COMMODITY MOVEMENTS ON THE TEXAS HIGHWAY SYSTEM: DATA COLLECTION AND SURVEY RESULTS

FINAL REPORT

by

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16. Abstract

This report presents the survey procedures used and data collected in the development of commodity flow statistics for movements over Texas Highways. Response rates, sampling procedures, questionnaire design and the types of data provided by the responding motor carrier firms and truck operators are presented and discussed.

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
	AREA			
in^2	square inches	645.2	centimetres squared	cm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
	MASS (weight)			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
	VOLUME			
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

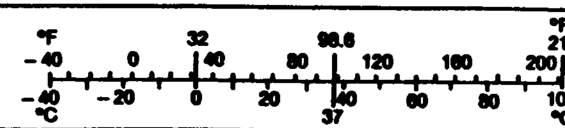
* SI is the symbol for the International System of Measurements

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
	AREA			
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
	MASS (weight)			
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
	VOLUME			
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

IMPLEMENTATION STATEMENT

The procedures presented in this report detail those used in the collection of commodity flow data from motor carriers firms and motor truck operators and a summary of the data collected. As shown in this report commodity flow data can be collected through sampling procedures. The design of the survey questionnaire is also discussed. It is recommended that these or similar techniques be employed in future efforts to update the information collected. Information developed in this investigation is not currently available from federal, state or private sources on as broad a base as is presented in this and companion documents.

DISCLAIMER

The contents of this report reflects the views of the authors who are responsible for the accuracy of the data and the facts presented. The contents do not necessarily reflect the official view or policies of the Texas Department of Transportation. This report does not constitute a standard, specification or regulation.

ACKNOWLEDGEMENT

The authors express their appreciation to the Texas Department of Transportation, the study sponsor. Mr. John Barker, Planning and Research Division (D-10). TxDOT was the Technical Contact for the study and provided valuable assistance and encouragement.

The cooperation of the motor carrier industry was a vital factor in the conduct of this work. Without the assistance of numerous truck firms, both in the for-hire and private sector, and their drivers, this effort would not have been successful. These firms and individual took time to provide detailed commodity and route data regarding the movements of the sample vehicles on the sample days. Their willingness to do this was no small feat, since information was requested to be provided on the vehicle each time the cargo statue changed.

Those individuals who took the time to complete the questionnaire recognize the important contribution the trucking industry makes to the economic well being of Texas and their role in a total transportation network. They also see the need for commodity movement data in order for TxDOT to develop highway facility plans to meet the various commodity transportation requirements. Since this was the first time flow data were collected on a statewide and broad commodity basis those firms and individuals which participated deserve the thanks of the authors.

ABSTRACT

This report presents the survey procedures used and data collected in the data collection phase in support of the development of commodity flow statistics for movements over Texas highways. Sampling procedures, response rates questionnaire design and development and the types of data provided by the responding motor carrier firms are summarized and discussed.

EXECUTIVE SUMMARY

Data collected in support of the commodity of flow study are presented in this report. These data are summarized in several categories. Only unexpanded data summaries are presented. Expanded and more detailed statistical data and analysis are found in Research Report 1104-3F.

The report is composed of five sections and three appendices. Section 1 is the introduction and provides background in the study development. A discussion and review of available data sources is presented in Section 2. Section 3 details the development and desire of the survey instrument used to collect commodity movement information from motor carrier firms and individual operators. The result of the data collection effort is discussed in Section 4. Section 5 contains a summary of the data collected. In addition, problems associated with the data collection effort are discussed.

The data collected and summarized in this report was used in the development of detailed commodity flow statistics. The Research Report 1104-3F contains the results of the study and presents detailed information on a regional, commodity and highway type basis for the entire state. The summary data contained in this report are intended to illustrate the extent of data available for analysis purposes.

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COMMODITY FLOW STUDY

1.0 Introduction

The growth of the Texas economy coupled with the population expansion in major metropolitan areas has put severe strains on highway systems planning. Increasing truck traffic and commodity movements on Texas highways has created a pressing need to design and implement new strategies for dealing with the actual system demands, and to develop highway system plans that will satisfy future highway system freight transportation needs. One of the purposes of this study is to identify the major commodity flow routes in order to develop a reasonable plan for future public investment in transportation.

Previous studies of highway freight transportation suggest that the appropriate source for data on commodity flow is the carriers. Shippers and receivers are not likely to have route-specific origin-destination data on commodity flows. However, since carriers are directly involved in hauling goods on the roads, they generally keep or have access to this type of information. The competitive aspects of the "for-hire" motor carriers is such that detailed commodity flow statistics are considered proprietary and not generally available to the public[1]. In addition, a large percentage of the motor trucks on the highways are engaged in private carriage and data on their activities are likewise unavailable. Heavy-duty trucks are the primary consideration in this study since they are the most likely to transport commodities.

To study the entire carrier-truck population (265,154 trucks) would be extremely expensive and time-consuming. Therefore, a sampling approach was used to keep expenses and data processing effort to a minimum. Then after sampling, inferences about the population can be derived from the sample with a determined margin of error. Thus, a

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[1] "For-hire" motor truck provide third party transport service (i.e. from shippers to receivers). Firms transporting their own products are engaged in private carriage.

statistical sampling approach has been used for estimating the pattern distributions of commodity flows in Texas for this study. Mailing questionnaires supported with an efficient follow-up procedure was found to be an economical and appropriate method for collecting the data required for this study from carriers.

1.1 Previous Studies of Commodity Flow

Lieder (1969, 1970) conducted a study of a mail survey designed to test procedures for collecting truck commodity data from a sample of truck registrants. His first study (1969), based on Kansas data, revealed that it is necessary to mail the questionnaires more than once to obtain a satisfactory response rate. His second study was addressed to population carriers of two states, Missouri and Wisconsin. He reports obtaining an 80% positive rate because of a well-designed follow-up procedure. The sample size used in the Lieder study was 819 for each state. Two strata were defined: (1) the first stratum comprised trucks which had licenses to carry more than 26,000 lb, and (2) the second stratum was comprised of the carriers who have licenses to carry less than 26,000 lb. A follow-up procedure was conducted by phone for one third of the sample, by mail for another third, and not used with the remaining one third. Three weeks after the first mailing was defined as the cut-off day for expecting a reply, and most of the positive responses were obtained during the first two weeks. Samples of the questionnaires and letters mailed to carriers are available, (Highway Research Board, when ordering refer to XS-35, HRB Special Report 120).

2.0 DATA SOURCES

2.1 Introduction

This section addresses the primary and secondary data sources considered in obtaining commodity flow information. In selecting the final source for commodity flow information, the study staffs' primary objective was to ensure broad statewide and commodity group coverage.

2.2 Primary Data Sources

There are three primary sources from which commodity flow information can be collected:

1) shippers 2) receivers 3) carriers

In formulating the data collection tasks, all of these sources were considered and evaluated. From the perspective of the study it was recognized that the success of a data collection effort from any of these sources was dependent on the extent of cooperation received. Since the firms in the three groups considered are not compelled to provide the requested information it is necessary to rely on voluntary response. All of these sources are relatively large groups and the level of expected cooperation tends to vary inversely with the size of the population.

Most previous work in this area has tended to favor carriers as the primary data source. However, there are over of 260,000 trucks registered in Texas. While these numbers represent truck units and not firms, it is obvious that there is a very large number of private and "for-hire" truck operations. As large as the carrier group is, the number of shippers, receivers, warehouses, etc., are still larger. Truck firms both for-hire and private provide for the highway movement of commodities, and are in a position to provide the information necessary to develop a reliable database. However, many carriers consider data regarding commodity movements as proprietary and chose not to participate in the data collection effort. Also, with such a large and diverse carrier group it is impossible to develop a census of commodity movements.[2]

Another question that is relevant pertains to the method that would be used to collect the data. There are three basic ways to collect the raw data. First, trucks can be stopped at selected locations within specific corridors and drivers interviewed. In order to do this, it would be necessary to have the cooperation of the TxDOT and the DPS, since the physical stopping of vehicles for this purpose would be in direct conflict with the policy of uninhibited traffic movement. Also, truck drivers may not be willing to cooperate or may not be in a position to respond to the questions. As well, it is doubtful that data could be collected for a 24-hour period or at more than a few locations within the state.

The second method is to conduct personal interviews at selected truck terminal locations and collect the necessary information. This method, if agreeable to the selected firms would probably result in high quality data. Also, more data elements could be collected and the number of observations (truck trips) could increase. However, some firms might seriously object to someone going through their files for data and it might be necessary for the firm to provide someone to assist during this process. This method would result in high total costs but low data unit costs. Travel would be extensive and require additional personnel. Locating and surveying small firms and owner-operators would also pose a significant problem.

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[2] Although the U.S. Bureau of the Census collects data and publishes a Census of Transportation it is not commodity/route specific and lacks the detail required for freight transportation planning.

The third data collection method is to ask the sample firms to provide the data by a mail questionnaire procedure. Detailed instructions can be provided, only a limited number of questions would be asked, and only few observations would be requested. While a low response rate should be expected, the quality of the data provided is generally high. This is perhaps the least expensive procedure for data collection and is therefore the most common method used in previous projects of this type and scope.

An NCHRP report, *Freight Data Requirements for Statewide Transportation System Planning*, indicates that obtaining traffic flow data from shippers or receivers presents more problems than using carriers as the data source. Presented below are some of the advantages and disadvantages the report cited for both shippers and carriers.

State Conducted Shipper Surveys. Under this option, states would conduct their own shipper survey in the analogous fashion to the *Census of Transportation*.

Advantages:

- Selection of shippers or consignees for interview purposes can be directly tailored to the nature of the problem at hand and the information desired.
- Likewise, the type of information sought can be either general or very specialized.
- Most surveys do not directly involve the carriers. Therefore, this type of survey is useful in situations where carriers might suspect that the information provided might be used against their perceived interests.
- These surveys can be directly focused on the transport decision-making process. This allows more detailed data collection addressing issues as specific as deemed necessary.

Disadvantages:

- Surveys are costly to perform and difficult to administer.
- States may not be in a position to develop the universe of shippers.
- It is difficult, if not impossible, to capture overhead traffic, (states can only survey shipments originating or terminating within the state).
- It is far more difficult to ensure quality and control in the design and execution of the survey than with a repetitive effort performed on a national basis.
- Surveys now depend completely on voluntary cooperation from shippers.
- Because each state would individually approach shippers for the data it desires, little or no standardization among states would result. Each survey would tend to be unique, designated to serve a narrow, specific purpose and would inevitably have its own sample design, formats, stratifications, and summarizations. Therefore, the data obtained would be difficult to incorporate into a "national" data set. Hence, it would not serve national purposes simultaneously with state purposes.

State-conducted shipper surveys have proven to be very useful and necessary for certain types of total freight planning. Using this approach, it is possible to assemble specialized supplemental information from a subset of shippers. Since this group is not usually subject to direct administrative oversight by state or national agencies, this technique can be used to fill present traffic flow data gaps.

States Obtained Traffic Flow Data from Carriers. Under this option, states would directly request from the carriers operating within their borders the traffic flow data deemed necessary for freight planning purposes. This arrangement has a number of potential advantages and disadvantages.

Advantages:

- Helps establish working relationships by bringing carriers into the freight planning process.
- Bypasses existing traffic flow data systems and offers the possibility of obtaining data with a greater coverage (higher sampling rate, or even a census), greater depth (especially in terms of origination and destination coding), and provides the most current data.
- Leaves such problems as confidentiality, disclosure, etc., to be worked out mutually.
- Permits state DOT reimbursement for the computer processing or clerical labor involved in extracting the desired information, and/or the use of state DOT personnel in sampling records for the same.
- This type is especially useful when only a subset of data is required, such as for a particular corridor.
- Often reduces or eliminates the problem of obtaining more general, comprehensive agreements at higher levels.

Disadvantages:

- Because each state would individually approach the carriers for the pertinent data, no standardization would result without some type of national administration. Also, since the data obtained by the states would not be part of a national data set, it would not serve national and state purposes simultaneously. Each request would tend to be unique, designed to serve a narrow specific purpose, and would inevitably have its own sample design, formats, stratifications, and summarizations. In most cases, this would mean incompatibility with future data needs unless extensive and costly long range data needs forecasting is performed.

- For the larger carriers, there is a real possibility of a multiplicity of requests, these are costly and time-consuming for the carrier to handle, assuming that the carrier is agreeable to releasing the data in the first place.
- Because state DOT's must operate in public view, there is a real public concern of politicians using the data to exploit their own purposes at the carrier's expense. Consequently carriers often are wary of state promises or ability to maintain data confidentiality.
- There is no clear feeling as to any benefits that may accrue to carriers as a result of sharing data; government has historically been considered more as a foe than a friend (attitude is formed more by regulatory agencies than by executive agencies).
- Data requests depend largely on voluntary cooperation from carriers, although in some cases it is possible to mandate compliance through state regulatory agency directives to regulated carriers.

Although the disadvantages of carrier based surveys are more numerous than the advantages, the advantages may outweigh the disadvantages. For all cases concerning carrier based traffic data flows, obtaining data directly from carriers is easier when:

(1) good rapport has been established between state DOT and the carrier personnel.

(2) the information requested has been provided previously and is asked in a recurrent format.

(3) cooperative cost- or staff- sharing arrangements (where collection work at the carrier is done by DOT personnel), minimize the burden of the request on the carriers. Conceivably, this technique would be useful for carriers that are not large enough to employ electronic data processing for control and administration purposes.

The several advantages and disadvantages mentioned do not all necessarily impact the current effort. For example, this project is not part of a national effort. Also, data necessary to analyze the modal selection process will not be collected. At some future time it might be decided to collect data on transit time, rates, loss and damage, and similar attributes which influence modal selection by shippers.

2.3 Secondary Data Sources

Several secondary data sources were examined during the initial study phase. These included:

- *Truck Inventory and Use Survey* (TIUS), Bureau of the Census,
- *Commodity Transportation Survey* (CTS), Bureau of the Census,
- Firms providing freight databases compiled from other secondary sources, and
- Availability of commodity specific information.

After evaluation of these sources it was concluded that none provided the level of detailed information on commodities and geographic coverage considered essential for the study. The most current *Commodity Transportation Survey* (CTS) available is for 1977, but this report does not include certain commodity groupings essential for this study.

The TIUS is primarily a survey of trucks which collects information on their characteristic configuration, basic use, ownership, etc. While data is collected relating to the major commodities for the sample truck transports, the TIUS does not describe commodity flows.

The CTS is developed by a survey of manufacturing firms and a sample of freight bills or other similar shipping documents. Public use tapes are available for the CTS, however, they contain only state-to-state and production area (large SMSA or clusters of

SMSA's) information. For example, the CTS does not have data at the county level, which precludes any location specific grouping alternative. Also, information regarding routing and/or highway type is not available from this secondary data source.

A review of the information available from firms providing freight databases indicated that while the data integrity is very good on a nationwide basis, the firms databases generally do not contain sufficient detailed information at the state level for this study. This results because the information provided by these firms is developed from existing secondary databases. Also, accuracy of information is a critical consideration when using freight databases unless collection procedures are carefully analyzed.

2.4 Data Elements

In considering and evaluating what type of information to request from the sample motor carriers, questionnaires used in previous work of this nature were reviewed. Specifically examined were the questionnaires used in the TIUS, CTS, *Nationwide Truck Commodity Flow Study*, and *Statewide Commodity Goods Movement Study* conducted by TxDOT in 1975.

The objective of the *Nationwide Commodity Flow Study* conducted by the FHWA most closely paralleled the current effort in that motor trucks were sampled in order to determine their activity during the sample period. The questionnaire used by the TxDOT in the *Statewide Commodity Goods Movement Study* was sent to manufacturing firms. It asked for information regarding the percentage of shipments and inbound raw materials by make. The TIUS and CTS discussed in the previous section were also reviewed. The TIUS requests data regarding the vehicle and was sent to carriers. The CTS is sent to manufacturing firms and requests information regarding shipments.

In evaluating the anticipated data elements necessary for the commodity flow study the information needs were categorized as necessary, nice to have, and not necessary. Information in these three categories include:

Necessary Data:

Origin/destination	Route information	Commodity weight/volume
Loaded/empty status	Commodity description/indicator	

Nice to Have Data:

Truck type	Ownership	Gross vehicle weight
Number of axles	Miles of travel: Intercity & Intracity	

Information Not Necessary:

Customers	Rates/charges

The above classifications are based upon the requirements of the study, the willingness of carriers to provide the data, and the availability of data from other sources. Based on the results previously recorded and other surveys it was assumed that questionnaires requesting an excess of information and displaying extensive detail would result in low response rates and incomplete or incorrect information. For reasons previously discussed it was assumed that request for proprietary information would incur strong resistance from carriers.

