, Office of Highway Information Management

Availability: DOT/FHWA, Office of Highway Information Management, HPM-30, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-5052.

Contact for Additional Information:
William Grush
Data Manager
DOT/FHWA, HPM-30
(202)366-5052

MODE: Highway	GEOGRAPHY: Other	USEFULNESS: Useful	USE WITH MANUAL: Establish sampling base for survey

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Motor Carrier Census

Abstract: This system includes the name and address, type and size of operation, commodities transported and other characteristics of the operation of approximately 300,000 motor carriers (truck and bus) and shippers subject to the Federal Motor Carrier Safety Regulations or Federal Hazardous Materials Regulations.

Source of Data: Interstate motor carriers are required to submit an identification form, Form MCS-150, to FHWA which results in the carrier being registered in the data base system and being issued a USDOT number.

Attributes:
Geographic Coverage of Data: U.S., Canadian, and Mexican Carriers Operating in U.S.
Time Span of Data Source: Current
First Developed: 1979
Update Frequency: Continual
Number of Records: ~300,000
File Size: Varies
File Format: EBCDIC
Media: 9-track Tape, 6250 bpi/1600 bpi

Significant Features and/or Limitations: On-line data base that is directly accessible by all Office of Motor Carrier Headquarters and field personnel. Changes to the data can be made at any time, generally after contact with the motor carrier, i.e., a safety or compliance review, roadside, inspection, etc.

Sponsoring Organization: Department of Transportation, Federal Highway Administration, Office of Motor Carriers

Availability: The Scientex Corporation, OMC Data Dissemination Program, P.O. Box 13028, Arlington, VA 22219. Price, $275/6250 bpi tape; $375/1600 bpi tape.

Contact for Additional Information:
Linda Giles
Data Manager
DOT/FHWA, HIA-10
(202)366-2971

MODE: Highway	GEOGRAPHY: National, state	USEFULNESS: Useful	USE WITH MANUAL: Establish sampling base for survey

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Annual Registration Filings

CONTENT: Varies significantly from state to state. The data include: Size of motor carrier Measured by equipment used, employees, and/or estimate revenue.

Type of operation: Service, for-hire, private, construction, agriculture, off-highway.

Commodity hauled: Broad classifications usually, no greater detail than 2-digit SIC level.

Area of operation: Range of operation carrier.

MODE: Demographics, Flows, etc., highway	GEOGRAPHY: National, state	USEFULNESS: Useful	USE WITH MANUAL: Establish sampling base for survey

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Annual Motor Carrier Reports

CONTENT: Employment and leased-employee information for Class I and Class II for hire motor carriers (this group represents a small percent of total for-hire carriers).

METHODOLOGY: For-hire motor carriers file for interstate operating authority with the ICC. Class I and Class II carriers (annual revenues greater than $3 million) also submit a Motor Carrier Annual Report (Form M). An employment census (including the number of leased owner-operators) is included in Form M.

MODE: Highway	GEOGRAPHY: National	USEFULNESS: Marginal	USE WITH MANUAL: Establish sampling base for survey

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Motor Freight Transportation and Warehousing Survey

Abstract: This data base reflects information obtained from firms furnishing local and long-distance trucking, and courier services, except by air; public warehousing and storage including farm product warehousing, refrigerated, general, and special warehousing and storage. Excluded are private motor carriers and independent owner-operators. The data items consist of total operating revenue, and total operating expenses that include annual payroll and employee benefits. Information collected from trucking firms also includes commodities carried, end-of-year inventory of revenue generating equipment, and type of carrier.

Source of Data: Data are collected from employer businesses on a national level.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1984-1991
First Developed: 1984
Update Frequency: Annual
Last Update: 05/93
Number of Records: 2,345
File Size: Not Available
File Format: Not Available
Media: CENDATA, Hardcopy

Corresponding Printed Source: Motor Freight Transportation and Warehousing Survey

Sponsoring Organization: Department of Commerce, Bureau of the Census, Business Division

Availability: DOC/Bureau of the Census, Business Division, Washington, DC 20233; telephone, (301)763-3990. Price, $2.50.

Contact for Additional Information:
Christine Tucker
Project Manager
DOC/Bureau of the Census, Business Division
(301)763-3990

MODE: Demographics, Flows, etc.	GEOGRAPHY: National, state, metropolitan	USEFULNESS: Marginal	USE WITH MANUAL: Establish sampling base for survey

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: 1987 Census of Transportation Geographic Area Series (TC87-A-1) Publication

Abstract: Presents data for establishments with payroll from selected transportation for the United States, each state, District of Columbia, and selected metropolitan statistical areas (MSA's). Presents general statistics on number of establishments, revenue, payroll, and employment by varied transportation classifications. Data are also provided on revenue and employees per establishment, and on revenue and payroll per employee. Comparative statistics showing percent changes in revenue and payroll between 1982 and 1987 are also shown for some kind-of-business classifications.

Source of Data: 1987 Economic Census; 1987 Census of Transportation (transportation companies).

Attributes:
Geographic Coverage of Data: National, Stratified by State, Selected Metropolitan Statistical Areas
Time Span of Data Source: January 1, 1987 - December 31, 1987
First Developed: 1991
Update Frequency: Every Five Years
Media: Tape, Hardcopy

Significant Features and/or Limitations: Covers selected transportation industries as defined in Division E of the Standard Industrial Classification (SIC) Manual. Includes all establishments with one or more paid employees primarily engaged in these classifications: SIC 42, motor freight, transportation and warehousing; SIC 44, water transportation; and SIC 47, transportation services. Excludes firms without paid employees, governmental establishments, and auxiliary establishments.

Sponsoring Organization: Department of Commerce, Bureau of the Census, Business Division

Availability: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)783-3238
Contact for Additional Information:
Dennis Shoemaker
Chief
DOC/Bureau of the Census, Utilities Census Branch
(301)763-2662

SUBPART a: AIR

MODE: Air	GEOGRAPHY: Facility- airport, marine port, etc.	USEFULNESS: Useful	USE WITH MANUAL: Growth factor/Base year statistics/Forecast statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Airport Activity Statistics of Certificated Route Air Carriers Publication

Abstract: This report presents detailed data on the volume of revenue passengers, freight express, and mail traffic carried by U.S. certificated route air carriers for each airport and individual airline; and total departures by airport, airline, and aircraft model operated. Scheduled/nonscheduled service shown by airport and carrier are included.

Source of Data: Data are derived from RSPA Form Schedules T-100 and T-3.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1993
First Developed: 1962
Update Frequency: Annual
Last Update: 06/93

Sponsoring Organization: Department of Transportation, Federal Aviation Administration, Statistics and Forecast Branch and Research and Special Programs Administration, Office of Airline Statistics

Availability: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone (202)512-1800 or National Technical Information Service, Springfield, VA 22161; telephone, (703)487-4650

Contact for Additional Information:
Patricia Beardsley, Data Manager
DOT/FAA, APO-110
(202)267-8032
fax, (202)267-9636

Paul Gravel, Data Manager
DOT/RSPA/DAI-1
(202)366-9059
fax, (202)366-3383

MODE: Air	GEOGRAPHY: Facility- airport, marine port, etc.	USEFULNESS: Specialized	USE WITH MANUAL: Growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Aviation Data and Analysis System (ADAS)

Abstract: This system provides access to official agency activity forecasts and approved benefit/cost methodologies for any airport or group of airports reported by the system. ADA also provides all the tools necessary to study the effects on the benefit/cost ratio of changes in costs, aviation activities, or airport specifics such as runway utilization, existing minima, or weather data.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1993
First Developed: 1993
Update Frequency: Not Available
Last Update: Unknown
Number of Records: ~4,000
File Size: Not Available
File Format: Not Available
Media: Not Available

Significant Features and/or Limitations: Descriptive historical and forecasted data are stored for approximately 4,000 airports nationwide.

Sponsoring Organization: Department of Transportation, Federal Aviation Administration, Information Systems Branch

Availability: DOT/FAA, Information Systems Branch, APO-130, 800 Independence Ave., SW, Washington, DC 20591; telephone, (202)267-3550; fax, (202)267-5800.

Contact for Additional Information:
Staff, DOT/FAA, APO-130
(202)267-3550

MODE: Air	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: FAA Statistical Handbook of Aviation Publication

Abstract: This report covers statistical data from the Federal Aviation Administration, National Airspace System, airports, airport activity, U.S. air carrier fleet, U.S. civil air carrier operating data, airmen, general aviation aircraft, aircraft accidents, aeronautical production, and imports/exports.