Based on the results of previous surveys and the research completed and discussed above, the final questionnaire format was decided and structured. A copy of the final questionnaire, found in Appendix A, contains a limited number of questions from the necessary and nice to know categories. These categories include:

- Truck type indicator for sample vehicle
- In service indicator for sample day

- Intracity use section providing:
  - city
  - principal commodity
  - miles of travel
- Intercity use section providing:
  - origin
  - destination
  - commodity description
  - commodity weight
  - route(s) identification and mileage

The information regarding intercity use was requested for each time the status of the vehicle changed. A change is made whenever there is an addition, deletion, or exchange in commodity or weight during the sample period. For example, if during the sample day the vehicle made several stops to pick-up or off-load cargo, information regarding the change was requested. Also, information was requested if the vehicle moved from point "A" to point "B" loaded, and then returned to "A" or continued on to point "C". Each change in status is defined as a "trip" for purposes of the study.

For each trip the respondent was asked to record origin, destination, the two digit *Standard Transportation Commodity Code* (STCC) identifier, cargo weight (in tons) and specific routes traveled between a change in status, and mileage on each route.

2.5 Vehicle Registration Tapes

Information regarding motor trucks registered or apportioned in Texas is maintained by the Division of Motor Vehicles, TxDOT. Since the focus of this study is on commodity movements over the Texas highway system, it was appropriate to direct the questionnaires to the registrants recorded on these tapes. For this reason, the records provided on these tapes were chosen as the study population from which to draw the sample.

The vehicle registration data tapes provided by TxDOT contained information on trucks with a registered gross vehicle weight (GVW) of 2,600 pounds and greater. The vehicle registration classes on the tape consisted of:[3]

1) truck (02).
2) farm truck (03).
3) combination (truck/tractor) (04).
4) farm truck/tractor (05).
5) apportioned (49).

[3] The numbers in parentheses are the registration classification codes used on the registration. See Appendix B for tape information and extraction information.

3.0 DESIGN OF THE SURVEY INSTRUMENT

3.1 Design of the Survey Instrument

As discussed in the previous section, the initial task in survey preparation was the identification of the data elements to be requested. Secondly, the questionnaire was designed to accurately extract the data from the selected source. For the purpose of this study, and to assure higher response rates, it is considered necessary to keep the survey short, and the questions simple and concise. At the same time it was necessary to explain the purpose of the survey, provide detailed instructions, furnish necessary examples, and include a list of commodity codes to be used for proper completion of the survey by the respondents.

Since the survey form was designed and intended to be completed by the driver of the vehicle during the sampling period, areas of possible confusion or misinterpretation needed to be eliminated. For this reason a pilot survey was used to identify possible areas of ambiguity in the instructions and questions[4]. During each of the four survey periods, numerous phone calls were received by members of the study team relating to clarification and interpretation of the surveys. The majority of the callers requested information relating to clarification of commodity codes and commodity code definition.

The final questionnaire design, as found in the Appendix A, comprised three sections. Section A was designed to be completed by everyone receiving a questionnaire, section B was to be completed only if the sample vehicle was used for intracity travel but was not engaged in intercity travel at any time during the sample period, and section C was to be completed if the vehicle was used for intercity travel at any time during the sample day.

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[4] A detailed discussion concerning the pilot survey and the results of the pilot survey can be found in Section 4.2.

3.2 The Survey Instrument

The three sections of the survey are detailed as follows:

1) Questionnaire - Section A
2) Questionnaire - Section B
3) Questionnaire - Section C

Questionnaire - Section A:

At the beginning of the questionnaire, the recipient is asked if the sample vehicle (identified by vehicle license number and vehicle identification number (VIN)), is currently in their fleet. If the vehicle was no longer in fleet, the respondent is asked to mark the appropriate box and return the questionnaire. If the vehicle is in fleet, additional questions in Section A ask for information regarding the configuration of the sample vehicle and if the vehicle was in use during the sample day. The additional information, relating to the vehicle configuration, provides possible classification categories and information on the truck fleet of the state. If the vehicle was not in use, the respondent is asked to disregard Section B and C, and return the questionnaire. If the vehicle is in fleet, and if the vehicle was in use during the survey period, the survey asks the respondent to continue completing either Section B or C of the survey based on the vehicles usage. Specifically, the questionnaire asks the respondent to provide information pertaining to intracity or intercity travel and commodity transport.

Questionnaire - Section B:

Section B of the questionnaire is intended to recover information on intracity service of the sample vehicle. Although the purpose of the study is to develop data on intercity commodity movements by the various trucks, the addition of the questions concerning intra-city travel should not deter respondents from completing the questionnaire, and provides additional information that may prove useful.

Questionnaire - Section C:

This section of the questionnaire was designed to capture information on inter-city traffic flows and commodity movements. Information on individual trips made by the sample trucks on the survey date was asked to be recorded. The specific informational items requested were:

- Origin
- Destination
- Commodity Code
- Cargo Weight (Tons)
- Route Identification and Mileage

4.0 DATA COLLECTION

4.1 Population Characteristics

The source of information that provides the greatest coverage of the commodity flows in Texas is the carriers. In early 1988 there were 265,154 trucks registered in Texas with gross vehicle weight over 10,000 lb. In this study, these trucks are considered the population for sampling purposes. Table 4.1 provides a description of this population.

Table 4.1
Truck Distribution (Jan. 1988)

GVW (1000)	Truck	Farm Truck	Truck Trac.	Tractor & Trailer	Total	Percent
10-30	122,791	29,079	10,464	1,238	163,572	62%
30-50	25,202	1,616	15,939	890	43,647	16%
> 50	9,401	164	48,087	283	57,935	22%
Total	157,394	30,859	74,490	2,411	265,154	100%

Studying the characteristics of all members of a population can be extremely time-consuming and expensive, therefore, statistical sampling was used as a means of circumventing these restraints. Statistical examination requires sampling only a fraction of the population. This saves time and money without compromising accuracy. The obvious question arising here is determination of appropriate sample size that minimizes sampling errors, yet provides enough information to make inferences about the population. Other considerations involved future database usage pertaining to Traffic Assignments and Networking.

Because of the trade-offs involved in sampling, the sampling problem may be viewed as an ordinary optimization problem. For instance, if a chosen sample size is close to population size, then accuracy in parameter estimation is gained but resources are consumed at a high rate. On the other hand, if the sample size chosen is very small, time and resources are conserved, but accuracy in population estimation parameters are lost due to sampling errors. These errors could cause misleading population inferences resulting in undesirable and fallacious economic decision making. Therefore, the sampling problem consists of finding a suitable sample size which maximizes parameter accuracy while minimizing use of resources.

It can be shown that if sampling cost and expected loss functions for parameter inaccuracy are possible to obtain, then the optimization problem can be formulated and probably a simple solution can be obtained (Cochran, 1977).

In most practical situations, the sampling cost and the loss function involved in sampling are not trivial to obtain. Therefore, the following heuristic and economical procedure is suggested. This sampling procedure had two steps: a pilot survey, and a procedure for determining the final sample size.

4.2 The Pilot Survey

The pilot survey was a preliminary data collection task to obtain initial parameter estimates so a reliable sample size can be ascertained. The pilot-sample size was determined on the basis of population size, and on economic and data processing limitations. The pilot survey was also designed to test three preliminary population responses:

1) The determination of those weight stratums which exhibit the highest rate of response.

2) The determination of whether commodity flows differs between weekends and weekdays.

3) The design of the two questionnaire styles.

The pilot survey comprised 1,500 trucks and was divided into three sub-samples of 500 each. The first 500 questionnaires were used to find the weight stratum with the highest rate of response. The second 500 questionnaires were used to test whether the commodity flow is different between weekends and weekdays. The remaining 500 questionnaires were used to measure the quality of responses for the two types of questionnaires.

4.3 Pilot Survey Implementation

A computerized random generation procedure was used to draw a total sample size of 1,500 trucks from a population of 265,154. Two questionnaire types were designed. Questionnaire A demands the most response effort but provides more comprehensive commodity flow data for all aspects of this study. Questionnaire B, which involves the least response effort, requests only the most basic and pertinent commodity flow information. The use of the two differing questionnaires provides a very simple sampling experiment to test these two questionnaire types. Two hundred fifty type A and 250 type B questionnaires were mailed on the sampling day (Wednesday, June 29, 1988). These questionnaires collect commodity flow information over a 24 hour period.

One objective of the pilot survey is to have an approximate image of commodity flows on the Texas highway system over a 24-hour period. To determine weekday/weekend day with heaviest flow, a dual mailing experiment was conducted. This experiment entailed mailing 250 type A questionnaires on a week day, (Wednesday, June 29, 1988), and mailing 250 type A questionnaires on a weekend day, (Saturday, June 25, 1988).

To detect the weight stratum which provides the highest flow rate of response another experiment was conducted. For this experiment 500 type A questionnaires without previous weight classification were mailed on a weekday sample day, (Wednesday, June 29, 1988).

It has been proven that questionnaire response rates are increased through the use of a mailing follow-up procedure. Therefore, to increase the rate of response, a mailing follow-up procedure was conducted. On Monday, July 11, 1988, reminder notices were mailed to 1,100 non-responding carriers. The response cut-off day for the pilot survey was set on Tuesday, July 26, 1988.

4.4 Pilot Survey Evaluation

Of the 1,500 questionnaires mailed, fifty-seven were undeliverable resulting from relocations or incorrect addresses. One hundred of the returned questionnaires showed the chosen trucks no longer in the fleet service. Accordingly, the actual sample size is reduced to 1,343. Thirty days after the sampling day, 351 questionnaires were received which contained positive responses[5]. This resulted in an overall response rate of 26.14%. From these 351 questionnaires, forty-seven surveys provided information concerning trucks with intercity service during the sampling day. Therefore, for our purposes,.the resulting overall response rate for those trucks providing pertinent commodity flow information is considered to be 3.50%.

Results from the first experiment showed questionnaire A provided the highest number of returned surveys. However, questionnaire B provided the highest response rate with commodity flow information. Table 4.2 provides a breakdown of the experiment's results used for analysis in the first experiment. The data suggests that the questionnaire

[5] A positive response is considered to be a response to a delivered questionnaire which has been completed, and returned with information indicating the truck was in fleet and in use during the twenty four hour survey period.

designed should be improved on the basis of questionnaire B.

Table 4.2 Questionnaire Design Experiment Data						
Quest Type	Sample Day	Number Mailed	Actual Sample Size	Number of Returned Surveys	Responses with Flow Info.	Rate of Resp. with Flow (%)
A	Wed.	250	226	63	5	2.2%
B	Wed.	250	229	44	15	6.6%

Results from the weekday/weekend experiment are summarized in Table 4.3. This table shows that the rate of response with commodity flow is larger on Wednesday than on Saturday. In accordance with this finding it was decided to conduct mailings on weekdays.

Table 4.3 Sample Day Experiment Data						
Quest Type	Sample Day	Number Mailed	Actual Sample Size	Number of Returned Surveys	Responses with Flow Info.	Rate of Resp. with Flow (%)
A	Wed.	250	212	57	7	3.3%
A	Sat.	250	225	73	2	0.9%

The final experiment included mailing five hundred questionnaires without assigned weight classifications. Since the purpose of this experiment is to identify the weight stratum with the highest rate of response, weight stratum assignments were made after the questionnaires were returned. Table 4.4 shows that the stratum of trucks registered with a gross vehicle weight (GVW) of over 50,000 lb is the one with the highest response rate with commodity flow information. A major discovery of the weight stratum experiment showed that commodity flow information can be best extracted by studying only those trucks with GVW over 50,000 lbs.

Table 4.4
Weight Stratum Experiment Data

GVW in 1000's	Quest Type	Sample Day	Number Mailed	Actual Sample Size	Number of Returned Surveys	Resp. with Flow Info.	Rate of Resp. with Flow (%)
10-30	A	Wed.	305	274	80	5	1.8%
30-50	A	Wed.	77	68	12	2	2.9%
> 50	A	Wed.	118	109	22	11	10.1%

4.5 Sampling Implementation

To collect the information necessary for this study it was determined that a direct mail survey would be economically effective. Information from the pilot survey experiments confirmed that a direct mailing survey would satisfy the data collection needs of this study.

To isolate the seasonal variations of commodity flows, data collection over four seasons was deemed necessary. The information gained from the pilot survey shows the required statistical sample size is 3262 (See Appendix C). Approximately 10% of the questionnaires were returned undeliverable, the minimum number of questionnaires mailed should be 3600. In accordance with our derivation of **n**, our sampling plan consists of mailing a minimum of 900 questionnaires every 4 months. The pilot survey data suggests that Wednesday is an appropriate day to collect commodity flow information for each season. To increase the rate of response, a mailing follow-up procedure will be conducted.

5.0 SURVEY RESULTS

5.1 Introduction

This section presents information on the data obtained, and problems encountered during the survey, as well as suggested areas for refinement and improvement for subsequent studies of this nature. The information presented here is complied from the data collected during this study, and based on this returned information, is designed to represent truck commodity flows throughout the state of Texas over a twenty-four hour period. The information is generally presented in graphical form, tabular form, or both. Much of the information shown is a summary of the data used in the network matrices and for traffic assignment tasks. In some of the graphical presentation formats, various commodity codes numbers and truck type numbers are used to avoid a cluttered appearance. In these cases, and unless otherwise specified, truck types are defined as follows:

Truck Type 1	-	Single Unit Trucks
Truck Type 2	-	Tractor & Semi Trailer
Truck Type 3	-	Truck & Trailer
Truck Type 4	-	Tractor, Semi, & Full Trailer

Likewise, the commodity codes presented are representative of the Eight Aggregated Commodity Codes used in this survey. They are defined as follows:

Commodity Code 1	-	Agricultural and Related Products
Commodity Code 2	-	Hazardous Materials
Commodity Code 3	-	Construction Materials and Supplies
Commodity Code 4	-	Food and Related Products
Commodity Code 5	-	Manufacturing Products and Supplies

Commodity Code 6 - Machinery and Equipment

Commodity Code 7 - Mixed Freight Shipments

Commodity Code 8 - Empty / No Load

5.2 Survey Summary Data

During the course of this study, four questionnaire sets were sent to the owners of a sample of trucks. The sample of trucks were drawn from vehicle registration tapes provided by SDHPT[6]. The survey forms were sent approximately one week prior to the sample days which were: April 26, 1989, July 12, 1989, November 8, 1989, and March 21, 1990. All of the sample days were Wednesdays. These dates were selected to correspond with the four season, providing a Spring, Summer, Fall, and Winter survey representation.

Table 5.1 provides a summary of the survey questionnaires mailed and returned. A total of 30,541 questionnaires were mailed over the approximately twelve (12) month period. Of the 30,541 survey questionnaires mailed, 11,027 were returned by the recipients[7]. It should be emphasized that the successful return of a questionnaire only means that some information regarding the sample vehicle was provided for the sample.

TABLE 5.1

Number of Survey Mailed & Returned		
Surveys Mailed	Surveys Returned	Percent Returned
30,541	11,027	36.106%

As presented in Table 5.2, of the total surveys sent, 36.1 percent

[6] For detailed information on sample selection of trucks see Appendix B.

[7] It should be noted that this number of returned surveys does not include those surveys returned by the Post Office as undeliverable. However the number does include those vehicle reported "not in fleet" and those reported "not in use" on the sample day.

were returned by the recipient and 4.7 percent were returned by the Post Office. However, only 7.6 percent of the returned surveys contained information on intercity travel while an additional 6.8 percent indicated intracity travel only. More than 13 percent of the returned

TABLE 5.2

Distribution of Returned Surveys		
Category	Returned Surveys	Percent of Total Mailed
Not in Fleet	2,507	8.209%
Not in Use	4,120	13.490%
Intra-City Travel	2,090	6.843%
Inter-City Travel	2,310	7.564%
Total Responses	11,027	36.106%
Returned by Post Office (R.P.O.)	1,423	4.659%
Total Responses & R.P.O.'s	12,450	40.765%
Number of Surveys Mailed	30,541	100.000%

survey forms indicated that the sample truck was not in service on the sample day. For more than eight percent of the sample vehicles, the truck was no longer in the fleet because the truck had been sold or was no longer registered to the respondent.

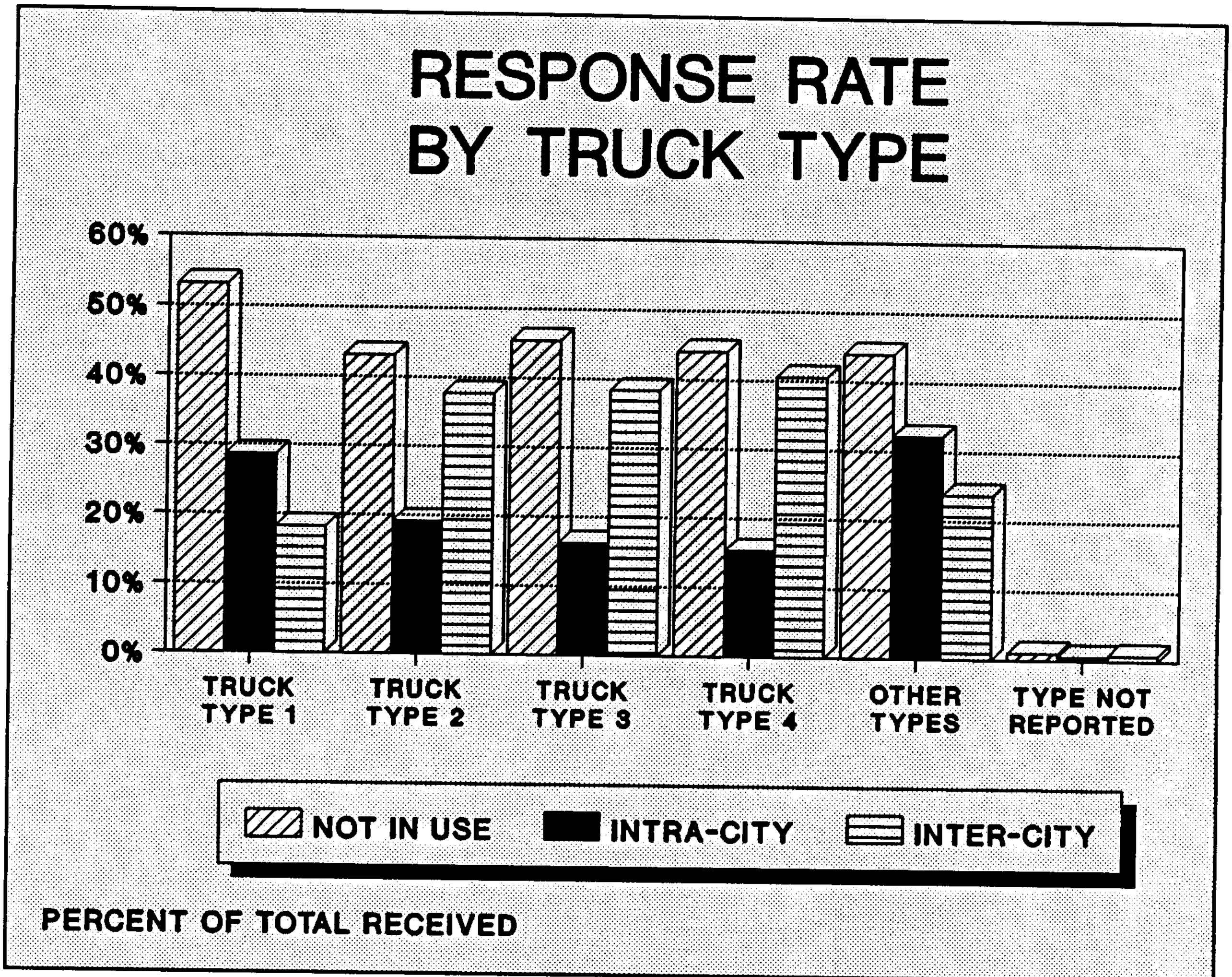


Figure 5.1

The response rate for the various sample trucks varied significantly. The response rates by Truck Type are shown in Figure 5.1. The data suggests that the more commercialized Type 2, 3, and 4 trucks provided the majority of the intercity travel, while the smaller type one trucks are allowed to provide local intracity travel. The survey data presented here also suggests a large amount of unused resources identified by the idle "Not in use" category. This is significant because in the data shown, almost 50 percent of the usable trucks were not used during the survey periods. Thus, the data shows a vast unused resource potential for possible carrier use should it be needed.

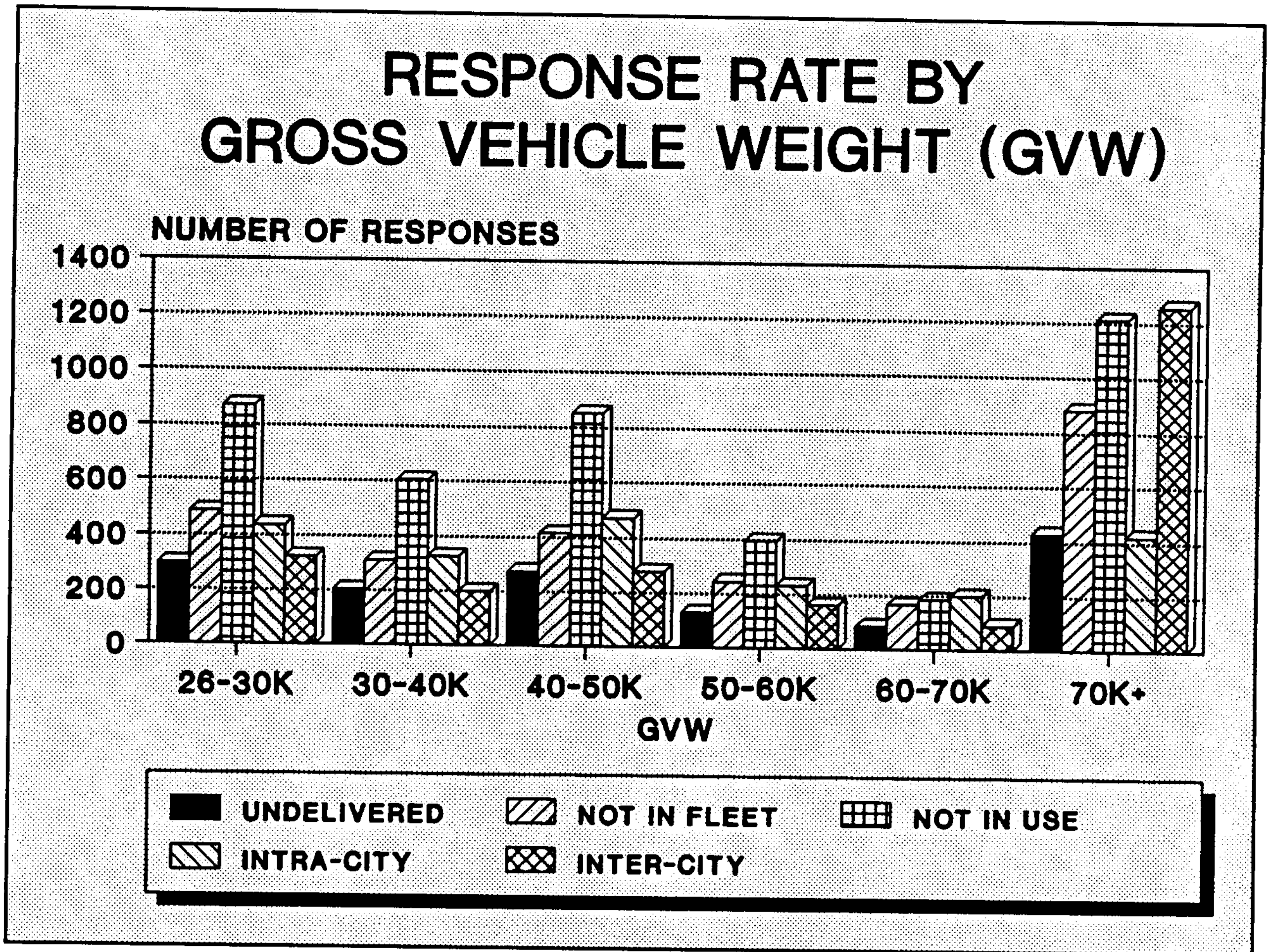


Figure 5.2

The data presented in Figure 5.2 shows a detailed level of the actual response rates based on Gross Vehicle Weight (GVW). The registration tapes and the database design provided the ability to show the response rate and other statistics by GVW thus providing another helpful categorical breakdown classification.

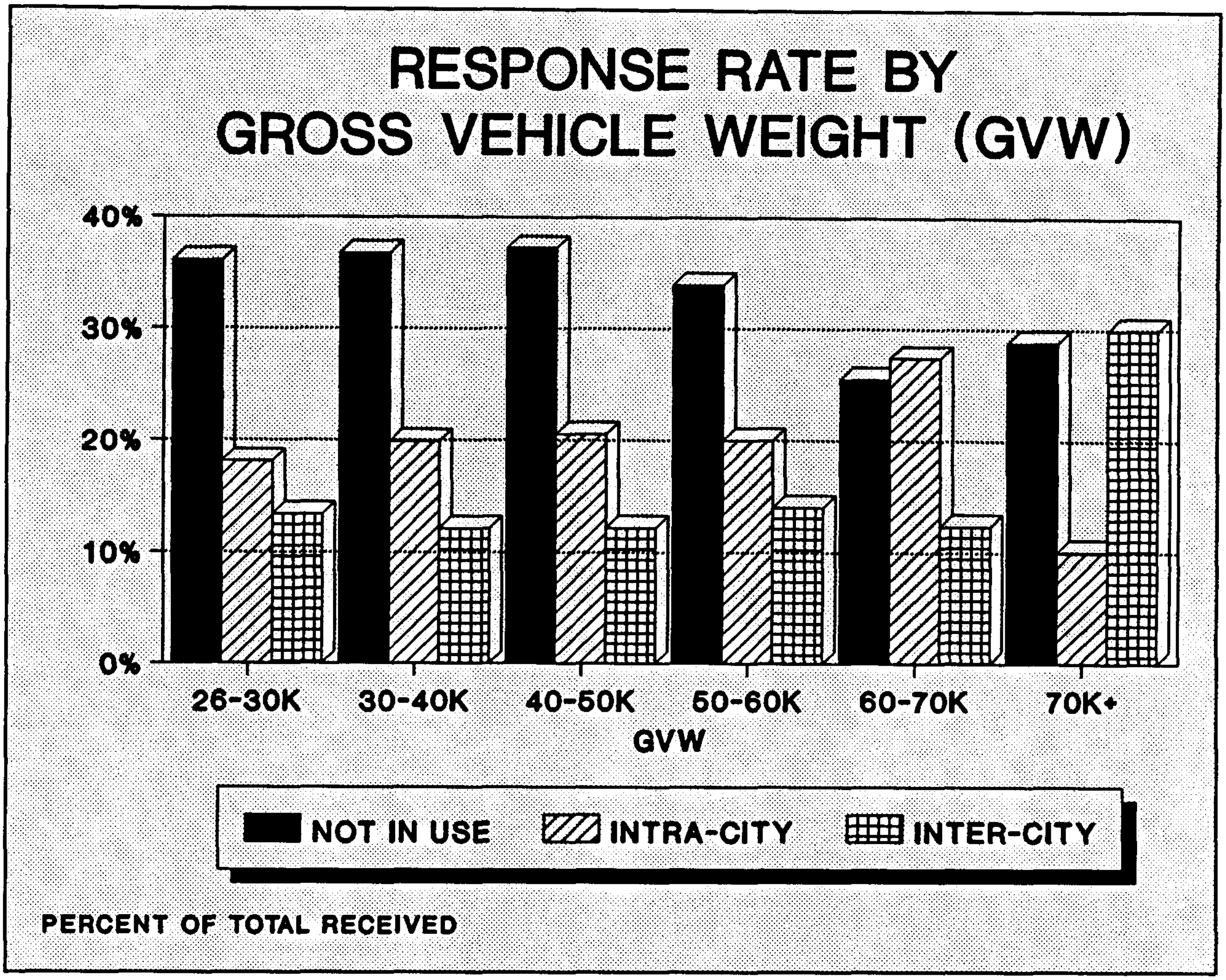


Figure 5.3

Figure 5.3 presents a response rate breakdown by GVW in a percentage format similar to that seen in Figure 5.1. This chart's data reflects a similar usage pattern to that in Figure 5.1 showing the larger trucks providing the most efficient daily resource usage out of all of the sample trucks. Regardless of this efficiency, there is still a widespread unused resource potential throughout all the truck types and GVW's classifications.

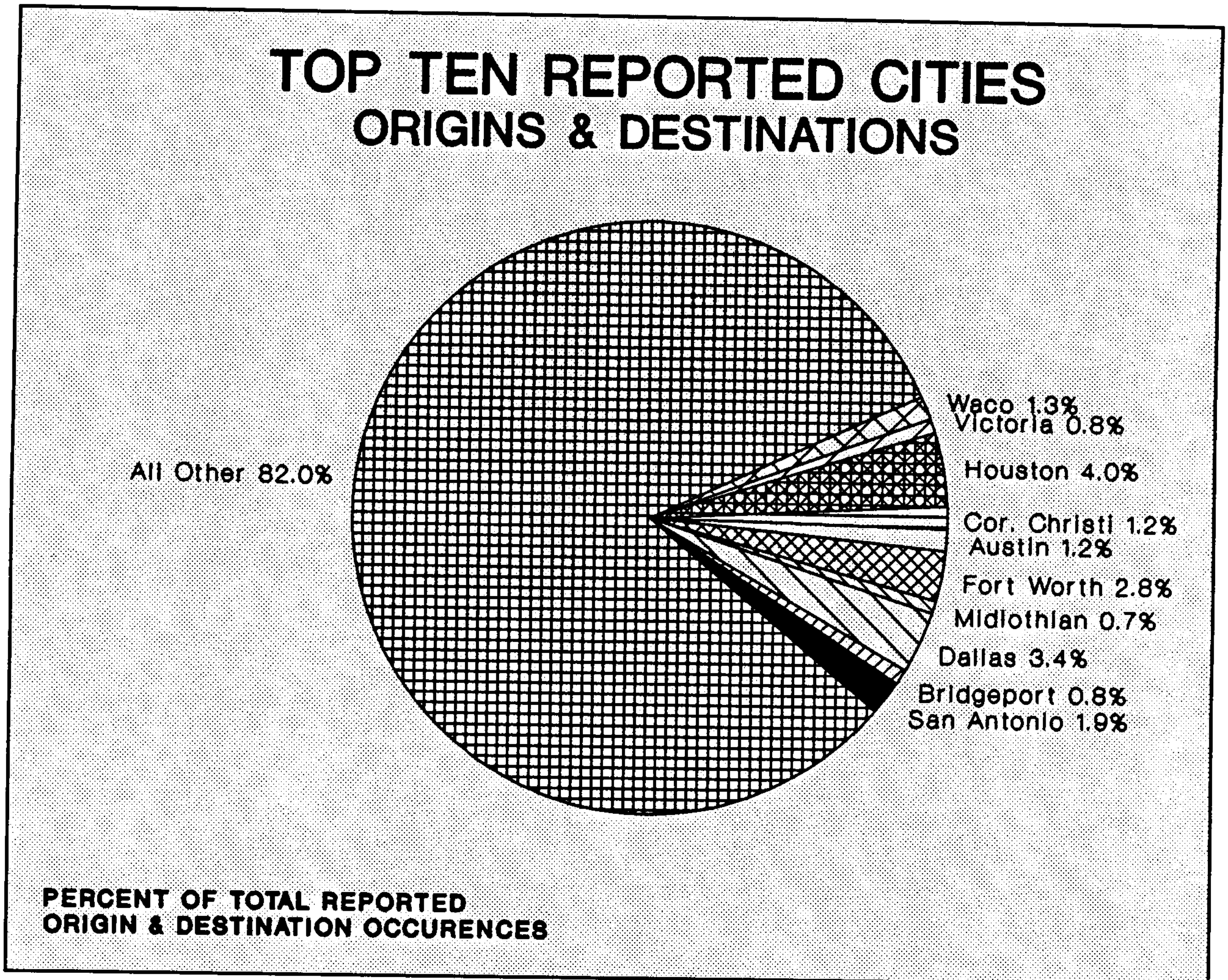


Figure 5.4

Figure 5.4 presents the top ten key cities represented in the survey as either an origin or a destination. These cities listed in order of most frequented to least frequented are:

1) Houston
2) Dallas
3) Fort Worth
4) San Antonio
5) Waco
6) Corpus Christi
7) Austin
8) Bridgeport
9) Victoria
10) Midlothian

These ten key cities combined represent 18% of the total origins and destinations occurrences with the top three cities combining to over 50% of this amount. As hub cities,