Source of Data: Federal Aviation Administration.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1991
First Developed: 1945
Update Frequency: Annual

Sponsoring Organization: Department of Transportation, Federal Aviation Administration, Statistics and Forecast Branch

Availability: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone (202)512-1800 or National Technical Information Service, Springfield, VA 22161; telephone (703)487-4650

Contact for Additional Information:
Patricia Beardsley
Statistician
DOT/FAA, APO-110
(202)267-8032

MODE: Air	GEOGRAPHY: Facility-airport, marine port, etc.	USEFULNESS: Marginal	USE WITH MANUAL: Growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Terminal Area Forecast

Abstract: Twelve-year forecast of aviation activity at selected airports in the U.S., encompassing at least those airports with towers and/or receiving commercial service. For each airport, detailed forecasts are made for the four major user groups of the air traffic control system: air carrier, air taxi/commuter, general aviation, and military. Summary tables contain national, FAA regional, and state aviation data and other airport specific highlights. Forecasts are prepared to meet the budget and planning needs of the FAA and to provide airport specific information that can be used by state and local aviation authorities, by the aviation industry, and by the general public.

Source of Data: FAA-developed.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Twelve Years
First Developed: 1993
Update Frequency: Annual
Last Update: 1992
Number of Records: Not Available
File Size: Not Available
File Format: Not Available
Media: Hardcopy

Corresponding Printed Source: Terminal Area Forecast

Sponsoring Organization: Department of Transportation, Federal Aviation Administration, Statistics and Forecast Branch

Availability: Printed Source: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone (202)512-1800 or National Technical Information Service, Springfield, VA 22161; telephone, (703)487-4650

Contact for Additional Information:
Staff, DOT/FAA, APO-110
(202)267-3355

SUBPART 4-b: PIPELINE

MODE: Pipeline	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Capacity and Service on the Interstate Natural Gas Pipeline System Publication

Abstract: This report identifies and quantifies the capability of the national natural gas pipeline infrastructure to transport natural gas to the natural gas markets of the country. The report examines the capabilities of the pipelines that make up this network to move gas across regional and state borders and compares these to 1990 levels of natural gas flow to and within regional markets. In addition, envisioned and currently approved plans to construct major new pipelines and expand existing systems are presented and assessed relative to the needs of the current and near-term marketplace.

Source of Data: A variety of government (federal, state, and regional) publications and industry documents, data bases, interviews, and industry analytical reports.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1990
First Developed: 1990
Update Frequency: One-Time Special Report
Last Update: 06/92

Sponsoring Organization: Department of Energy, Energy Information Administration, National Energy Information Center

Availability: National Technical Information Service, Springfield, VA 22161; telephone (703)487-4650

Contact for Additional Information:
Staff , DOE/EIA/National Energy Information Center
(202)586-8800; Fax, (202)586-0727.

MODE: Pipeline	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Statistics of Interstate Natural Gas Pipeline Companies

Abstract: This data base contains financial and operational data on major interstate natural gas pipeline companies as defined by the Federal Energy Regulatory Commission (FERC).

Source of Data: Data are collected on FERC Form 2, Annual Report of Major Natural Gas Companies, from interstate natural gas companies subject to the accounting and reporting requirements of the FERC.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Current year
First Developed: 1976
Update Frequency: Annual
Last Update: 04/92
Number of Records: 240/year
File Size: 2.5-3.0MB
File Format: EBCDIC
Media: 9-Track Tape, 1600/6250 bpi; Hardcopy

Significant Features and/or Limitations: Data are company specific to the reporting company.

Corresponding Printed Source: Statistics of Interstate Natural Gas Pipeline Companies 1990

Sponsoring Organization: Department of Energy, Energy Information Administration

Availability: National Technical Information Service, Springfield, VA 22161; telephone (703)487-4650. Requests for tape conversion to disk can be made through NTIS.

Contact for Additional Information:
Juanita Mack
Data Manager
EIA/National Energy Information Center
(202)586-6169

SUBPART 4-c: RAIL

MODE: Rail	GEOGRAPHY: National, state, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Carload Waybill Sample

Abstract: This data base contains rail shipment data such as origin and destination points, type of commodity, number of cars, tons, revenue, length of haul, participating railroads, and interchange locations. The waybill sample contains confidential information and is used primarily by Federal and state agencies. The public-use version of the sample, however, contains aggregated nonconfidential data. Movements are aggregated to the BEA-to-BEA level at the 5-digit STCC level. For a particular commodity, the origin or destination BEA is not included unless there are at least three freight stations in the BEA and there are at least two more freight stations than railroads in the BEA.

Source of Data: Annual stratified sample of waybills for railroads which terminate over 4,500 cars per year.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1991
First Developed: Unknown
Update Frequency: Annual
Last Update: 1993
Number of Records: >350,000
File Size: Not Available
File Format: ASCII
Media: 9-track Tape, 6250 bpi, CD-ROM

Significant Features and/or Limitations: The waybill sample contains confidential information and is used primarily by Federal and state agencies. There is, however, a public-use version that contains aggregate nonconfidential data.

Corresponding Printed Source: Carload Waybill Statistics: Territorial Distribution, Traffic and Revenue by Commodity Class

Sponsoring Organization: Interstate Commerce Commission

Performing Organization: Department of Transportation, Federal Railroad Administration, Office of Policy Systems

Availability: CD-ROM: DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone, (202)366-3282; fax, (202)366-3640. Tape: Mr. James Nash, ICC, Office of Economics, 12th and Constitution, Washington, DC 20423; telephone, (202)927-5740; fax, (202)927-6225. Printed Source: National Technical Information System, Springfield, VA 22161; telephone, (703)487-4650

Contact for Additional Information:
James Nash, Data Manager
ICC, Office of Economics
(202)927-5740

MODE: Rail	GEOGRAPHY: National, state, metropolitan, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: FRA National Planning Network

Abstract: This data base presents a digital representation of the major continental U.S. railway systems, covering some 186,000 miles of track. Link attributes include owning railroads, trackage rights railroads, state, previous owning railroads, subsidiary railroads, FAA region, passenger service, U.S. Geological Survey (USGS) region, and significance in civil rail lines important to national defense. All links in original USGS data are retained. Links subsequently abandoned are so identified. Node attributes include name, state (where there is a name), standard point location code, and junction code, if any.

Source of Data: USGS 1:2,000,000 digital line graph.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Current
First Developed: 1990
Update Frequency: As Required
Number of Records: 11,010/Nodes; 15,800/Links
File Size: 13MB
File Format: ASCII
Media: Disk

Significant Features and/or Limitations: Locational accuracy of the network is approximately +/- 1,200 meters for those links carrying shape point data.

Sponsoring Organization: Department of Transportation, Federal Railroad Administration, Office of Policy Systems

Availability: DOT/FRA, Office of Policy Systems, RRP-20, 400 7th Street, SW, Washington, DC 20590: telephone (202)366-2920; Fax, (202)366-7688.

Contact for Additional Information:
Raphael Kedar
Director, DOT/FRA, RRP-20
(202)366-2920

MODE: Rail, highway	GEOGRAPHY: National, state, other	USEFULNESS: Specialized, useful	USE WITH MANUAL: Network related

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Grade Crossing Inventory System (GCIS)

Abstract: This system contains a record of every public and private crossing in the U.S. along with the accident history of each crossing. Information includes the identification number, railroad, railroad division, subdivision, milepost and branch, state, county, city or nearest city, street or highway, and crossing type. In addition, public grade crossing information such as number of daily train movements, train speeds, type and number of tracks, details of crossing protection both active and passive, crossing angle, number of traffic lanes, daily highway traffic volume, pavement markings, advance warning signs, crossing surface, highway system, and percentage of trucks is available.

Source of Data: Information is supplied by the railroads and states on an optional basis.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Current Year
First Developed: 1973
Update Frequency: Continual
Number of Records: ~600,000
File Size: ~200MB
File Format: Sequential
Media: 9-track Tape, Disk, Hardcopy

Corresponding Printed Source: Railroad-Highway Crossing Accidents

Sponsoring Organization: Department of Transportation, Federal Railroad Administration, Data Analysis Branch

Availability: DOT/FRA, Data Analysis Branch, RRS-22.1, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-2760. Price, $35/tape, non-government agencies. No charge to government agencies, railroad, or railroad labor requestors.