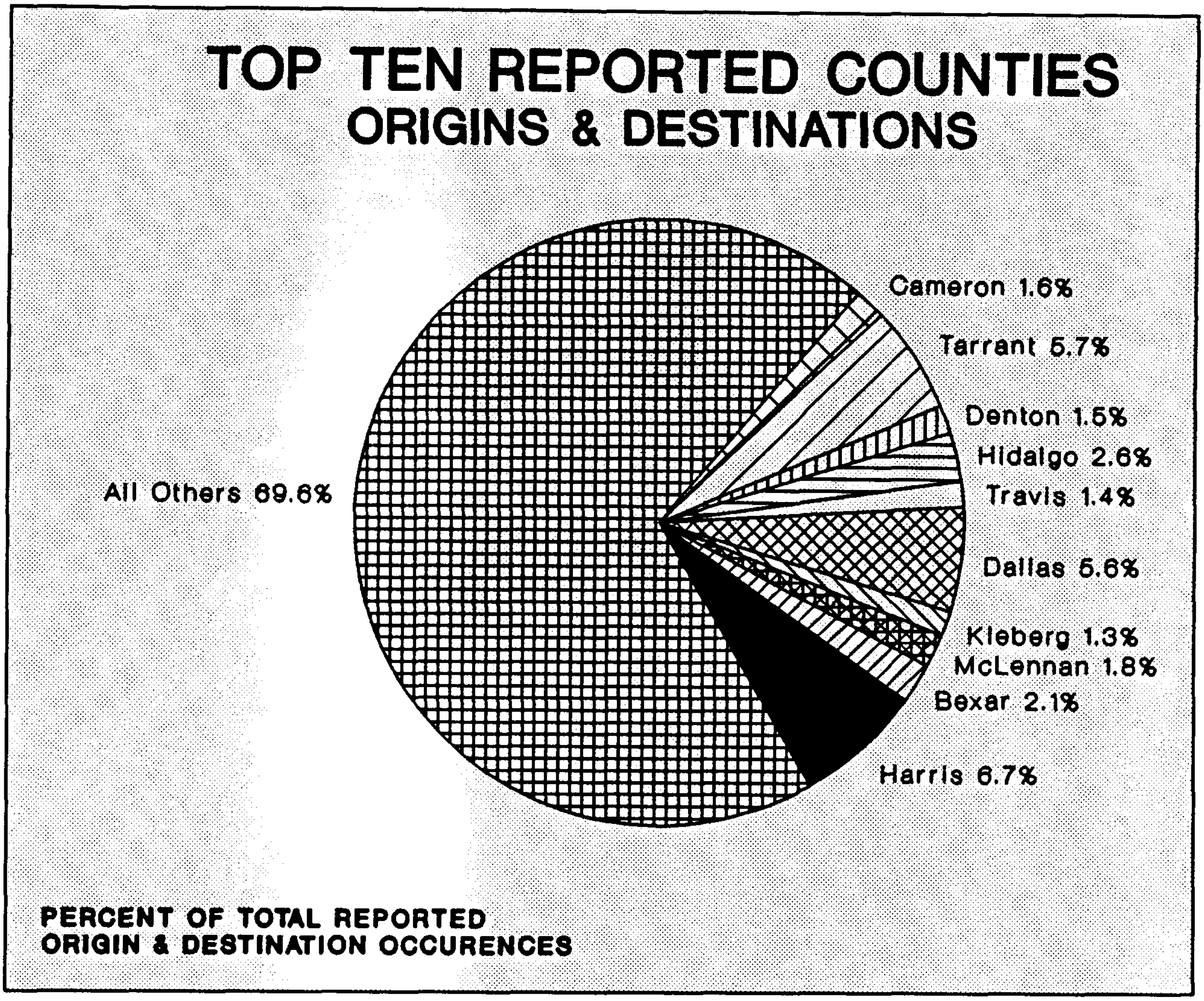


Figure 5.5

these locations provide production and attraction in significantly large amounts. However, as the production and attraction declines in the lesser ten, the production and attraction of these cities is not necessarily large enough to affect the production and attraction at the county level. This can be seen in Figure 5.5 which represents the top ten key counties. These top ten counties in order of magnitude are:

1) Harris	2) Tarrant	3) Dallas
4) Hidalgo	5) Bexar	6) Mc Lennan
7) Cameron	8) Denton	9) Travis
10) Kleberg		

There is a significant shifting of order between the key cities and key counties. This shifting is worthy of noting because it shows the added production and attraction from adjacent cities within the counties. The top ten key counties comprise approximately 31% of the total origin and destination occurrences. As with the key cities, the top three key counties incorporate over 50% of this amount or 18% of the total production and attraction at the county level.

5.3 Attributes of Sample Trucks Reporting Intercity Travel by Load Status

TABLE 5.3

Distribution of Truck Miles by Load Status		
LOAD STATUS	MILES TRAVELED	PERCENT OF TOTAL MILES
LOADED	292,551	62.846%
EMPTY	172,951	37.154%
TOTAL	465,502	100.000%

A total of 2,310 sample trucks reported intercity travel (See Table 5.2). Table 5.3 shows these trucks traveled 465,502 miles. Almost 63 percent of these miles were traveled by loaded trucks. For the four independent surveys, the percentage of loaded miles traveled ranged from 60.8 percent to 64.7 percent. It should be noted that the "loaded" category only indicates that some quantity of a commodity was transported during the twenty-four hour survey period. Table 5.3 also shows that trucks travel empty approximately 37 percent of the time.

Table 5.4 presents data concerning the distribution of miles of travel by highway type and truck load status. As noted in the table, the highest percentage of loaded miles were reported on the Interstate Highway facilities, with a reported 121,983 loaded miles. The category of "other" in the highway type column is representative of a combination of miles traveled on recreational roads, park roads, and spurs. These combined systems had the lowest percentage of reported loaded miles traveled. Although the reported mileage by highway type varied significantly between the different highway types, one should note that the percentages of total miles traveled, given in the table, indicate only marginal differences.

Table 5.5 provides a mileage breakdown of load status by highway type as well as the associated percentages. The data suggests a direct relationship between the highway system

TABLE 5.4

Truck Empty/Loaded Status by Highway Type					
HIGHWAY TYPE	LOADED MILES	PERCENT OF TOTAL MILES	EMPTY MILES	PERCENT OF TOTAL MILES	TOTAL MILES
IH	121,983	66.949%	60,221	33.051%	182,204
US	100,745	61.624%	62,738	38.376%	163,483
SH	54,621	59.071%	37,846	40.929%	92,467
FM	14,084	55.725%	11,190	44.275%	25,274
LP	948	54.420%	794	45.580%	1,742
OTHER	170	51.205%	162	48.795%	332
TOTAL	292,551	62.846%	172,951	37.154%	465,502

size and the corresponding mileage for the loaded trucks and an inverse relationship for the empty units.

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY MILEAGE BREAKDOWN BY LOAD STATUS AND HIGHWAY TYPE

LOAD STATUS	IH	US	SH	FM	LP	PR & RR	TOTAL MILES	AS A % OF EMPTY
LOADED	121,983	100,745	54,621	14,084	948	170	292,551	62.846%
EMPTY	60,221	62,738	37,846	11,190	794	162	172,951	37.154%
TOTAL	182,204	163,483	92,467	25,274	1,742	332	465,502	100.000%
A PERCENT OF LOADED	66.949%	61.624%	59.071%	55.725%	54.420%	51.205%	62.846%	
A PERCENT OF EMPTY	33.051%	38.376%	40.929%	44.275%	45.580%	48.795%	37.154%	
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

TABLE 5.5

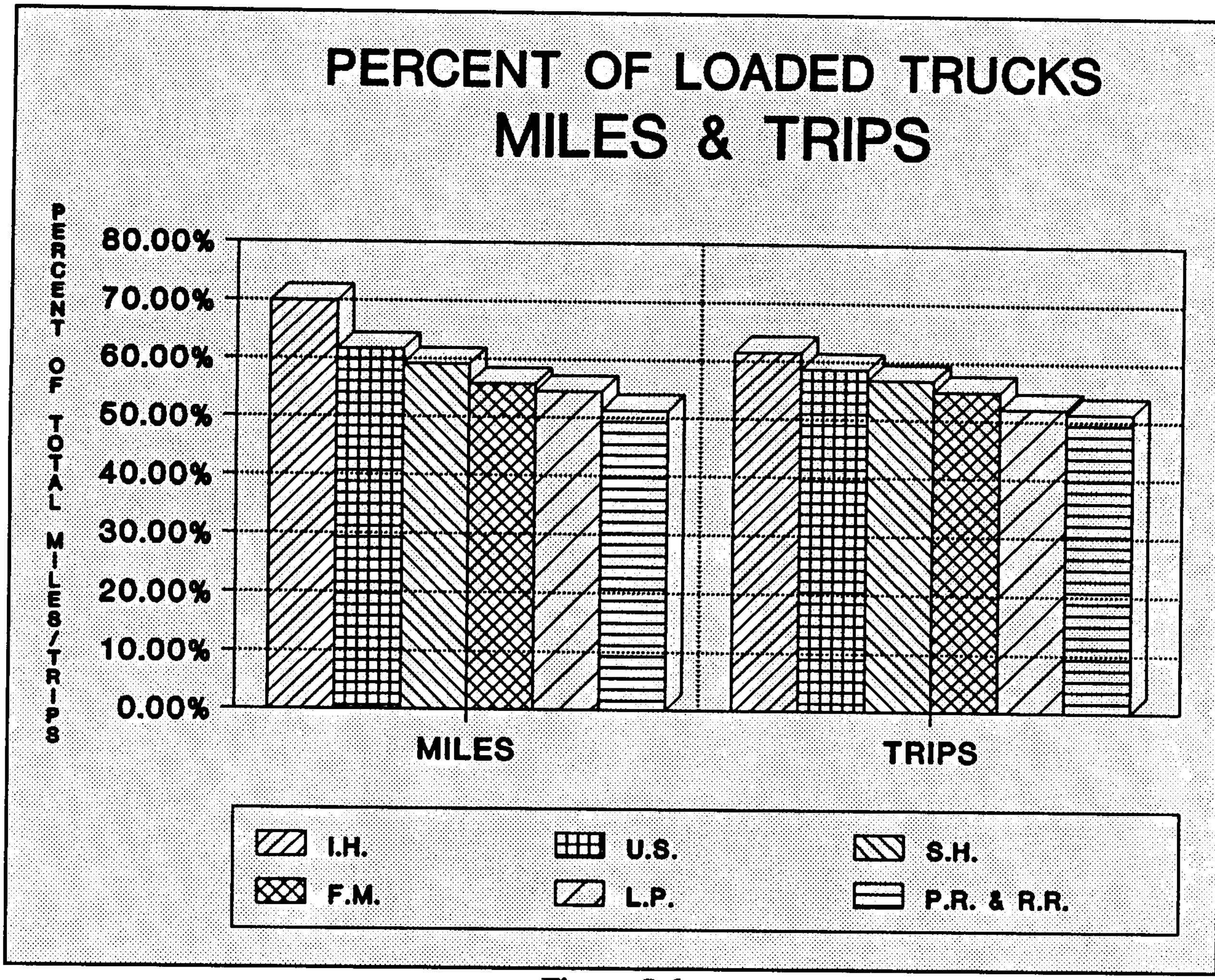


Figure 5.6

Figure 5.6 shows the percentage of miles and trips of loaded trucks by highway type. As in Table 5.5 the direct relationship between system size and number of trips and miles traveled is easily visible.

Table 5.6 provides the most comprehensive look at the truck distributions by loaded/empty status. This comprehensive table shows the full spectrum of empty and loaded trucks broken down by commodity codes for trips, miles, tons, and ton miles for intercity travel.

COMMODITY REPRESENTATION OF ALL SURVEYS
(INTER - CITY)

COMM CODE	COMMODITY NAME	TRIPS	TRIPS AS A PERCENT OF EMPTY	PERCENT OF TOTAL TRIPS	MILES	MILES AS A PERCENT OF EMPTY	PERCENT OF TOTAL MILES
1	AGRICULTURE & RELATED	475	14.346%	6.002%	36,687	21.212%	7.881
2	HAZARDOUS MATERIALS	856	25.853%	10.816%	34,832	20.140%	7.483
3	CONSTRUCTION MATERIALS	1,443	43.582%	18.234%	67,419	38.982%	14.483
4	FOOD & RELATED PRODUCTS	626	18.907%	7.910%	41,655	24.085%	8.948
5	MANUFACTURING SUPPLIES	426	12.866%	5.383%	40,336	23.322%	8.665
6	MACHINERY & EQUIPMENT	349	10.541%	4.410%	21,758	12.580%	4.674
7	MIXED FREIGHT SHIPMENTS	428	12.927%	5.408%	49,864	28.831%	10.712
8	EMPTY	3,311	100.000%	41.837%	172,951	100.000%	37.154
	TOTAL	7,914		100.000%	465,502		100.000

TABLE 5.6
PART I of II

COMMODITY REPRESENTATION OF ALL SURVEYS
(INTER - CITY)

COMM CODE	COMMODITY NAME	TONS	PERCENT OF TOTAL TONS	TON MILES	PERCENT OF TOTAL TONS MILES
1	AGRICULTURE & RELATED	8,565	12.644%	717,651	15.117%
2	HAZARDOUS MATERIALS	12,810	18.910%	620,173	13.064%
3	CONSTRUCTION MATERIALS	26,608	39.279%	1,393,061	29.345%
4	FOOD & RELATED PRODUCTS	6,305	9.308%	548,026	11.544%
5	MANUFACTURING SUPPLIES	4,705	6.946%	605,572	12.756%
6	MACHINERY & EQUIPMENT	4,904	7.239%	320,843	6.759%
7	MIXED FREIGHT SHIPMENTS	3,844	5.675%	541,899	11.415%
8	EMPTY	0	0.000%	0	0.000%
	TOTAL	67,741	100.000%	4,747,225	100.000%

TABLE 5.6

PART II of II

5.4 Attributes of Sample Trucks Reporting Intercity Travel by Miles Traveled

Figure 5.7 presents the distribution of miles traveled by highway type. It is not

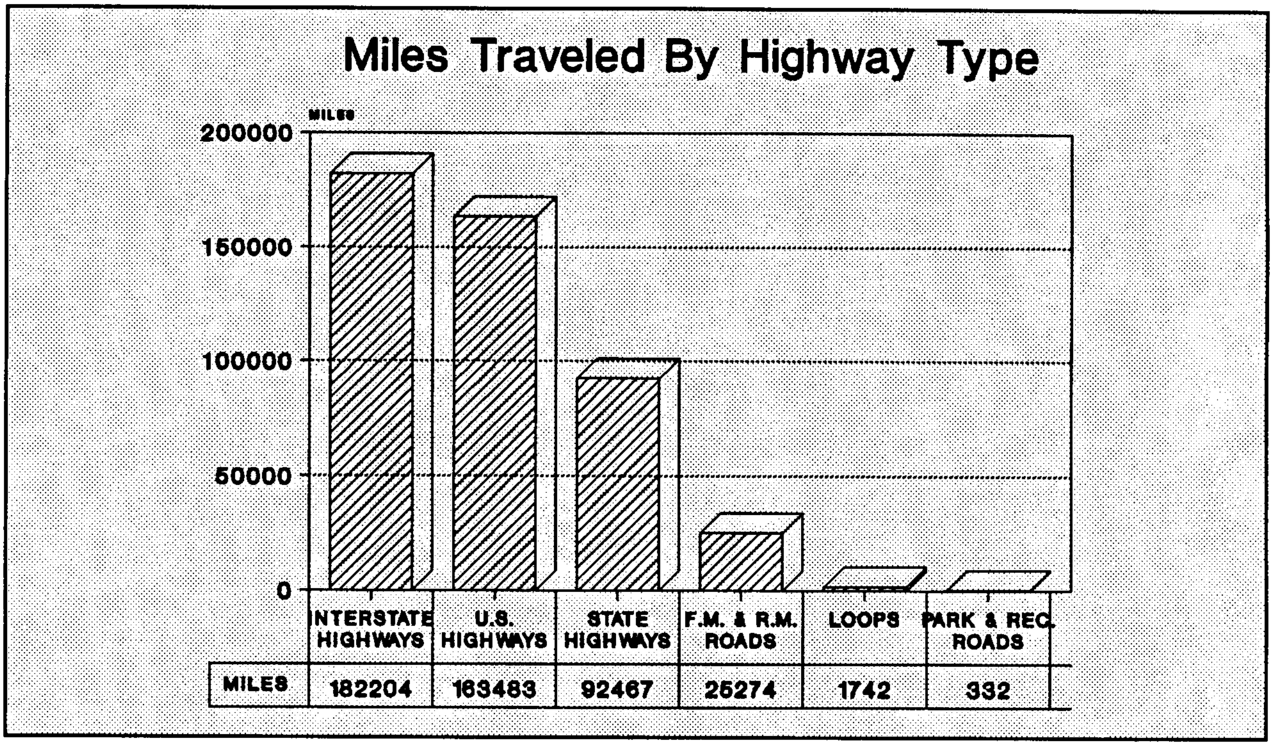


Figure 5.7

surprising to find that interstate highways had the highest volume of traffic with more than 39 percent of the total miles traveled on this system. Interstate highway traffic volume was closely followed by U.S. highways, then State highways, Farm and Ranch to Market roads, Loops, and last Park and Recreational roads.

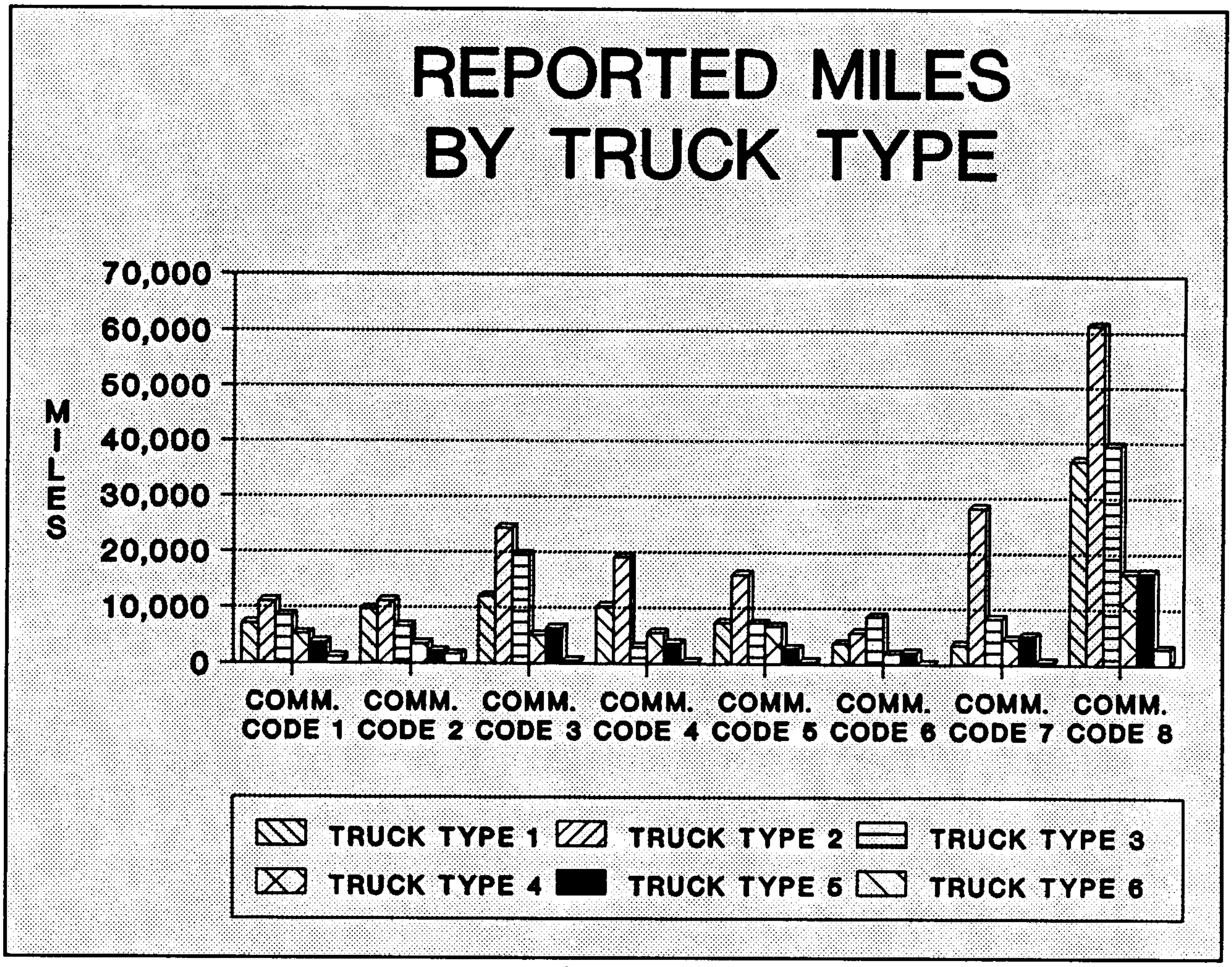


Figure 5.8

The distribution of all intercity miles traveled based on the returned surveys broken down by truck type and commodity code is shown in Figure 5.8. This breakdown shows the Tractor and Semi Trailer as the dominate vehicle for commodity movements.

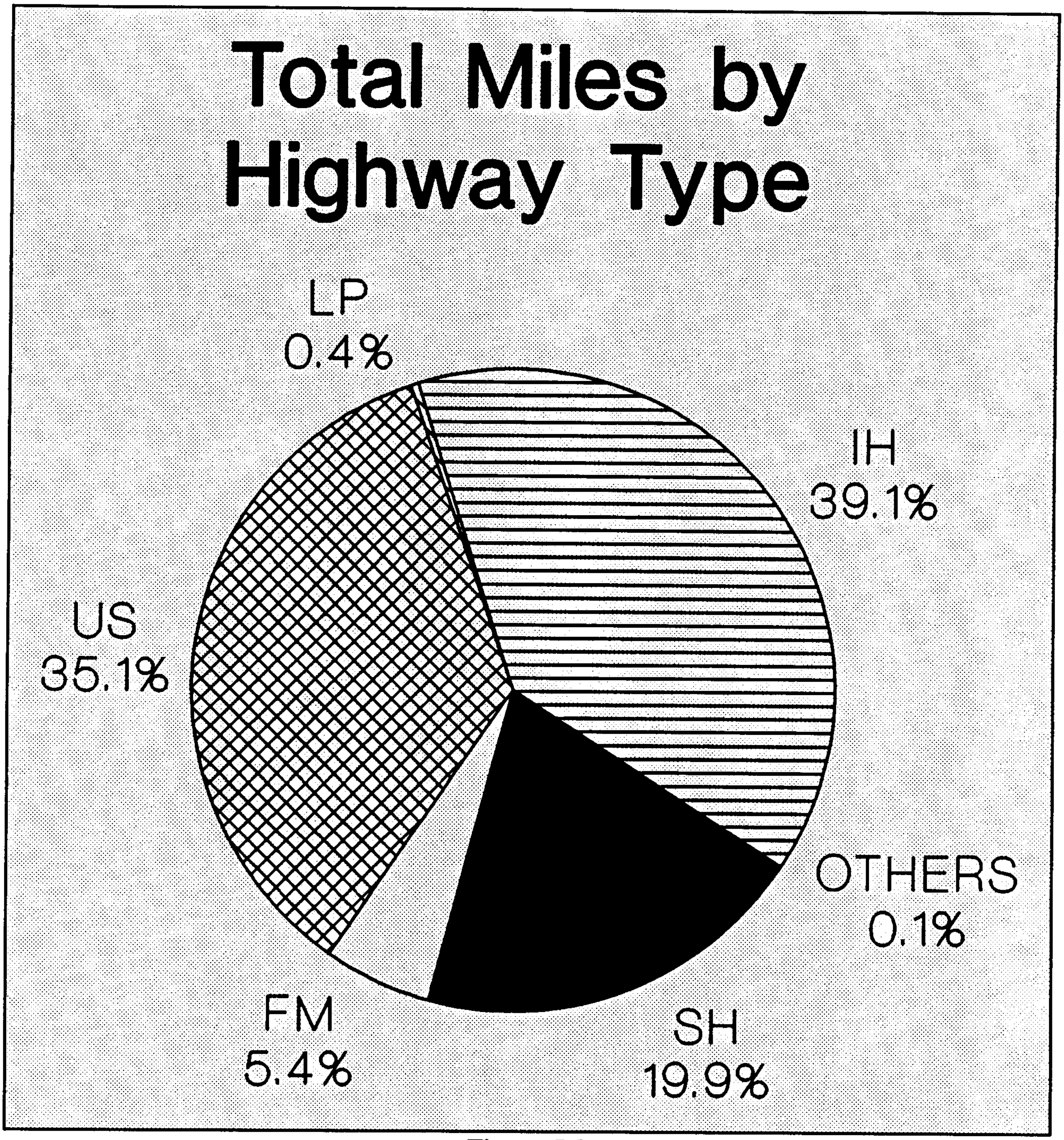


Figure 5.9

The percentage of total miles traveled by Highway type is presented in Figure 5.9. The graph shows the Interstate Highway as the roadway of choice, followed closely by U.S. Highways. These two highway types reported over 74 percent of the total miles traveled, with 39.1 percent and 35.1 percent respectively. Again the evident pattern displayed is that of increasing mileage with increasing system size.

The next three tables, Table 5.7, Table 5.8, and Table 5.9 provide extensive reviews of the actual mileage and percentage of miles traveled by the sample trucks. These tables provide information broken down by commodity code and highway type, commodity code and truck type, and commodity code and gross vehicle type respectively.

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY MILEAGE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	IH MILES	PERCENT OF IH MILES	PERCENT OF TOTAL MILES
1	AGRICULTURE & RELATED	10,460	5.741%	2.247%
2	HAZARDOUS MATERIALS	11,878	6.519%	2.552%
3	CONSTRUCTION MATERIALS	24,650	13.529%	5.295%
4	FOOD & RELATED PRODUCTS	19,421	10.659%	4.172%
5	MANUFACTURING SUPPLIES	18,340	10.066%	3.940%
6	MACHINERY & EQUIPMENT	6,898	3.786%	1.482%
7	MIXED FREIGHT SHIPMENTS	30,336	16.649%	6.517%
8	EMPTY	60,221	33.051%	12.937%
	TOTAL	182,204	100.000%	39.141%

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY MILEAGE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	US MILES	PERCENT OF US MILES	PERCENT OF TOTAL MILES
1	AGRICULTURE & RELATED	15,805	9.668%	3.395%
2	HAZARDOUS MATERIALS	11,856	7.252%	2.547%
3	CONSTRUCTION MATERIALS	22,749	13.915%	4.887%
4	FOOD & RELATED PRODUCTS	14,743	9.018%	3.167%
5	MANUFACTURING SUPPLIES	13,763	8.419%	2.957%
6	MACHINERY & EQUIPMENT	7,612	4.656%	1.635%
7	MIXED FREIGHT SHIPMENTS	14,217	8.696%	3.054%
8	EMPTY	62,738	38.376%	13.477%
	TOTAL	163,483	100.000%	35.120%

TABLE 5.7

PART I of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY MILEAGE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	SH MILES	PERCENT OF SH MILES	PERCENT OF TOTAL MILES
1	AGRICULTURE & RELATED	8,438	9.125%	1.813%
2	HAZARDOUS MATERIALS	7,254	7.845%	1.558%
3	CONSTRUCTION MATERIALS	15,178	16.415%	3.261%
4	FOOD & RELATED PRODUCTS	6,794	7.347%	1.459%
5	MANUFACTURING SUPPLIES	7,023	7.595%	1.509%
6	MACHINERY & EQUIPMENT	5,350	5.786%	1.149%
7	MIXED FREIGHT SHIPMENTS	4,584	4.957%	0.985%
8	EMPTY	37,846	40.929%	8.130%
	TOTAL	92,467	100.000%	19.864%

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY MILEAGE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	FM MILES	PERCENT OF FM MILES	PERCENT OF TOTAL MILES
1	AGRICULTURE & RELATED	1,821	7.205%	0.391%
2	HAZARDOUS MATERIALS	3,628	14.355%	0.779%
3	CONSTRUCTION MATERIALS	4,436	17.552%	0.953%
4	FOOD & RELATED PRODUCTS	648	2.564%	0.139%
5	MANUFACTURING SUPPLIES	1,085	4.293%	0.233%
6	MACHINERY & EQUIPMENT	1,816	7.185%	0.390%
7	MIXED FREIGHT SHIPMENTS	650	2.572%	0.140%
8	EMPTY	11,190	44.275%	2.404%
	TOTAL	25,274	100.000%	5.429%

TABLE 5.7

PART II of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY MILEAGE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	LP MILES	PERCENT OF LP MILES	PERCENT OF TOTAL MILES
1	AGRICULTURE & RELATED	79	4.535%	0.017%
2	HAZARDOUS MATERIALS	190	10.907%	0.041%
3	CONSTRUCTION MATERIALS	356	20.436%	0.076%
4	FOOD & RELATED PRODUCTS	41	2.354%	0.009%
5	MANUFACTURING SUPPLIES	123	7.061%	0.026%
6	MACHINERY & EQUIPMENT	82	4.707%	0.018%
7	MIXED FREIGHT SHIPMENTS	77	4.420%	0.017%
8	EMPTY	794	45.580%	0.171%
	TOTAL	1,742	100.000%	0.374%

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY MILEAGE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	PR & RR MILES	PERCENT OF PR & RR MILES	PERCENT OF TOTAL MILES
1	AGRICULTURE & RELATED	84	25.301%	0.018%
2	HAZARDOUS MATERIALS	26	7.831%	0.006%
3	CONSTRUCTION MATERIALS	50	15.060%	0.011%
4	FOOD & RELATED PRODUCTS	8	2.410%	0.002%
5	MANUFACTURING SUPPLIES	2	0.602%	0.000%
6	MACHINERY & EQUIPMENT	0	0.000%	0.000%
7	MIXED FREIGHT SHIPMENTS	0	0.000%	0.000%
8	EMPTY	162	48.795%	0.035%
	TOTAL	332	100.000%	0.071%

TABLE 5.7

PART III of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY MILEAGE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	TOTAL MILES	PERCENT OF TOTAL MILES
1	AGRICULTURE & RELATED	36,687	7.881%
2	HAZARDOUS MATERIALS	34,832	7.483%
3	CONSTRUCTION MATERIALS	67,419	14.483%
4	FOOD & RELATED PRODUCTS	41,655	8.948%
5	MANUFACTURING SUPPLIES	40,336	8.665%
6	MACHINERY & EQUIPMENT	21,758	4.674%
7	MIXED FREIGHT SHIPMENTS	49,864	10.712%
8	EMPTY	172,951	37.154%
	TOTAL	465,502	100.000%

TABLE 5.7

PART IV of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	SINGLE UNIT TRUCKS	PERCENT OF SINGLE UNIT TRUCKS	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	7,094	7.879%	1.524%
2	HAZARDOUS MATERIALS	9,671	10.741%	2.078%
3	CONSTRUCTION MATERIALS	11,981	13.307%	2.574%
4	FOOD & RELATED PRODUCTS	10,215	11.346%	2.194%
5	MANUFACTURING SUPPLIES	7,290	8.097%	1.566%
6	MACHINERY & EQUIPMENT	3,672	4.078%	0.789%
7	MIXED FREIGHT SHIPMENTS	3,480	3.865%	0.748%
8	EMPTY	36,631	40.686%	7.869%
	TOTAL	90,034	100.000%	19.341%

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TRACTOR & SEMI TRAILER	PERCENT OF TRACTOR & SEMI TRAILER	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	10,994	6.234%	2.362%
2	HAZARDOUS MATERIALS	11,151	6.323%	2.395%
3	CONSTRUCTION MATERIALS	24,245	13.747%	5.208%
4	FOOD & RELATED PRODUCTS	19,065	10.810%	4.096%
5	MANUFACTURING SUPPLIES	15,968	9.054%	3.430%
6	MACHINERY & EQUIPMENT	5,655	3.207%	1.215%
7	MIXED FREIGHT SHIPMENTS	28,056	15.908%	6.027%
8	EMPTY	61,226	34.716%	13.153%
	TOTAL	176,360	100.000%	37.886%

TABLE 5.8

PART I of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TRUCK & TRAILER	PERCENT OF TRUCK & TRAILER	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	8,483	8.417%	1.822%
2	HAZARDOUS MATERIALS	6,670	6.618%	1.433%
3	CONSTRUCTION MATERIALS	19,397	19.246%	4.167%
4	FOOD & RELATED PRODUCTS	2,982	2.959%	0.641%
5	MANUFACTURING SUPPLIES	7,276	7.219%	1.563%
6	MACHINERY & EQUIPMENT	8,481	8.415%	1.822%
7	MIXED FREIGHT SHIPMENTS	8,194	8.130%	1.760%
8	EMPTY	39,303	38.996%	8.443%
	TOTAL	100,786	100.000%	21.651%

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TRACTOR SEMI & FULL TRAILER	PERCENT OF TRACTOR, SEMI, & FULL TRAILER	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	5,264	10.777%	1.131%
2	HAZARDOUS MATERIALS	3,481	7.127%	0.748%
3	CONSTRUCTION MATERIALS	5,060	10.360%	1.087%
4	FOOD & RELATED PRODUCTS	5,481	11.222%	1.177%
5	MANUFACTURING SUPPLIES	6,694	13.705%	1.438%
6	MACHINERY & EQUIPMENT	1,878	3.845%	0.403%
7	MIXED FREIGHT SHIPMENTS	4,548	9.311%	0.977%
8	EMPTY	16,437	33.653%	3.531%
	TOTAL	48,843	100.000%	10.493%

TABLE 5.8

PART II of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	OTHER TRUCK TYPES	PERCENT OF OTHER TRUCK TYPES	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	2,924	10.524%	0.628%
2	HAZARDOUS MATERIALS	1,489	5.359%	0.320%
3	CONSTRUCTION MATERIALS	3,576	12.871%	0.768%
4	FOOD & RELATED PRODUCTS	1,252	4.506%	0.269%
5	MANUFACTURING SUPPLIES	1,897	6.828%	0.408%
6	MACHINERY & EQUIPMENT	995	3.581%	0.214%
7	MIXED FREIGHT SHIPMENTS	4,447	16.006%	0.955%
8	EMPTY	11,204	40.325%	2.407%
	TOTAL	27,784	100.000%	5.969%

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TRUCK TYPE NOT REPORTED	PERCENT OF TRUCK TYPE NOT REPORTED	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	1,928	8.887%	0.414%
2	HAZARDOUS MATERIALS	2,370	10.924%	0.509%
3	CONSTRUCTION MATERIALS	3,160	14.566%	0.679%
4	FOOD & RELATED PRODUCTS	2,660	12.261%	0.571%
5	MANUFACTURING SUPPLIES	1,211	5.582%	0.260%
6	MACHINERY & EQUIPMENT	1,077	4.964%	0.231%
7	MIXED FREIGHT SHIPMENTS	1,139	5.250%	0.245%
8	EMPTY	8,150	37.566%	1.751%
	TOTAL	21,695	100.000%	4.661%