Contact for Additional Information
Robert Finkelstein, Chief
DOT/FRA, RRS-22
(202)366-2760; Fax, (202)366-7592

SUBPART 4-d: WATER

MODE: Waterway	GEOGRAPHY: National, facility-airport, marine port, etc.	USEFULNESS: Specialized, useful	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Port Facilities Inventory

Abstract: This system contains detailed information on more than 4,000 major ocean and river port facilities, including location, physical characteristics, cargo handling equipment and capacities.

Source of Data: Data are purchased from the U.S. Army Corps of Engineers which systematically surveys all U.S. ports; additional data supplied periodically port authorities.

Attributes:
Geographic Coverage of Data: Major U.S. ocean and river port facilities
Time Span of Data Source: 1988-1994
First Developed: 1976
Update Frequency: As Information is Available
Number of Records: 4,000
File Size: 8MB
File Format: ASCII, dBASE
Media: Disk

Significant Features and/or Limitations: Extensive detail on major U.S. port facilities, both ocean and river; does not include all U.S. port facilities.

Sponsoring Organization: Department of Transportation, Maritime Administration, Office of Port and Intermodal Development

Availability: DOT/MARAD, Office of Port and Intermodal Development, MAR-832, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-5477; fax, (202)366-6988.

Contact for Additional Information:
William Dean, Data Manager
DOT/MARAD, MAR-832
(202)366-5477; fax, (202)366-6988

MODE: Waterway	GEOGRAPHY: National, facility- airport, marine port, etc.	USEFULNESS: Specialized, useful	USE WITH MANUAL: Growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Port Series, 1921-Present

Abstract: The fifty-seven reports in the port series include information on commercial facilities at the principal U.S. Coastal, Great Lakes and Inland Ports. Each report consists of complete listings of a port area's waterfront facilities, including information on berthing, cranes, transit sheds, grain elevators, marine repair plants, fleeting areas, and docking and storage facilities. Aerial maps show the locations of the described facilities.

Source of Data: Facility operators, port organizations, transportation companies conduct on-site investigations.

Attributes:
Geographic Coverage of Data: U.S. Coastal, Inland Ports, and Waterways
Time Span of Data Source: Varies 1-10 Years
First Developed: 1987/Data File; 1921/Printed Source
Update Frequency: Every 8-12 Years
Number of Records: ~10,000
File Size: 56MB
File Format: ASCII
Media: Tape, CD-ROM, Diskettes, Hardcopy

Significant Features and/or Limitations: Contains complete physical data on each facility limited by knowledge of on-site informants.

Corresponding Printed Source: Port Series 1921-Present

Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, CEWRC, Navigation Data Center

Availability: U.S. Army Corps of Engineers, CEWRC, Navigation Data Center, Ports and Waterways Division, Casey Building, Ft. Belvoir, VA 22060-5586; telephone, (703)355-3315; fax, (703)355-0047. Price, $6-$26 depending on size.

Contact for Additional Information:
John Vetter, Data Manager
COE/CEWRC, Navigation Data Center
(703)355-3315

Bob Ray, Data Manager
COE/CEWRC, Navigation Data Center
(703)355-3315

Jim Feagans, Data Manager
COE/CEWRC, Navigation Data Center
(703)355-3315

Sid Formal
Data Manager
COE/CEWRC, Navigation Data Center
(703)355-3315

MODE: Multi-mode, waterway	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Estimated Waterborne Commerce Statistics Publication

Abstract: The estimated Waterborne Commerce Statistics report provides tonnage estimates of the national waterborne commerce and selected waterways by major commodity groupings for the most recent calendar year. It also shows actual annual tonnage by commodity for nine years prior to the year being estimated.

Source of Data: Vessel operating companies file vessel operation reports and lock performance monitoring systems reports.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1989-1992
First Developed: 1989
Update Frequency: Annual
Last Update: 1992

Significant Features and/or Limitations: Timely estimates and 10-year trends.

Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office

Availability: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280, telephone, (504)862-1424; fax, (504)862-1423

Contact for Additional Information:
Thomas Mire, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424; Fax, (504)862-1423

Roy Walsh, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424; Fax, (504)862-1423

MODE: Multi-mode, waterway	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Waterborne Commerce of the United States, Parts 1 thru 5 Publication

Abstract: The statistics of waterborne commerce have been published in five parts by the regional offices of the Corps of Engineers since 1953. Prior to 1953, the statistics were published annually as Part 2 of the annual report of the Chief of Engineers. Tables give tonnage and ton-miles of freight traffic by commodities; comparative statement of traffic, trips, and drafts of vessels. Parts include: Part 1-Atlantic Coast Area; Part 2-Gulf Coast, Mississippi River System and Antilles (Puerto Rico and Virgin Islands); Part 3--Great Lakes Area; Part 4-Pacific Coast, Alaska, and Pacific Islands area; and Part 5--National Summaries.

Source of Data: Vessel operating companies file vessel operating reports.

Attributes:
Geographic Coverage of Data: National, U.S. Territories
Time Span of Data Source: 1953-present
First Developed: 1953
Update Frequency: Annual

Significant Features and/or Limitations: All companies moving commerce by water are required by law to report. Hardcopy dates back to 1920.

Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office

Availability: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280, telephone (504)862-1424; fax, (504)862-1423. Price, $17.50.

Contact for Additional Information:
Thomas Mire, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424

Roy Walsh, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424

MODE: Multi-mode, waterway	GEOGRAPHY: National, state, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Origin and Destination of Waterborne Commerce of the United States, Public Domain Data

Abstract: This database contains aggregated information that depicts waterborne commodity movements between 26 geographical regions or between individual states of the U.S. This database protects the confidentiality of the data provided by the individual companies and provides the origin/destination commodity flows.

Source of Data: Vessel operating companies file vessel operations reports.

Attributes:
Geographic Coverage of Data: National, U.S. Territories
Time Span of Data Source: 1985-1992
First Developed: 1985
Update Frequency: Annual
Last Update: 1992
Number of Records: 400
File Size: 10,000 Bytes
File Format: ASCII
Media: Disk, Hardcopy

Significant Features and/or Limitations: All companies moving commerce by water are required by law to report.

Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office

Availability: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280, telephone, (504)862-1424; fax, (504)862-1423. Price, $5, data file; $15, printed source.

Contact for Additional Information:
Thomas Mire, Data Manager
COE/Waterborne Commerce Statistics Office
(504)862-1424

Roy Walsh, Data Manager
COE/Waterborne Commerce Statistics Office
(504)862-1424

MODE: Waterway	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: U.S. Waterborne Exports and Outbound Intransit Shipments (TM-780)

Abstract: This data base provides information on the shipping weight and value by type of vessel service by Customs district and port of lading by foreign port or country/area of unlading by SITC Rev. 3 and by country of destination. The report presents percentage of containerized cargo. In-transit tables present data on country of origin and destination. An annual version (TA-780) is also available.

Source of Data: U.S. Customs Service.

Attributes:
Geographic Coverage of Data: National, U.S. Customs Districts and Ports of Lading, Foreign Ports of Countries of Unlading, Countries of Origin/Destination
Time Span of Data Source: 1989-present
First Developed: 1989
Update Frequency: Monthly
Number of Records: ~200,000/Month
File Size: 20-25MB
File Format: Flat ASCII
Media: Disk, Tape

Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division

Availability: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)457-1237.

Contact for Additional Information:
Norman Teague
Data Manager
DOC/Bureau of the Census, Foreign Trade Division
(301)763-5140

MODE: Waterway	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: U.S. Waterborne General Imports and Inbound Intransit Shipments (TM-380)

Abstract: This data base presents type of vessel services by U.S. Customs port by foreign port by SITC commodity by country of origin. Data provided include shipping weight, customs value, import charges, and percentage of containerized and containerized and noncontainerized cargo. Inbound intransit shipments are also included. An annual version (TA-380) is also available.

Source of Data: U.S. Customs Service.

Attributes:
Geographic Coverage of Data: National, U.S Customs Districts and Ports of Unlading, Foreign Ports of Lading, Countries of Origin/Destination
Time Span of Data Source: 1989-present
First Developed: 1989
Update Frequency: Monthly
Number of Records: ~200,000/Month
File Size: 20MB
File Format: Flat ASCII
Media: Tape

Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division

Availability: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)457-2317; Fax, (301)457-1237.

Contact for Additional Information:
Norman Teague, Data Manager
DOC/Bureau of the Census, Foreign Trade Division
(301)457-2317

MODE: Waterway	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Maritime Statistical Information System

Abstract: This system contains detailed information on U.S. oceanborne foreign trade statistics by commodity, vessel, port, weight and value; vessel data on all merchant vessels over 1,000 gross tons and worldwide itineraries for the same vessels.