TABLE 5.8

PART III of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TOTAL TRUCKS	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	36,687	7.881%
2	HAZARDOUS MATERIALS	34,832	7.483%
3	CONSTRUCTION MATERIALS	67,419	14.483%
4	FOOD & RELATED PRODUCTS	41,655	8.948%
5	MANUFACTURING SUPPLIES	40,336	8.665%
6	MACHINERY & EQUIPMENT	21,758	4.674%
7	MIXED FREIGHT SHIPMENTS	49,864	10.712%
8	EMPTY	172,951	37.154%
	TOTAL	465,502	100.000%

TABLE 5.8

PART IV of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY GROSS VEHICLE WEIGHT(GVW) & COMMODITY

COMM CODE	COMMODITY NAME	GVW >26,000 & <30,000	PERCENT OF GVW >26,000 & <30,000	PERCENT OF ALL WEIGHTS
1	AGRICULTURE & RELATED	3,234	9.175%	0.695%
2	HAZARDOUS MATERIALS	3,699	10.494%	0.795%
3	CONSTRUCTION MATERIALS	2,718	7.711%	0.584%
4	FOOD & RELATED PRODUCTS	4,247	12.049%	0.912%
5	MANUFACTURING SUPPLIES	4,086	11.592%	0.878%
6	MACHINERY & EQUIPMENT	2,412	6.843%	0.518%
7	MIXED FREIGHT SHIPMENTS	2,396	6.797%	0.515%
8	EMPTY	12,457	35.340%	2.676%
	TOTAL	35,249	100.000%	7.572%

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY GROSS VEHICLE WEIGHT(GVW) & COMMODITY

COMM CODE	COMMODITY NAME	GVW >30,001 & <40,000	PERCENT OF GVW >30,001 & <40,000	PERCENT OF ALL WEIGHTS
1	AGRICULTURE & RELATED	1,835	8.653%	0.394%
2	HAZARDOUS MATERIALS	2,571	12.124%	0.552%
3	CONSTRUCTION MATERIALS	1,460	6.885%	0.314%
4	FOOD & RELATED PRODUCTS	2,970	14.005%	0.638%
5	MANUFACTURING SUPPLIES	2,603	12.275%	0.559%
6	MACHINERY & EQUIPMENT	1,582	7.460%	0.340%
7	MIXED FREIGHT SHIPMENTS	918	4.329%	0.197%
8	EMPTY	7,267	34.269%	1.561%
	TOTAL	21,206	100.000%	4.556%

TABLE 5.9

PART I of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY GROSS VEHICLE WEIGHT(GVW) & COMMODITY

COMM CODE	COMMODITY NAME	GVW >40,001 & <50,000	PERCENT OF GVW >40,001 & <50,000	PERCENT OF ALL WEIGHTS
1	AGRICULTURE & RELATED	3,587	10.515%	0.771%
2	HAZARDOUS MATERIALS	1,570	4.602%	0.337%
3	CONSTRUCTION MATERIALS	6,065	17.779%	1.303%
4	FOOD & RELATED PRODUCTS	2,465	7.226%	0.530%
5	MANUFACTURING SUPPLIES	4,125	12.092%	0.886%
6	MACHINERY & EQUIPMENT	1,711	5.016%	0.368%
7	MIXED FREIGHT SHIPMENTS	1,522	4.462%	0.327%
8	EMPTY	13,068	38.308%	2.807%
	TOTAL	34,113	100.000%	7.328%

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY GROSS VEHICLE WEIGHT(GVW) & COMMODITY

COMM CODE	COMMODITY NAME	GVW >50,001 & <60,000	PERCENT OF GVW >50,001 & <60,000	PERCENT OF ALL WEIGHTS
1	AGRICULTURE & RELATED	1,051	4.464%	0.226%
2	HAZARDOUS MATERIALS	975	4.141%	0.209%
3	CONSTRUCTION MATERIALS	1,829	7.768%	0.393%
4	FOOD & RELATED PRODUCTS	4,434	18.833%	0.953%
5	MANUFACTURING SUPPLIES	3,236	13.744%	0.695%
6	MACHINERY & EQUIPMENT	1,300	5.522%	0.279%
7	MIXED FREIGHT SHIPMENTS	1,488	6.320%	0.320%
8	EMPTY	9,231	39.207%	1.983%
	TOTAL	23,544	100.000%	5.058%

TABLE 5.9

PART II of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY GROSS VEHICLE WEIGHT(GVW) & COMMODITY

COMM CODE	COMMODITY NAME	GVW >60,001 & <70,000	PERCENT OF GVW >60,001 & <70,000	PERCENT OF ALL WEIGHTS
1	AGRICULTURE & RELATED	612	5.324%	0.131%
2	HAZARDOUS MATERIALS	736	6.402%	0.158%
3	CONSTRUCTION MATERIALS	1,362	11.848%	0.293%
4	FOOD & RELATED PRODUCTS	216	1.879%	0.046%
5	MANUFACTURING SUPPLIES	1,516	13.187%	0.326%
6	MACHINERY & EQUIPMENT	1,799	15.649%	0.386%
7	MIXED FREIGHT SHIPMENTS	364	3.166%	0.078%
8	EMPTY	4,891	42.545%	1.051%
	TOTAL	11,496	100.000%	2.470%

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY GROSS VEHICLE WEIGHT(GVW) & COMMODITY

COMM CODE	COMMODITY NAME	GVW >70,001	PERCENT OF GVW >70,001	PERCENT OF ALL WEIGHTS
1	AGRICULTURE & RELATED	26,368	7.758%	5.664%
2	HAZARDOUS MATERIALS	25,281	7.438%	5.431%
3	CONSTRUCTION MATERIALS	53,985	15.883%	11.597%
4	FOOD & RELATED PRODUCTS	27,323	8.039%	5.870%
5	MANUFACTURING SUPPLIES	24,770	7.288%	5.321%
6	MACHINERY & EQUIPMENT	12,954	3.811%	2.783%
7	MIXED FREIGHT SHIPMENTS	43,176	12.703%	9.275%
8	EMPTY	126,037	37.081%	27.076%
	TOTAL	339,894	100.000%	73.017%

TABLE 5.9

PART III of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
MILEAGE BREAKDOWN BY GROSS VEHICLE WEIGHT(GVW) & COMMODITY

COMM CODE	COMMODITY NAME	ALL WEIGHTS	PERCENT OF ALL WEIGHTS
1	AGRICULTURE & RELATED	36,687	7.881%
2	HAZARDOUS MATERIALS	34,832	7.483%
3	CONSTRUCTION MATERIALS	67,419	14.483%
4	FOOD & RELATED PRODUCTS	41,655	8.948%
5	MANUFACTURING SUPPLIES	40,336	8.665%
6	MACHINERY & EQUIPMENT	21,758	4.674%
7	MIXED FREIGHT SHIPMENTS	49,864	10.712%
8	EMPTY	172,951	37.154%
	TOTAL	465,502	100.000%

TABLE 5.9

PART IV of IV

5.5 Attributes of Sample Trucks Reporting Intercity Travel by Trips

The database and survey design also allow information extraction with trips as the

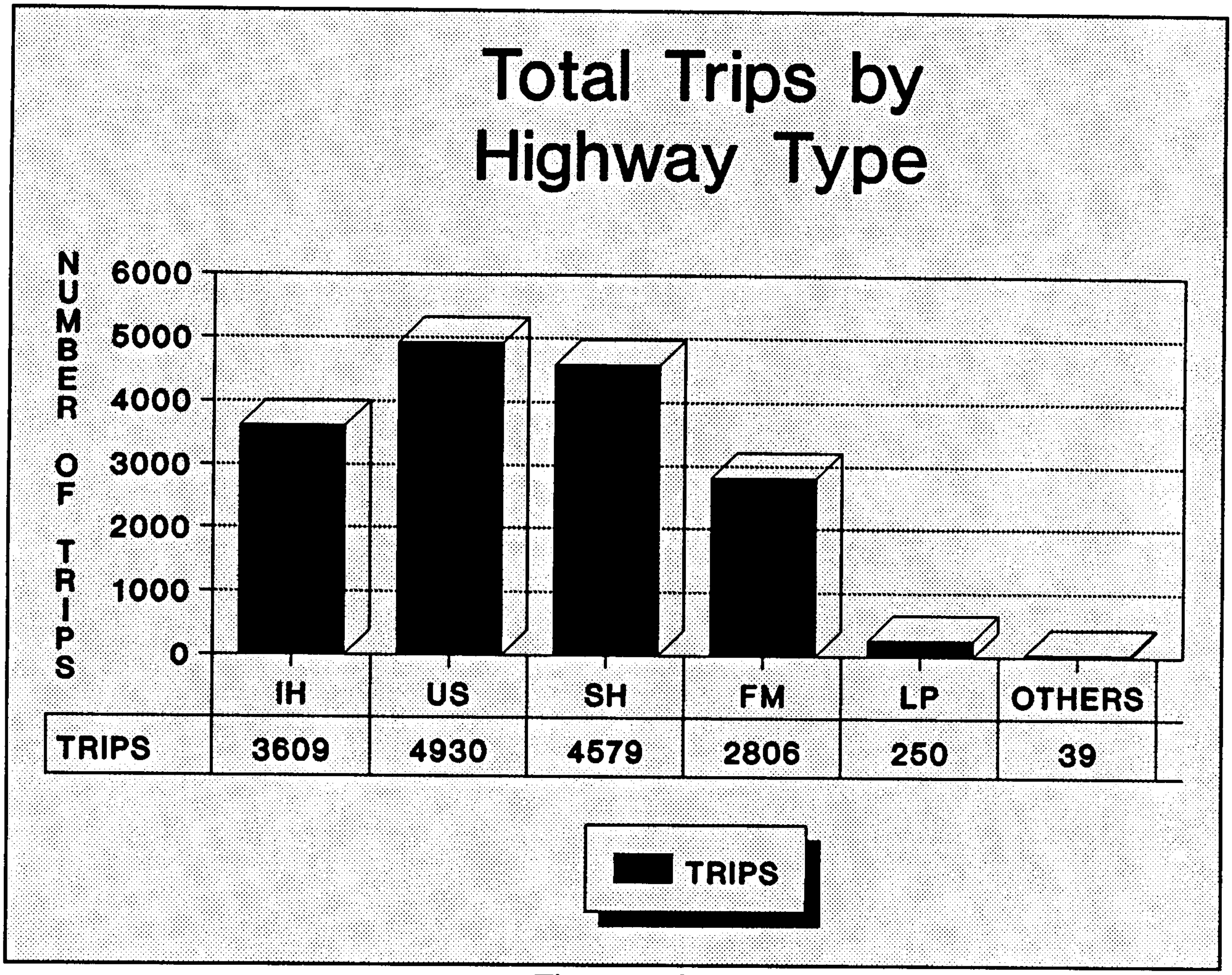


Figure 5.10

main categorical field. Figure 5.10 shows a breakdown of trips taken on the various system types by the sample trucks. This display, when broken down by trips shows different distribution then was seen in the mileage presentation with the Interstate highway system showing a large frequency of trips, but not a majority.

The distribution of intercity trips taken by the sample trucks, broken down by truck

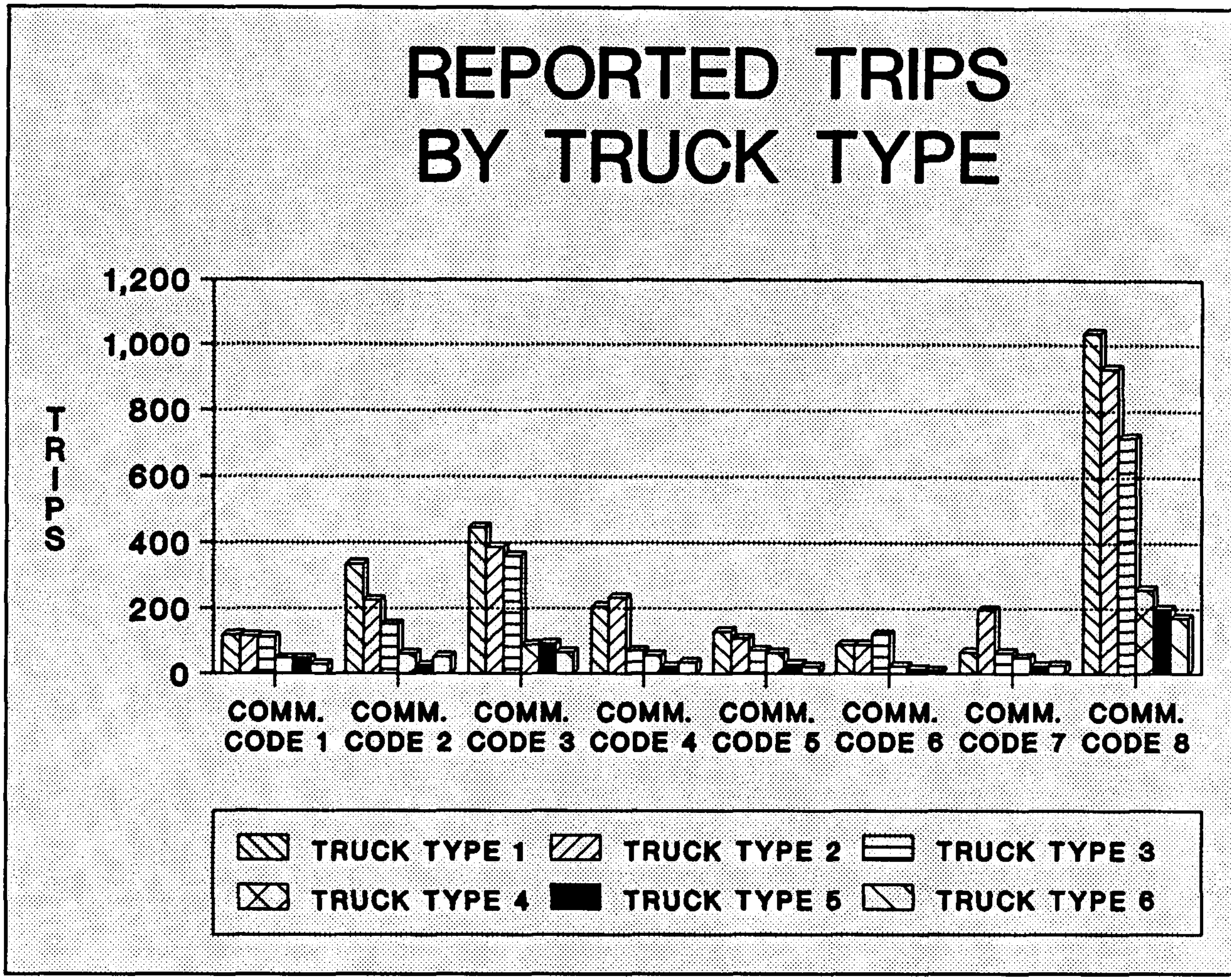


Figure 5.11

type and commodity code is shown in Figure 5.11. This graph of trip frequency shows that Single Unit Trucks overshadow the other truck type for commodity movements based on trip frequencies.