Source of Data: Bureau of Census for foreign trade data; Lloyd's Maritime Information Services primarily for vessel data and exclusively for itinerary data.

Attributes:
Geographic Coverage of Data: National/Oceanborne Foreign; Worldwide/Merchant Fleet and Itinerary
Time Span of Data Source: 1989-present
First Developed: 1991
Update Frequency: Monthly/Foreign Trade; Quarterly/Vessel and Itinerary
Last Update: 07/93
Number of Records: 6 Million/Year - Foreign Trade; 40,000 - Vessel Characteristics; 1 million/Year - Itinerary
File Size: ~1GB/Year
File Format: ASCII, dBASE
Media: Disk

Significant Features and/or Limitations: Foreign Trade data available at the individual vessel level, linked to vessel characteristics and movements. Data base contains proprietary and copyright information and can only be released in summary form.

Corresponding Printed Source: United States Oceanborne Foreign Trade Routes, Merchant Fleets of the World, Vessel Inventory Report

Sponsoring Organization: Department of Transportation, Maritime Administration, Office of Trade Analysis and Insurance

Availability: DOT/MARAD, Office of Trade Analysis and Insurance, MAR-570, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-2277. Publications are free; price for special requests depends upon data requested.

Contact for Additional Information:
Robert Brown, Chief
DOT/MARAD, MAR-570
(202)366-2277

MODE: Waterway	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: American Intermodal Equipment Inventory

Abstract: This system records all intermodal equipment of U.S.-flag intermodal marine carriers and major container leasing companies operating in the U.S. It includes for each company the type and number, dimensions of containers and trailers. Chassis are shown by types, number of units and containers carried. The size and number of slots available on container vessels and barges is recorded. Forty foot equivalent units of trailers along with automobile capacity are also included for Ro/Ro ships and barges.

Source of Data: Survey of U.S.-flag carriers and major leasing companies operating in the U.S.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1991-present
First Developed: 1991
Update Frequency: Annual
Number of Records: 1,000
File Size: 250K
File Format: ASCII, dBASE
Media: Disk

Significant Features and/or Limitations: Only source of aggregated data on American-owned containers, chassis, trailers and vessels, that are essential for planning most efficient use of U.S. intermodal equipment.

Corresponding Printed Source: Inventory of American Intermodal Equipment

Sponsoring Organization: Department of Transportation, Maritime Administration, Office of Port and Intermodal Development

Availability: DOT/MARAD, Office of Port and Intermodal Development, MAR-831, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-4357. Data available in second half of year following close of period.

Contact for Additional Information:
Doris Bautch
Data Manger
DOT/MARAD, MAR-831
(202)366-4357

MODE: Waterway	GEOGRAPHY: National, facility-airport, marine port, etc.	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Analysis of Ports for National Defense

Abstract: This system includes data on specific evaluations of the commercial ports capabilities to support early deployment of DoD military units during a contingency. Port areas analyzed include Baltimore, Boston, Charleston, Hampton Roads, Jacksonville, Morehead City, Narraganset Bay, New York and New Jersey, Philadelphia, Savannah, Wilmington (NC), Beaumont, Houston, New Orleans, Gulfport, Port Arthur, Pascagoula, Lake Charles, Port Hueneme, Los Angeles, Long Beach, and San Diego. Military Ocean Terminals in New Jersey and Oakland are also evaluated. Data include number and characteristics of berths, ship mixes, staging areas, inloading/outloading positions, cargo handling apparatus, rail and highway access, and general information on port facilities. Also included is a theoretical cargo throughput capability for each port.

Source of Data: MTMC conducts this study through site visits and questionnaires.

Attributes:
Geographic Coverage of Data: Continental United States and military ocean terminals in New Jersey and Oakland
Time Span of Data Source: 1977-present
Update Frequency: Every Three Years
Last Update: 1994

Sponsoring Organization: Department of Defense, Department of Army, Military Traffic Management Command, Transportation Engineering Agency

Availability: Department of Army, Military Traffic Management Command, Transportation Engineering Agency, 720 Thimble Shoals Blvd., S130, Newport News, VA 23606-2475; telephone, (804)599-1186; fax, (804)599-1563.

Contact for Additional Information:
Ralph Compton, Data Manager
MTMCTEA
(804)599-1186

MODE: Waterway	GEOGRAPHY: National, facility-airport, marine port, etc.	USEFULNESS: Specialized, useful	USE WITH MANUAL: Growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Tonnage for Selected United States Ports

Abstract: This data base provides listings of tons handled at U.S. Ports for a given calendar year. The ports are sorted by total, domestic, and foreign tonnage and alphabetically.

Source of Data: Vessel operating companies file vessel operation reports.
Attributes:
Geographic Coverage of Data: National, U.S. Territories
Time Span of Data Source: 1992
First Developed: 1986
Update Frequency: Annual
Last Update: 1992
Number of Records: 600
File Size: 50,000 Bytes
File Format: ASCII
Media: Disk, Hardcopy

Corresponding Printed Source: Tonnage for Selected United States Ports

Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office

Availability: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280, telephone, (504)862-1424; fax, (504)862-1423

Contact for Additional Information:
Thomas Mire, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424

Roy Walsh, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424

MODE: Waterway	GEOGRAPHY: National, demographics, Flows, etc.	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Exposure Data Base (EDB)

Abstract: This system was developed to provide accurate program Measures of Effectiveness (MOE) and effective resource allocation using operational data concerning vessel inventories on specific waterways by gross tonnage and vessel type. System generates matrices of commercial vessel transits and cargo data in a port area, region or district, and nationwide in domestic and foreign trade during a time frame. These transits would become an indicator or predictor of the amount of the industry's exposure to particular hazards, being compared to the number of incidents (pollution, casualties, deaths) occurring within the same time frame.

Source of Data: U.S. Army Corps of Engineers, domestic traffic; Bureau of Census, foreign trade.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Current Year
First Developed: Unknown
Update Frequency: Annual
Number of Records: Not Available
File Size: Not Available
File Format: Write One Read Many
Media: 9-track Tape, CD-ROM

Significant Features and/or Limitations: System will generate a measure of effectiveness that is independent of current data gathering practices in the Marine Safety program, and provides vessel and cargo activity reports unavailable from any other system. The EBD can be used in conjunction, with other data bases such as the casualty and pollution data bases. It can also be used independently to provide throughput data for risk analysis projects.

Sponsoring Organization: Department of Transportation, United States Coast Guard, Marine Safety Evaluation Branch

Availability: DOT/USCG, Marine Safety Evaluation Branch, G-MMI-3, 2100 2nd Street, Washington, DC 20593; telephone, (202)267-1430, fax, (202)267-1416

Contact for Additional Information:
CDR Thomas Tansey, Data Manager
DOT/USCG, G-MMI-3
(202)267-1430

MODE: Waterway	GEOGRAPHY: National, facility-airport, marine port, etc.	USEFULNESS: Specialized, useful	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Waterborne Transportation Lines of the United States

Abstract: This system contains information on vessel operators, characteristics and description of operations for all domestic vessel operations. Major data content include alphabetical listing of operators, description of vessels (net registered tons, length, breadth, draft loaded, horse power, capacity, highest point above waterline, cargo handling equipment, year built, home base), description of operations (principal commodities carried and areas served). General ferries, floating equipment used in construction work such as dredges, pile drivers, fishing vessels, and recreational craft are not included.

Source of Data: Vessel operating companies complete annual questionnaire.

Attributes:
Geographic Coverage of Data: National, U.S. Territories
Time Span of Data Source: 1940-1992
First Developed: 1940
Update Frequency: Annual
Last Update: 1992
Number of Records: 40,000, Vessels
File Size: 9MB; Owners/Operators, 3,200
File Format: ASCII
Media: Tape, Disk, Hardcopy
Corresponding Printed Source: Waterborne Transportation Lines of the United States

Sponsoring Organization: Department of Defense, Department of Army, U.S. Army Corps of Engineers, Products and Services Office

Availability: U.S. Army Corps of Engineers, Products and Services Office, Waterborne Commerce Statistics Center, P.O. Box 61280, New Orleans, LA 70161-1280; telephone, (504)862-1424; fax, (504)862-1423. Price, $50/data file; $10/printed source.

Contact for Additional Information:
Thomas Mire, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424

Roy Walsh, Data Manager
COE/Waterborne Commerce Statistics Center
(504)862-1424

SUBPART 4-e: MULTIMODAL AND OTHER

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: Metropolitan	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Data Bank: U.S. Exports of Domestic and Foreign Merchandise (EM-545)

Abstract: This data base presents current month and cumulative data on the net quantity, value, and shipping weight for 10-digit Schedule B by number, by country of destination, by Custom district of export, and by method of transportation. An annual tape (EA-645) is also available.

Source of Data: U.S. Customs Service and Canadian Customs.

Attributes:
Geographic Coverage of Data: National, U.S. Customs Districts of Exportations, Countries of Destination
Time Span of Data Source: 1989-present
First Developed: 1989
Update Frequency: Monthly
Number of Records: 840,000
File Size: 230MB
File Format: ASCII
Media: Tape

Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division

Availability: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)763-5140. Price, $2400.

Contact for Additional Information:
Yvonne Tayler
DOC/Bureau of the Census, Foreign Trade Division
(301)763-5140

Gerline Roundtree
DOC/Bureau of the Census, Foreign Trade Division
(301)763-5140

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: National, state	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Surface Transborder Commodity Data

Abstract: The Bureau of Census provides the Bureau of Transportation Statistics with unpublished freight flow data by commodity type of mode of transportation (rail, truck or pipeline) for U.S. exports and imports to and from Canada and Mexico. The purpose of this program is to provide information needed to monitor increased traffic associated with the North American Free Trade Agreement and provide border communities better data to plan transportation improvements.

Source of Data: Bureau of the Census, Foreign Trade Division

Attributes:
Geographic Coverage of Data: U.S., Canada, Mexico
Time Span of Data Source: 04/93-03/94
First Developed: 1993
Update Frequency: Monthly
Last Update: 06/93
Number of Records: ~1 Million/Month (3/4 Million/Canada; 1/4 Million/Mexico)
File Size: 1.87MB (3 Months of Data, 04/93-06/93)
File Format: dBASE
Media: Disk

Significant Features and/or Limitations: Files are organized by commodity detail or by geographic detail to satisfy Census confidentiality regulations.

Sponsoring Organization: Department of Transportation, Bureau of Transportation Statistics

Performing Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division

Availability: DOT/Bureau of Transportation Statistics, 400 7th Street, SW, Room 2104, Washington, DC 20590; telephone (202)366-3282; fax (202)366-3640

Contact for Additional Information:
Joel Palley
Industry Economist
DOT/Federal Railroad Administration, RRP-31
(202)366-0348

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Data Bank: U.S. General Imports and Imports for Consumption (IM-145)

Abstract: This data base contains data on the net quantity and value of imports for consumption and general imports by 10-digit HTSUSA commodity code by country of origin by Customs districts of entry and unlading. Method of transportation is included. An annual tape (IA-245) is also available.

Source of Data: U.S. Customs Service.

Attributes:
Geographic Coverage of Data: National, U.S. Customs Districts of Entry and Unlading, Country of Origin
Time Span of Data Source: 1989-present
First Developed: 1989
Update Frequency: Monthly
Number of Records: 1,000,000
File Size: 570MB
File Format: ASCII
Media: Tape

Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division

Availability: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)763-5140. Price, $2400.

Contact for Additional Information:
Yvonne Taylor
DOC/Bureau of the Census, Foreign Trade Division
(301)763-5140

Gerline Roundtree
DOC/Bureau of the Census, Foreign Trade Division
(301)763-5140

MODE: Demographics, Flows, etc.	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Worldwide Household Goods Information System for Transportation (WHIST)

Abstract: The WHIST data base provides MTMC with an automated means of acquiring, processing, storing and reporting personal property rate and shipment information. It is a centralized data base of personal property data with the decision support tools necessary to easily retrieve and display this information in a variety of formats. The system is responsible for the acquisition of data from a number of outside sources, assuring validity of the data and formatting and displaying the data on appropriate WHIST hardware components both for use by internal MTMC users and for redistribution to external organizations. This system works in conjunction with the Transportation Operational Personal Property System (TOPS).

Source of Data: Service finance centers process data.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Latest 4 years
First Developed: 1988
Update Frequency: Monthly
Number of Records: 6,235,289
File Size: 13GB
File Format: Flat File
Media: Tape

Corresponding Printed Source: MSR-Q Progress Report

Sponsoring Organization: Department of Defense, Department of Army, Headquarters, Military Traffic Management Command, Headquarters

Availability: HQMTMC, 5611 Columbia Pike, Falls Church, VA 22041-5050. Data previously provided under TSC OMNI Contract DTRS-57-89-D-0034 by PRC Corporation.

Contact for Additional Information:
William Jackson, Functional
MTMC-IM-D
(703)756-1192; Fax, (703)756-2871

Robert Dyer, Programmer
MTMC-IM-D
(703)756-1192; Fax, (703)756-2871

Betsy Cunningham, Functional
MTMC-OP-CM-O

(703)756-1192; Fax, (703)756-2871

Irene Stegall, Data Manager
MTMC-OP-CM-D
(703)756-1192; Fax, (703)756-2871

MODE: Demographics, Flows, etc., multi-mode	GEOGRAPHY: National, state, metropolitan	USEFULNESS: Specialized, useful	USE WITH MANUAL:

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Fresh Fruit & Vegetable Shipments

CONTENT: For each mode of transport, data are collected from regulatory agencies, shippers, and transportation firms. The data include type of fresh fruit or vegetable, origination, destination, mode, tonnage, and rate ranges. The data are reported for major cities and for states. Exports are also reported.

METHODOLOGY: Several sources are used to report the data. The agencies, federal and state, that inspect and report movements by commodity are the major sources of information. Shippers and transportation firms are also utilized but are not sampled with any statistical procedure. Data are compiled without the ability to cross-check redundant reporting throughout.

AVAILABILITY: Data are published weekly and annually.

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL: Growth factor

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Industry Productivity and Technology Studies Publication

Abstract: This program develops indexes of productivity for individual industries. Statistics on industry labor productivity are published for railroad transportation, bus carriers, intercity trucking, air transportation, and petroleum pipelines. Also, statistics for multifactor productivity are published for railroad transportation.

Source of Data: Synthesis of other statistics from output/input data from various government sources and trade associations.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Current Year
Update Frequency: Annual

Sponsoring Organization: Department of Labor, Bureau of Labor Statistics, Division of Industry Productivity Studies

Availability: DOL/Inquiries and Correspondence Branch, Office of Publications, Bureau of Labor Statistics, Washington, DC 20212; telephone, (202)606-5902

Contact for Additional Information:
Kent Kunze
Chief
DOL/BLS/Division of Productivity Studies
(202)606-5618; Fax, (202)606-5664

MODE: Demographics, Flows, etc.	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Economic Censuses

CONTENT: The censuses present complete, detailed statistics of specific economic sectors. Information covered includes employment by industry, establishments and payroll. The Economic Censuses provide statistics about business establishments once every five years, for the years ending in 2 and 7. The censuses do not cover the Post Office, railroad transportation, and large certified passenger air carriers.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Economic Censuses

CONTENT: The censuses present complete, detailed statistics of specific economic sectors. Information covered includes employment by industry, establishments and payroll. The Economic Censuses provide statistics about business establishments once every five years, for the years ending in 2 and 7. The censuses do not cover the Post Office, railroad transportation, and large certified passenger air carriers.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Occupational Employment in Federal Government

CONTENT: The Office of Personnel Management (OPM) maintains and publishes a statistical series on Federal employment and payrolls with information by agency, type of position and appointment, and characteristics of employees.

MODE: Demographics, flows, etc.	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Occupational Employment Database

CONTENT: Occupational information and company business activities are collected annually by the IRS from tax forms.

METHODOLOGY: The IRS maintains and updates administrative records on companies and individuals. The occupational information comes from two sources: 1) Form 1040, where individuals fill in a box, and 2) Schedule C (for self-employed persons and sole proprietorships) where individuals fill in a code box for the business activity.

Example: For the Schedule C, business activity code 6338 is defined as "Trucking, local and long-distance, including trash collection without dump." According to the IRS, 1991 data shows there were 349,327 forms coded 6338 -- a conservative estimate of self-employed independents.

MODE: Highway, demographics, flows, etc.	GEOGRAPHY: National, state	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Operating Permits

CONTENT: Registration for operating authority varies from state to state. In general, the data collected include carrier's base of operations, headquarters location, some measure of financial viability, proof of insurance, principal commodity hauled, type of equipment to be used, safety record, and carrier personnel.

TYPOLOGY MAPPING: For-hire carriers seeking operating authority within states must file varying kinds of reports with state agencies. The required information can provide detail on fleet size, employment, commodity, etc. Government and private fleets are not required to file reports.