The percentage of trip frequency for the sample trucks is shown in Figure 5.12. Again, this graph shows the same shift from the mileage data that was observed in Figure 5.10. This shift is represents the increased frequency of trips on the intermediate systems with U.S. highways and State highways having over 68 percent of the total trips. Combining

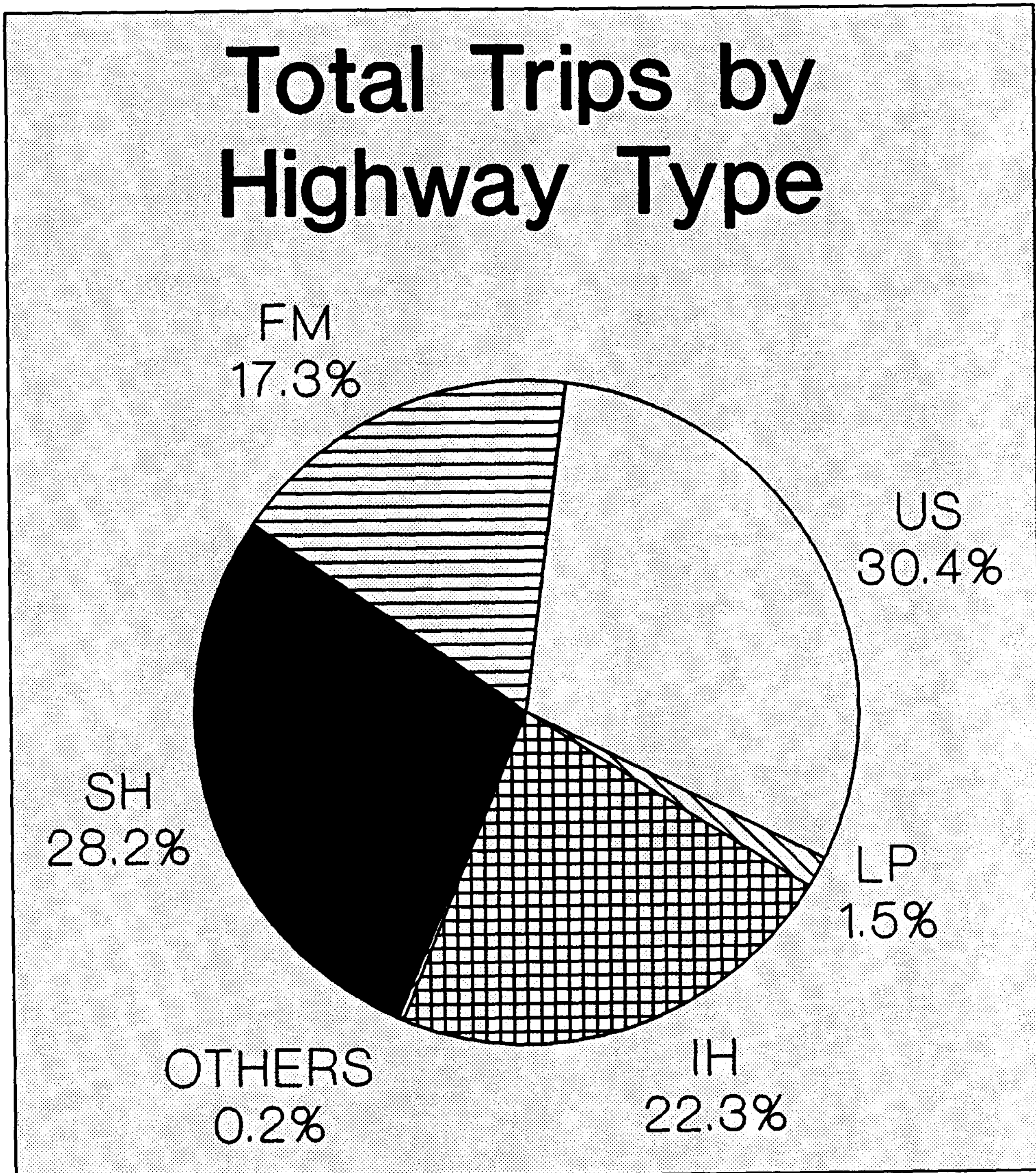


Figure 5.12

Interstate highways with the previous two highway type provides a representation of over 80 percent of the total trip frequency from this sample.

This breakdown reveals some interesting results when compared with the mileage statistics from the previous section. When the mileage or trip information is examined by apart from the other, the data only suggests patterns in the mileage format. However, when

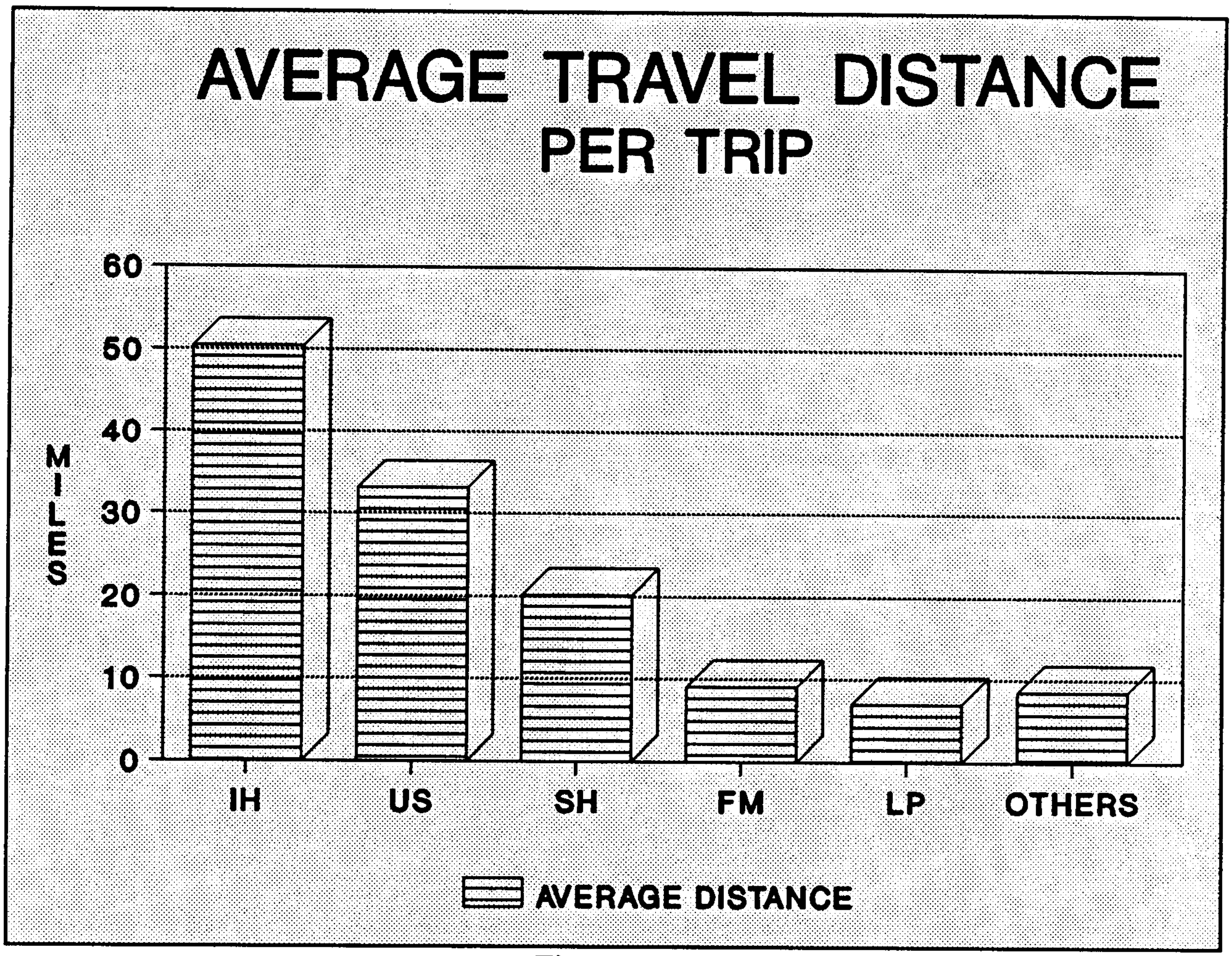


Figure 5.13

a comparison is made between the mileage data and the trip data in a merged form, such as that displayed in Figure 5.13, the data displays the dominate and direct relationship of the mileage data, the relationship of increased travel distances with the larger system types.

The next two tables, Table 5.10, and Table 5.11 provide an more through reviews of the actual trip frequencies and percentage of trips made by the sample trucks. These tables provide information broken down by commodity code and highway type, and commodity code and truck type, respectively.

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TRIPS BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	IH TRIPS	PERCENT OF IH TRIPS	PERCENT OF TOTAL TRIPS
1	AGRICULTURE & RELATED	180	4.988%	1.110%
2	HAZARDOUS MATERIALS	317	8.784%	1.955%
3	CONSTRUCTION MATERIALS	669	18.537%	4.126%
4	FOOD & RELATED PRODUCTS	362	10.030%	2.233%
5	MANUFACTURING SUPPLIES	259	7.177%	1.597%
6	MACHINERY & EQUIPMENT	119	3.297%	0.734%
7	MIXED FREIGHT SHIPMENTS	313	8.673%	1.931%
8	EMPTY	1,390	38.515%	8.573%
	TOTAL	3,609	100.000%	22.260%

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TRIPS BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	US TRIPS	PERCENT OF US TRIPS	PERCENT OF TOTAL TRIPS
1	AGRICULTURE & RELATED	421	8.540%	2.597%
2	HAZARDOUS MATERIALS	488	9.899%	3.010%
3	CONSTRUCTION MATERIALS	860	17.444%	5.304%
4	FOOD & RELATED PRODUCTS	407	8.256%	2.510%
5	MANUFACTURING SUPPLIES	256	5.193%	1.579%
6	MACHINERY & EQUIPMENT	230	4.665%	1.419%
7	MIXED FREIGHT SHIPMENTS	225	4.564%	1.388%
8	EMPTY	2,043	41.440%	12.601%
	TOTAL	4,930	100.000%	30.408%

TABLE 5.10

PART I of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TRIPS BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	SH TRIPS	PERCENT OF SH TRIPS	PERCENT OF TOTAL TRIPS
1	AGRICULTURE & RELATED	333	7.272%	2.054%
2	HAZARDOUS MATERIALS	459	10.024%	2.831%
3	CONSTRUCTION MATERIALS	881	19.240%	5.434%
4	FOOD & RELATED PRODUCTS	289	6.311%	1.783%
5	MANUFACTURING SUPPLIES	247	5.394%	1.523%
6	MACHINERY & EQUIPMENT	255	5.569%	1.573%
7	MIXED FREIGHT SHIPMENTS	137	2.992%	0.845%
8	EMPTY	1,978	43.197%	12.200%
	TOTAL	4,579	100.000%	28.243%

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TRIPS BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	FM TRIPS	PERCENT OF FM TRIPS	PERCENT OF TOTAL TRIPS
1	AGRICULTURE & RELATED	180	6.415%	1.110%
2	HAZARDOUS MATERIALS	401	14.291%	2.473%
3	CONSTRUCTION MATERIALS	582	20.741%	3.590%
4	FOOD & RELATED PRODUCTS	72	2.566%	0.444%
5	MANUFACTURING SUPPLIES	103	3.671%	0.635%
6	MACHINERY & EQUIPMENT	158	5.631%	0.975%
7	MIXED FREIGHT SHIPMENTS	45	1.604%	0.278%
8	EMPTY	1,265	45.082%	7.802%
	TOTAL	2,806	100.000%	17.307%

TABLE 5.10

PART II of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TRIPS BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	LP TRIPS	PERCENT OF LP TRIPS	PERCENT OF TOTAL TRIPS
1	AGRICULTURE & RELATED	7	2.800%	0.043%
2	HAZARDOUS MATERIALS	27	10.800%	0.167%
3	CONSTRUCTION MATERIALS	62	24.800%	0.382%
4	FOOD & RELATED PRODUCTS	4	1.600%	0.025%
5	MANUFACTURING SUPPLIES	10	4.000%	0.062%
6	MACHINERY & EQUIPMENT	15	6.000%	0.093%
7	MIXED FREIGHT SHIPMENTS	5	2.000%	0.031%
8	EMPTY	120	48.000%	0.740%
	TOTAL	250	100.000%	1.542%

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TRIPS BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	PR & RR TRIPS	PERCENT OF PR & RR TRIPS	PERCENT OF TOTAL TRIPS
1	AGRICULTURE & RELATED	3	7.692%	0.019%
2	HAZARDOUS MATERIALS	2	5.128%	0.012%
3	CONSTRUCTION MATERIALS	13	33.333%	0.080%
4	FOOD & RELATED PRODUCTS	1	2.564%	0.006%
5	MANUFACTURING SUPPLIES	1	2.564%	0.006%
6	MACHINERY & EQUIPMENT	0	0.000%	0.000%
7	MIXED FREIGHT SHIPMENTS	0	0.000%	0.000%
8	EMPTY	19	48.718%	0.117%
	TOTAL	39	100.000%	0.241%

TABLE 5.10

PART III of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TRIPS BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	TOTAL TRIPS	PERCENT OF TOTAL TRIPS
1	AGRICULTURE & RELATED	1,124	6.933%
2	HAZARDOUS MATERIALS	1,694	10.448%
3	CONSTRUCTION MATERIALS	3,067	18.917%
4	FOOD & RELATED PRODUCTS	1,135	7.001%
5	MANUFACTURING SUPPLIES	876	5.403%
6	MACHINERY & EQUIPMENT	777	4.792%
7	MIXED FREIGHT SHIPMENTS	725	4.472%
8	EMPTY	6,815	42.034%
	TOTAL	16,213	100.000%

TABLE 5.10

PART IV of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
TRIP FREQUENCY BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	SINGLE UNIT TRUCKS	PERCENT OF SINGLE UNIT TRUCKS	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	120	4.940%	1.516%
2	HAZARDOUS MATERIALS	336	13.833%	4.246%
3	CONSTRUCTION MATERIALS	446	18.361%	5.636%
4	FOOD & RELATED PRODUCTS	206	8.481%	2.603%
5	MANUFACTURING SUPPLIES	129	5.311%	1.630%
6	MACHINERY & EQUIPMENT	89	3.664%	1.125%
7	MIXED FREIGHT SHIPMENTS	67	2.758%	0.847%
8	EMPTY	1,036	42.651%	13.091%
	TOTAL	2,429	100.000%	30.692%

COMMODITY REPRESENTATION IN ALL SURVEYS
TRIP FREQUENCY BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TRACTOR & SEMI TRAILER	PERCENT OF TRACTOR & SEMI TRAILER	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	116	5.083%	1.466%
2	HAZARDOUS MATERIALS	225	9.860%	2.843%
3	CONSTRUCTION MATERIALS	387	16.959%	4.890%
4	FOOD & RELATED PRODUCTS	233	10.210%	2.944%
5	MANUFACTURING SUPPLIES	109	4.777%	1.377%
6	MACHINERY & EQUIPMENT	89	3.900%	1.125%
7	MIXED FREIGHT SHIPMENTS	196	8.589%	2.477%
8	EMPTY	927	40.622%	11.713%
	TOTAL	2,282	100.000%	28.835%

TABLE 5.11

PART I of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
TRIP FREQUENCY BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TRUCK & TRAILER	PERCENT OF TRUCK & TRAILER	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	113	6.754%	1.428%
2	HAZARDOUS MATERIALS	152	9.085%	1.921%
3	CONSTRUCTION MATERIALS	360	21.518%	4.549%
4	FOOD & RELATED PRODUCTS	71	4.244%	0.897%
5	MANUFACTURING SUPPLIES	72	4.304%	0.910%
6	MACHINERY & EQUIPMENT	121	7.233%	1.529%
7	MIXED FREIGHT SHIPMENTS	65	3.885%	0.821%
8	EMPTY	719	42.977%	9.085%
	TOTAL	1,673	100.000%	21.140%

COMMODITY REPRESENTATION IN ALL SURVEYS
TRIP FREQUENCY BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TRACTOR SEMI & FULL TRAILER	PERCENT OF TRACTOR, SEMI, & FULL TRAILER	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	48	7.328%	0.607%
2	HAZARDOUS MATERIALS	63	9.618%	0.796%
3	CONSTRUCTION MATERIALS	90	13.740%	1.137%
4	FOOD & RELATED PRODUCTS	57	8.702%	0.720%
5	MANUFACTURING SUPPLIES	64	9.771%	0.809%
6	MACHINERY & EQUIPMENT	25	3.817%	0.316%
7	MIXED FREIGHT SHIPMENTS	50	7.634%	0.632%
8	EMPTY	258	39.389%	3.260%
	TOTAL	655	100.000%	8.276%

TABLE 5.11

PART II of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
TRIP FREQUENCY BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	OTHER TRUCK TYPES	PERCENT OF OTHER TRUCK TYPES	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	48	10.435%	0.607%
2	HAZARDOUS MATERIALS	27	5.870%	0.341%
3	CONSTRUCTION MATERIALS	94	20.435%	1.188%
4	FOOD & RELATED PRODUCTS	23	5.000%	0.291%
5	MANUFACTURING SUPPLIES	30	6.522%	0.379%
6	MACHINERY & EQUIPMENT	15	3.261%	0.190%
7	MIXED FREIGHT SHIPMENTS	24	5.217%	0.303%
8	EMPTY	199	43.261%	2.515%
	TOTAL	460	100.000%	5.812%

COMMODITY REPRESENTATION IN ALL SURVEYS
TRIP FREQUENCY BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TRUCK TYPE NOT REPORTED	PERCENT OF TRUCK TYPE NOT REPORTED	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	30	7.229%	0.379%
2	HAZARDOUS MATERIALS	53	12.771%	0.670%
3	CONSTRUCTION MATERIALS	66	15.904%	0.834%
4	FOOD & RELATED PRODUCTS	36	8.675%	0.455%
5	MANUFACTURING SUPPLIES	22	5.301%	0.278%
6	MACHINERY & EQUIPMENT	10	2.410%	0.126%
7	MIXED FREIGHT SHIPMENTS	26	6.265%	0.329%
8	EMPTY	172	41.446%	2.173%
	TOTAL	415	100.000%	5.244%

TABLE 5.11

PART III of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
TRIP FREQUENCY BREAKDOWN BY TRUCK TYPE & COMMODITY

COMM CODE	COMMODITY NAME	TOTAL TRUCKS	PERCENT OF TOTAL TRUCKS
1	AGRICULTURE & RELATED	475	6.002%
2	HAZARDOUS MATERIALS	856	10.816%
3	CONSTRUCTION MATERIALS	1,443	18.234%
4	FOOD & RELATED PRODUCTS	626	7.910%
5	MANUFACTURING SUPPLIES	426	5.383%
6	MACHINERY & EQUIPMENT	349	4.410%
7	MIXED FREIGHT SHIPMENTS	428	5.408%
8	EMPTY	3,311	41.837%
	TOTAL	7,914	100.000%

TABLE 5.11

PART IV of IV

5.6 Attributes of Sample Trucks Reporting Intercity Travel by Tons & Ton Miles

Extraction of the data by tons and ton miles is another important element designed into the database structure. Information of this type and in various formats is often a meaningful and frequently requested. This data can be presented in any of the other previously displayed formats and is generally the information most often sought.