MODE: Demographics, Flows, etc.	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Employee Occupational Database

CONTENT: Occupational employment information is available from a database of employee records.

METHODOLOGY: Occupational counts are based on a search of job titles -- there is a code for each title.

AVAILABILITY: The occupational employment information is not available in publication. A computer program would have to be written to pull the data.

RELATED DATA SOURCES: The Postal Service database is a specialized segment. The Occupational Employment in Federal Government database does not include the Postal Service and Employment and Wages provides total Postal Service employment, but not by occupation.

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: National	USEFULNESS: Useful, specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Transportation Energy Data Book, Edition 14 Publication

Abstract: This publication is a statistical compendium containing over 200 pages of tables and figures. It is designed for use as a desk-top reference. The data book represents an assembly and display of statistics and information that characterize transportation activity, and presents data on other factors that influence transportation energy use.

Source of Data: Collected from various published and unpublished sources.

Attributes:
Geographic Coverage of Data: National, Some International
Time Span of Data Source: 1970-present
First Developed: 1976
Update Frequency: Annual
Last Update: 1994

Sponsoring Organization: Department of Energy, Office of Transportation Technologies

Performing Organization: Oak Ridge National Laboratory

Availability: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 5500A, MS 6366, Oak Ridge, TN 37831-6366; telephone, (615) 574-5957; fax, (615)574-3851

Contact for Additional Information:
Stacy Davis
Data Manager
Oak Ridge National Laboratory
(615)574-5957

MODE: Demographics, Flows, etc., Multi-mode	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: U.S. Trade with Puerto Rico and U.S. Possessions (FT-985) Publication

Abstract: This publication presents data on shipments to and from, and from and to the United States and Puerto Rico and U.S. possessions. The report shows for each territory by commodity, net quantity, value, vessel value, shipping weight, and air value and shipping weight information.

Source of Data: U.S. Customs Service.

Attributes:
Geographic Coverage of Data: U.S., Puerto Rico, American Samoa, Guam, and U.S. Virgin Islands
Time Span of Data Source: 1990-1992
First Developed: 1990
Update Frequency: Annual

Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division

Availability: DOC/Bureau of the Census, Foreign Trade Division, Room 2179-3, Washington, DC 20233; telephone, (301)763-5140. Price, $10.

Contact for Additional Information:
Yvonne Taylor
Data Manager
DOC/Bureau of the Census, Foreign Trade Division
(301)763-5140

Gerline Roundtree
Data Manager
DOC/Bureau of the Census, Foreign Trade Division
(301)763-5140

MODE: Multi-mode	GEOGRAPHY: State	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Coal Distribution Data

Abstract: This database contains information on coal distribution by origin, destination (state, Canada, and overseas), consumer category, and method of transportation. Coal production/purchases, stocks and distribution by secondary methods of transportation are also reported.

Source of Data: Data are collected on Form EIA-6, "Coal Distribution Report" from U.S. companies that owned or purchased coal and distributed in excess of 50,000 tons during a year. These companies include mining companies, wholesale coal dealers, and, retail coal dealers.

Attributes:
Geographic Coverage of Data: Worldwide
Time Span of Data Source: Current Quarter
First Developed: 1977
Update Frequency: Quarterly
Last Update: 09/30
Number of Records: Varies 2,500-8,500
File Size: Varies
File Format: ASCII
Media: Disk; Hardcopy

Significant Features and/or Limitations: Data not company specific.

Corresponding Printed Source: Coal Distribution was discontinued with the fourth quarter publication, 1991. Selected distribution tables have been incorporated into the Quarterly Coal Report and the Coal Industry Annual.

Sponsoring Organization: Department of Energy, Energy Information Administration, Survey Management Division

Availability: Diskette: Survey Management Division, Energy Information Administration, EI-52, Washington, DC 20585; telephone, (202)254-5400. Printed Source: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone, (202)512-1800.

Contact for Additional Information:
Thomas S. Murphy
Survey Manager
DOE/EIA, EI-522
(202)254-5561, Fax, (202)254-8503

MODE: Waterway, rail	GEOGRAPHY: National, other	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Coal Supply and Transportation Model (CSTM) Model; may also be interested in National Coal Model (NCM) from same source

Abstract: This model projects distribution patterns of coal supply and intermodal movements of coal. Both rail and water movements are represented, covering all major U.S. rail lines and barges by collier routes. Rail shipments are differentiated by sector and various adjustments are possible for coal cleaning, use of compliance coal, etc. A complete set of reports is produced that show detailed shipments, production, and transportation routes. Information on steam and metallurgical coal exports is also included.

Source of Data: DOE-developed.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: Current
First Developed: 1991
Media: 9-track tape, 1600/6250 bpi

Significant Features and/or Limitations: Written in Fortran IV. The program requires a VS FORTRAN compiler on an IBM 3084 computer under a MVS/XA operating system.

Sponsoring Organization: Department of Energy, Energy Information Administration

Availability: National Technical Information Service, Springfield, VA; 22161; Telephone: (703)487-4650

Contact for Additional Information: Coal Supply and Transportation Model:
Richard Newcombe
Data Manager
EIA/National Energy Information Center
(202)586-2415

Contact for Additional Information: National Coal Model
Robert Manicke
Data Manager
EIA/National Energy Information Center
(202)586-2157

MODE: Multi-mode	GEOGRAPHY: Other	USEFULNESS: Marginal	USE WITH MANUAL: Establish sampling base for survey

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Hazardous Materials Registration Program Database

Abstract: This system contains information supplied by certain offerors and transporters of hazardous materials on an annual registration statement required by amendments to the Hazardous Materials Transportation Act of 1974, Public Law 93-633. System contains information on the name and principal place of business of each registrant, and on the activities in which the registrant engaged during the previous year that required registration. Fees collected as part of this program fund grants that support emergency response planning and training programs of state and Indian tribal governments.

Source of Data: Hazardous materials offerors and transporters; Form DOT F5800.2.

Attributes:
Geographic Coverage of Data: National
Time Span of Data Source: 1992-Present
First Developed: 1992
Update Frequency: Daily
Number of Records: 75,000
File Size: 2 Files - 10MB, 40MB
File Format: System 1032 (VAX)
Media: 9-track Tape, Disk, Printout

Significant Features and/or Limitations: Only offerors and transporters meeting certain criteria must register.

Sponsoring Organization: Department of Transportation, Research and Special Programs Administration, Office of Hazardous Materials Planning and Analysis

Availability: Government: DOT/RSPA, Office of Hazardous Materials Planning and Analysis, DHM-60, 400 7th Street, SW, Washington, DC 20590; telephone, (202)366-4109; fax, (202)366-7435

Contact for Additional Information:
David W. Donaldson
Program Manager
DOT/RSPA, DHM-60
(202)366-4109

MODE: Highway	GEOGRAPHY: National, state, metropolitan	USEFULNESS: Specialized	USE WITH MANUAL:

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Quarterly Financial & Operating Reports

CONTENT: Balance sheet, income statement, and operating statistics of motor carriers required to file. Revisions are being made to the structure and definition of the accounts to be reported.

TYPOLOGY MAPPING: Only Class I & II for-hire carriers which report to the ICC are represented in this detailed database. Class I carriers are defined as having $10 million or more in annual operating revenue. Class II carriers are defined as having at least $3 million but less than $10 million in annual operating revenue.

AVAILABILITY: Data are available to the public and are compiled by secondary sources. Reports in their raw form are available as recorded by the Interstate Commerce Commission.

MODE: Demographics, Flows, etc., multi-mode	GEOGRAPHY: National, state, county, metropolitan, Detailed sub-areas	USEFULNESS: Very useful	USE WITH MANUAL: Growth factor, base year statistics

SOURCE: DIRECTORY OF TRANSPORTATION DATA SOURCES

TITLE: Census of Population and Housing, 1990: Census Transportation Planning Package (CTPP)

Abstract: The CTPP is a set of cost reimbursable special tabulations, produced for the Department of Transportation in each state. The detailed cross-tabulations have been designed to meet the needs of state and local transportation planners, and are provided for counties, places of 2,500 or more inhabitants and custom-defined traffic analysis zones (TAZs). The CTPP is a continuation of the 1970 and 1980 Urban Transportation Planning Package programs.

Geographic Coverage: The CTPP statewide tabulations will provide data for persons who live or work in the state. Data will be tabulated for the state, each county, county subdivision (only available for 9 states for workplace data), and place of 2,500 or more persons. Totals for state parts of MSAs, CMSAs, and PMSAs will also be provided, as will urbanized area totals (place of residence data only). The statewide tabulations will consist of six parts: Part A, tabulations by place of residence; Part B, tabulations by place of work; Part C tabulations by place of residence by place of work; Part D, tabulations by place of residence for areas of 75,000 or more persons; Part E, tabulations by place of work for areas of 75,000 or more persons; Part F, tabulations of place of residence by place of work for areas of 75,000 or more persons. Urban tabulations produced for the metropolitan planning organizations (MPO) in each area where the Census TIGER/Line files contain address ranges. Data will be tabulated for either standard census geography like census tracts of block groups, or for locally-defined, custom geographic areas like traffic analysis zones. Subtotals for study area, CTPP Region, MSA, CMSA, PMSA, and urbanized area (place of residence data only) will also be provided. The urban tabulation will consist or seven parts: Part 1, tabulations by small area of residence; Part 2 tabulations by small area of work; Part 3, tabulations of small area of residence by small area of work; Part 4, tabulations of large area of residence; Part 6 tabulations of super district of residence by super district of work for regions with 1 million of more persons; Part 7, tabulations by census tract of work; and Part 8, tabulations of small area of residence by small area of work for regions with one million or more persons. There is no Part 5 in the urban element 1990 CTPP.

Source of Data: 1990 Census of Population and Housing. Approximately 17.7 million housing units were sampled nationwide.

Attributes:
Geographic Coverage of Data: National. (See Abstract for more detail.)
Time Span of Data Source: 1990
Update Frequency: Every Ten Years
File Format: ASCII, EBCDIC
Media: 9-track Tape, 6250/1600 bpi, Tape Cartridge, IBM 3480 Compatible

Significant Features and/or Limitations: 1990 Census data are based on a sample, and subject to sampling and nonsampling errors.

Sponsoring Organization: Department of Commerce, Bureau of the Census, Journey-to-Work and Migration Statistics Branch

Availability: Summer 1993, continuing into 1994. Contact the state transportation agency or local metropolitan planning organization.

Contact for Additional Information:
Ernest Wilson (Hotline)
Subject-Matter Specialists
DOC/Bureau of the Census, Journey-to-Work and Migration Statistics Branch
(301)763-2201

Phillip A. Salopek
Subject-Matter Specialists
DOC/Bureau of the Census, Journey-to-Work and Migration Statistics Branch
(301)763-3850

SUMMARY OF ADDITIONAL SOURCES WHICH MAY BE OF INTEREST:

U.S. Waterborne Exports and General Imports (Source-U.S. Customs Service and Canadian Customs; Sponsoring Organization: Department of Commerce, Bureau of the Census, Foreign Trade Division); Great Lakes State Overseas Trade Report (Source-Journal of Commerce P.I.E.R.S. subscription; bills of lading and vessel manifests; Sponsoring Organization-Department of Transportation, Saint Lawrence Seaway Development Corporation); St. Lawrence Seaway Annual Traffic Report (Source- Vessel Transit Declarations filed by vessel representatives using Seaway lock facilities; Sponsoring Organization -Department of Transportation, Saint Lawrence Seaway Development Corporation, St. Lawrence Seaway Authority (Canadian))

MODE: Highway	GEOGRAPHY: National, state, metropolitan	USEFULNESS: Marginal	USE WITH MANUAL:

SOURCE: FOR-HIRE TRUCKING INDUSTRY SIZE STUDY

TITLE: Quarterly & Annual Financial Reports

CONTENT: Balance sheet and income statements with accompanying descriptions of publicly-traded carrier operations as related to financial performance.

TYPOLOGY MAPPING: Only carriers whose equity shares are traded publicly will be required to file financial reports with the SEC. This includes a few for-hire carriers, and a few private fleets whose trucking subsidiaries are reported as distinct operating divisions.

Appendix L

Commercial Data Sources

Appendix L

Commercial Data Sources

Adapted from *For-Hire Trucking Industry Size Study*, *TruckSource* and *Directory of Transportation Data Sources.* The databases, in alphabetical order by producer, are a sampling of those available. The individual sources can be contacted for additional information including available standard and special tabulations and prices. In addition, the general references cited in the introductory chapter can be consulted for additional data sources.

The key at the top of each page of this appendix categorizes the data in terms of perceived usefulness to the quick response freight modeling process. This is not meant to imply that data items categorized as "marginal" or "specialized" do not have very useful applications in other areas.

MODE: Air	GEOGRAPHY: National, state, facility	USEFULNESS: Specialized	USE WITH MANUAL:

Producer: Airports Council International - North America
1775 K Street, NW, Suite 500
Washington, D.C. 20006
Phone: (202) 293-8500
Fax: (202) 331-1362
Database: Worldwide Airport Traffic Report
Description: *The commodity measures in this database distinguish between express freight and mail, and provide an indication of the traffic split between Package and LTL carriers and Truckload carriers. The movements reflected in the database can indicate traffic that is competitive with trucks (long-haul) and also complementary (pick-up and delivery for air freight and mail). Unaffected types of operations are Personnel, Non-Goods, and Household Goods.*

MODE: Highway	GEOGRAPHY: National, state, metropolitan, detailed	USEFULNESS: Useful	USE WITH MANUAL: Base year statistics, network related, VMT related

Producer: American Trucking Associations
Trucking Information Services
2200 Mill Road
Alexandria, VA 22314
Phone: (703) 838-1880 (Information Center) or (800) ATA-LINE (Customer Service)

Fax: (703) 838-1792
Database: Commodity Flow Database - LTL
Description: *Shipment volume, weight, revenue, origination, and destination for participating carriers. Data are compiled and reported monthly. Reports are generated on 3-digit zip-code origination/destination basis. Data include exports, Canada by province, and Mexico as separate origination/destination points.*

MODE: Rail	GEOGRAPHY: National, state, facility	USEFULNESS: Specialized	USE WITH MANUAL:

Producer: Association of American Railroads
50 F Street, NW
Washington, D.C. 20001
Phone: (202) 639-2555
Fax: (202) 639-2558
Database: Freight Commodity Statistics
Description: *Rail freight data reported annually, including commodity detail, volume, origination railroad and terminating railroad. Data are collected from Class I railroads. Commodity classification is at 5-digit STCC levels, where available.*

MODE: Rail	GEOGRAPHY: National, state, facility	USEFULNESS: Specialized	USE WITH MANUAL:

Database: Weekly Carloadings
Description: *Originations and terminations by reporting railroads of carloads. Data are reported by name of railroad with originations, terminations, and total carloads indicated. Commodity classification is at 2-digit STCC level. Intermodal data are reported as carloadings for TOFC and COFC separately.*

MODE: Highway	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

Database: North American Trucking Survey
Description: Trip information for current and prior load, type of trip contract, annual miles, and other related operating characteristics for truckload motor carriers.

MODE: Air	GEOGRAPHY: National, state	USEFULNESS: Specialized	USE WITH MANUAL:

Producer: The Colography Group
1000 Johnson Ferry Road, Suite E 150
Marietta, GA 30068
Phone: (770) 565-0464
Fax: (770) 977-7383
Database: Air Freight Origin Traffic
Description: *Air traffic shipments, express and freight, based upon an establishments survey of firms generating air traffic shipments. The data reported on a geographic basis by industry type at the 4-digit SIC level. Data are also reported by domestic and export as aggregate destinations. The survey results of shippers that comprise this database include small shipments (under 3,000 lbs.) and express mail. The results are "outbound" only, so no lane detail is generated.*

MODE: Highway	GEOGRAPHY: National, state, metropolitan	USEFULNESS: Useful	USE WITH MANUAL:

Producer: Dun & Bradstreet Information Services
3 Sylvan Way
Parsippany, NJ 07054
Phone: (201) 605-6431 or (800) 624-5669 * 6431
Fax: (201) 605-6980
Database: Trinc Truck Fleet Marketing Database
Description: *Over 4 million companies who own trucks or companies who have trucking requirements. Includes private and for-hire fleets of one or more trucks. Listing includes name, address, phone number, SIC code, number of employees, sales volume, line of business.*

MODE: Waterway	GEOGRAPHY: National, state, Metropolitan	USEFULNESS: Specialized, useful	USE WITH MANUAL:

Producer: Knight-Ridder Publications, Journal of Commerce, Inc.
2 World Trade Center, Suite 2750
New York, NY 10048
Phone: (212) 837-7050 or 800-952-3839
Database: Port Import/Export Reporting Service
Description: *Shipment weight and value for waterborne traffic with origination/destination information as available on filed manifest with U.S. Customs. Commodity coding is based upon 6-digit harmonized codes, manifest description, or 7-digit code created by Journal of Commerce personnel. Origination and destination data for the U.S. is the city of record. Foreign data are either port or city of destination, as reported on the manifest.*

MODE: Multi-mode	GEOGRAPHY: National, other	USEFULNESS: Specialized, useful	USE WITH MANUAL:

Producer: McGraw-Hill Inc., Data Resources, Inc.
1221 Avenue of the Americas
New York, NY 10020
Phone: (212) 512-2000 or (800) 822-4726
Database: Freight Transportation & Logistics Service
Description: *Volume of shipments by weight for all modes of transportation. Origination/destination data are available at the BEA level. Commodity is reported at the 2-digit STCC level. Data also segment trucking into for-hire truckload, for-hire less-than-truckload, and private.*

MODE: Multi-mode	GEOGRAPHY: National, other	USEFULNESS: Specialized, useful	USE WITH MANUAL:

Producer: Reebie Associates, Inc.
P.O. Box 1436
Greenwich, CT 06836
Phone: (203) 661-8661
Fax: (203) 661-8886

Database: Transearch

Description: *Volume of shipments by weight for all modes of transportation, excluding pipeline. Origination/destination data are available at the BEA level. Commodity is reported at the 4-digit STCC level. Data also segment trucking into for-hire truckload, for-hire less-than-truckload, and private categories.*

MODE: Highway	GEOGRAPHY: National	USEFULNESS: Specialized	USE WITH MANUAL:

Source: Transmode, Inc.
3400 International Drive, NW
Washington, DC 20008
Phone: (202) 363-2954
Fax: (202) 363-3091

Database: Trucking Industry Structure Database

Content: *Uses TIUS, the National Motor Truckload Database (owned by AAR) and Financial and Operating Statistics published by the American Trucking Associations to produce cross section reports on industry movements by type of carrier, type of equipment and length of haul. Availability unknown.*

MODE: Highway	GEOGRAPHY: National, state, metropolitan	USEFULNESS: Useful	USE WITH MANUAL:

Producer: Transportation Technical Services (TTS)
500 Lafayette Blvd., Suite 220
Fredericksburg, VA 22401
Phone: (703) 899-9872 or (800) 666-4TTS
Fax: (703) 899-5768

Database: National Motor Carrier Directory Database

Description: *Information on over 27,000 for-hire trucking companies in the U.S. and Canada. Includes: Chief executive officer, headquarters address, phone number, revenue, number of trucks, tractors and trailers (owned and leased), primary commodity transported, TL or LTL.*

MODE: Highway	GEOGRAPHY: National, state, metropolitan	USEFULNESS: Useful	USE WITH MANUAL:

Producer: WEFA (Wharton Economic Forecasting)
401 City Line Ave., Suite 300
Balacynwyd, PA 19004
Phone: (610)667-6000

Database: Private Fleet Directory Database

Description: *Deals exclusively with private carriers (WalMart, Safeway, Ace Hardware, etc.). Information on over 19,000 of the largest private fleets in the U.S. Includes: Name and title of fleet manager, company and address, phone number, revenue, number of trucks, tractors and trailers.*

Appendix M

Recent Freight and Truck Surveys

Appendix M

Recent Freight and Truck Surveys

1. Phoenix, AZ- Maricopa Association of Governments (Tammy Flaitz, 602-506-4117) 1991 CSI study- comprehensive, well publicized

2. Phoenix, AZ, 1991, Combined Telephone Mailout-Mailback

3. Yuma, AZ, Yuma Metropolitan Planning Organization (Robert Vaughan, 520-783-8911): 1990 origin-destination survey, including 7 external and 2 internal stations, one exclusively for trucks. The data presented does not distinguish between truck and automobile flows for general flows.

4. Almeda County, CA, 1991, Combined Telephone Mailout-Mailback and Roadside Interview

5. Ontario, CN, 1988, Roadside Interview

6. Tampa, FL- Hillsborough County MPO (Joe Zambito, 813-272-5940): 1994 truck route study, has extensive discussion and comparison of various truck classification schemes.

7. Chicago, IL, 1986, Mailout-Mailback

8. Lafayette, IN, Tippecanoe County Area Plan Commission (James Hawley, 317-423-9242): 1986, Assessment of the goods distribution in the Greater Lafayette Area; part of TSM; included survey identifying concerns and most heavily traveled roads.

9. DesMoines, IA, DesMoines Area MPO (Kevin Gilchrist, 515-237-1316): 1991 I-235 Transportation Alternatives Study fax; and memo with 1984 trip production and attraction model equations and distribution rates; fax concentrating on identification of through-truck movements, information by time of day and day of week.

10. Louisville, KY, KIPDA (Harold Tull, 502-266-6084): February, 1995, External O/D survey, including weigh station truck surveys; includes some truck trip tables.

11. Minneapolis, St.Paul, MN (Jim Barton, 612-229-2735): January and February, 1995, studies on need for Intermodal Railroad Terminal Facilities in the Twin Cities Metropolitan Area, including assessment and demand analysis of future needs.

12. Kansas City, MO and KS, Mid-America Regional Council, (Bill Derrick, 816-474-4240; and Mark Kenneally of JBM Engineers- consultants- 816-561-9800) 1994-1995 study; six

working papers available to date including modal facilities inventory, freight flows, industry survey, regional freight opportunities, and freight infrastructure recommendations.

13. & N.Y, 1991, Roadside Interview

14. & N.Y., 1992-1994, Roadside Interview

15. Albany, NY, Capital District Transportation Committee (Kristina Younger, 518-458-2161): Internal CDTC memos, January and May 1995, focusing on time of day truck travel and performance measures relating to freight movement.

16. Triad Regional Study- Greensboro, High Point and Winston-Salem, NC (Michael Bruff, P.E., NC DOT, and Bill Martin, Barton-Aschman, 919- 677-0590) - combined phone/ mail-out, mail-back commercial vehicle survey with travel diaries/ manifests; pre-test conducted December, 1994, with the survey completed in early spring, 1994. Includes cars in commercial vehicles, includes trip activity and distribution of vehicles by industrial classification. Initial results available.

17. Lancaster and York, PA, Lancaster and York County Planning Commissions (Jephrey Rebert, 717-771-9870): August 1994, excerpts from PA 372 O/D survey for truck survey including trip tables, trip purposes, and internal versus external destinations; based on 179 surveys.

18. Berks County, PA, Berks County Planning Commission (Deborah Matherly, COMSIS Corporation, 301-588-0800)- October, 1994, cordon survey of truck O/D, 1000 plus surveys.

19. Memphis, TN, Memphis MPO (Abdul Razcik/ Clark Odor, 901-576-6768): March 1995, Presidents Island Industry Intermodal Survey; one page survey, distinguishing between rail, barge and truck trailer loads with minor commodity information (such as hazardous materials) and identification of issues for shippers.

20. Amarillo, TX, Amarillo MPO ( ), 1990 urban area truck travel survey, includes trip lengths.

21. El Paso, TX, 1994, Telephone Interview

22. Houston-Galveston, 1994, Combined Telephone Mailout-Mailback

23. Seattle, WA- Puget Sound Regional Council (Peter Beaulieu, 206-464-7537): 1994 and 1995, "Regional Freight Mobility Conference Proceedings"; "Planning for Freight Movements in the Puget Sound Region"; "Analysis of Freight Movements in the Puget Sound Region"- commodity and survey based freight study including rail, water and truck movements. Describes various databases used in the model, such as TIUS, Dun and Bradstreet Market Locator, and County Business Patterns.

24. Studies in process or planned for the near future include the following:

25. Savannah, GA, Chatham Co-Savannah Metropolitan Planning Commission, (Bill Herrington, 912-236-9523 and Alan Meyers - consultant- 703-758-8800), first phase of data collection to be complete in approximately 2 months; full study due for completion in approximately one year.

26. Evansville, IL, Evansville Urban Transportation Study, (Rose Zigenfus, 812-426-5230), are completing a study of intermodal activity centers and freight movements, documents not yet available.

27. Greensboro, NC- (Laura Rice, NCDOT, 919-733-4705), commercial vehicle survey underway.

28. Southwestern PA Regional Planning Commission, (Lucy Klain, 412-391-5590)- regional rail freight study to begin July 1.

29. Houston-Galveston Area Council (Jerry Bobo, 713-627-3200), commercial vehicle survey and multimodal facilities inventory study in progress, to be completed by September with final analysis by December 1995.

30. Austin, TX, Austin Transportation Study (Lee Hoy, 512-499-6423), study completed but stated to be very general look at freight movements.