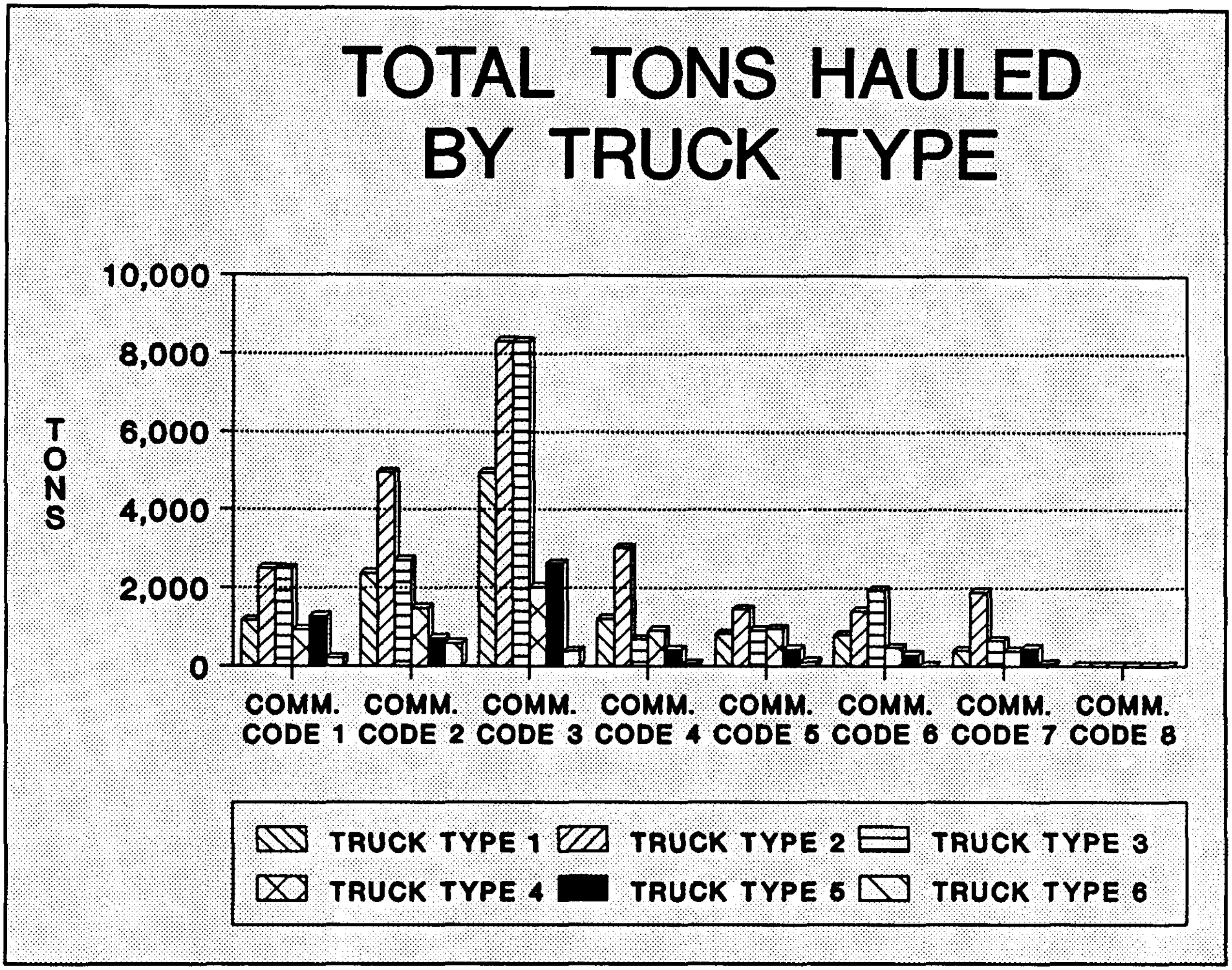


Figure 5.14

Figure 5.14 shows the distribution of total intercity tons hauls by the sample trucks broken down by truck type and commodity code. This breakdown shows the Tractor & Semi

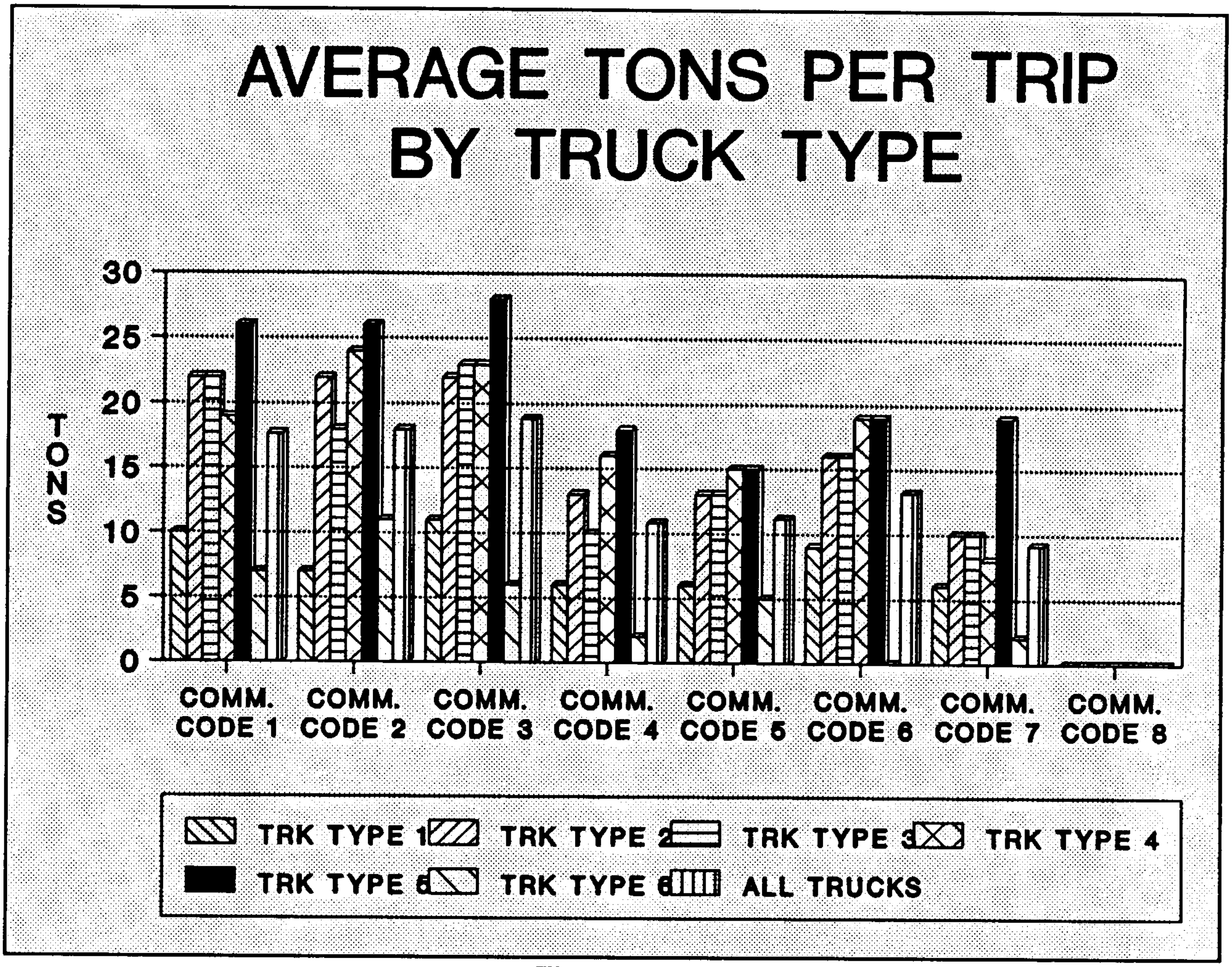


Figure 5.15

Trailer combinations hauling the most tonnage in the survey. More meaningful, however, is the average tons hauled per trip. This data is presented in Figure 5.15. Note that the graph in Figure 5.15 has an extra series which represents the average tons hauled by all truck types broken down by commodity code.

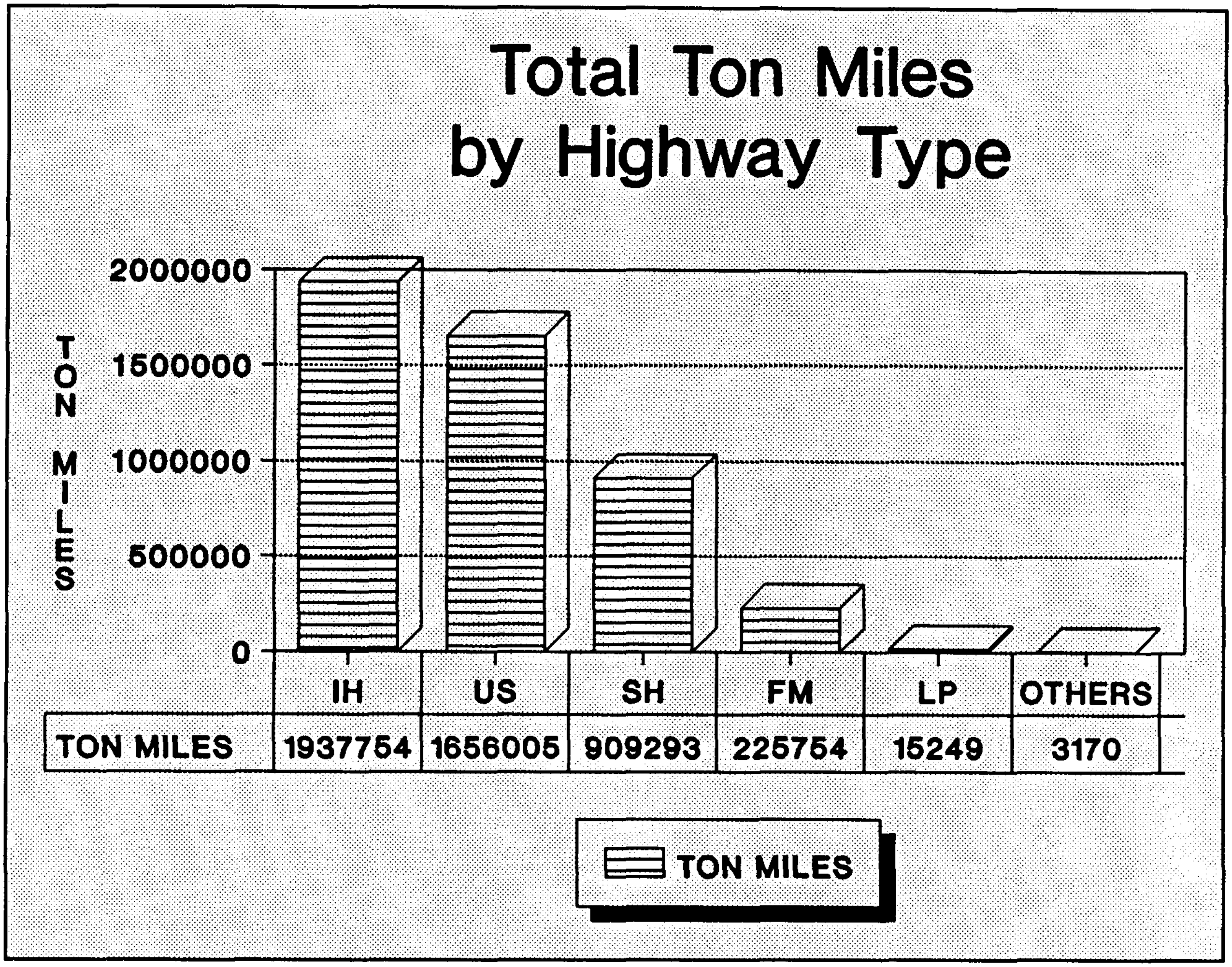


Figure 5.16

A very important aspect of any commodity flow study is the ton mile category. Figure 5.16 presents data regarding this indispensable category. The graph shows the direct relationship seen previously between facility capacity and truck size.

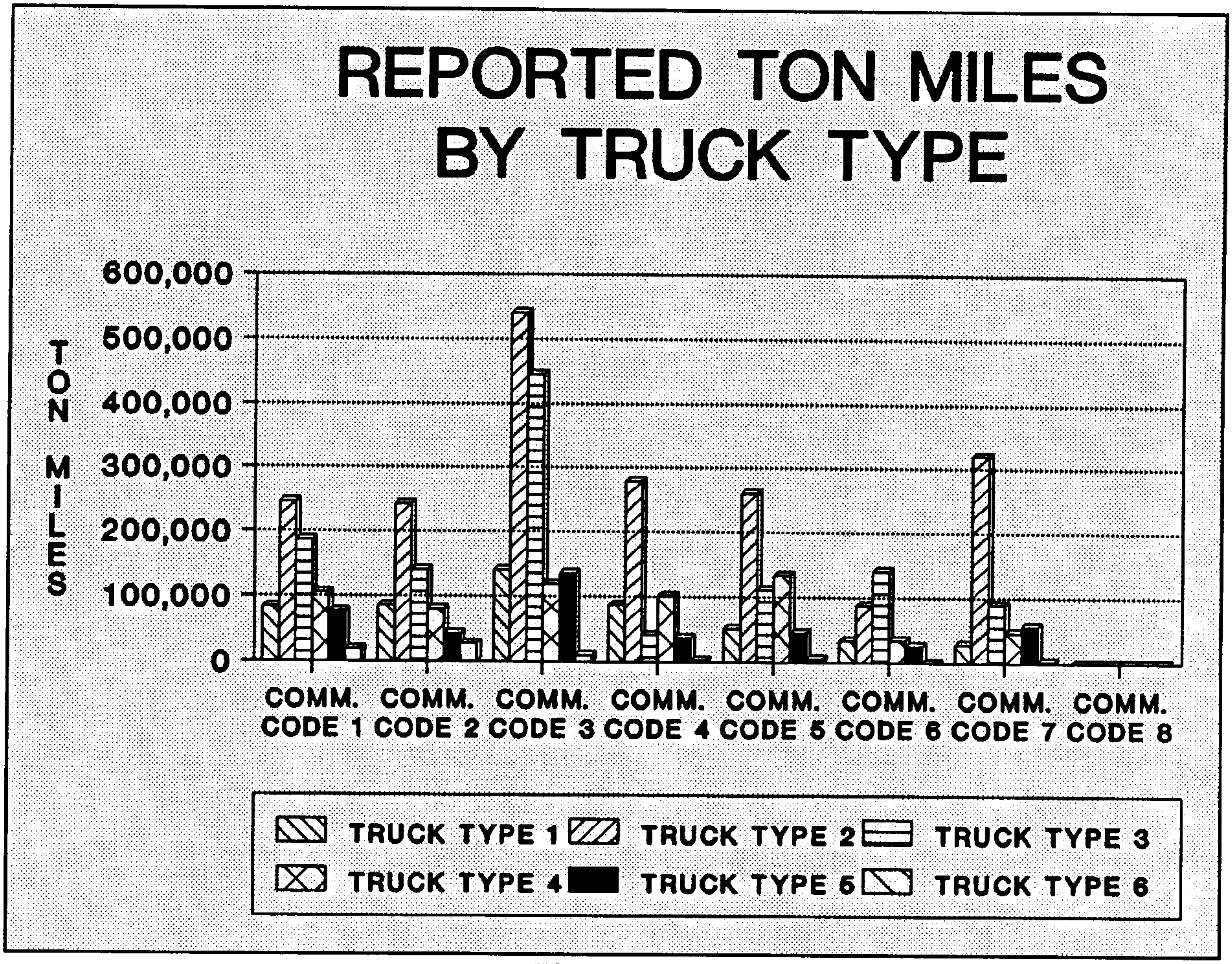


Figure 5.17

Figure 5.17 present a similar relationship showing breakdown of ton miles by truck type and commodity. This graph shows and overwhelming percentage of ton miles in the construction material area. Otherwise, the commodity movements appear relatively equal, with significant variations between truck types.

The percentage of ton miles traveled by the sample truck is presented in Figure 5.18. Because of the dominating affects of mileage on the ton miles the direct relationship mentioned previously is again apparent. Only slight change in the percentages a evident from the mileage percentages outlines previously.

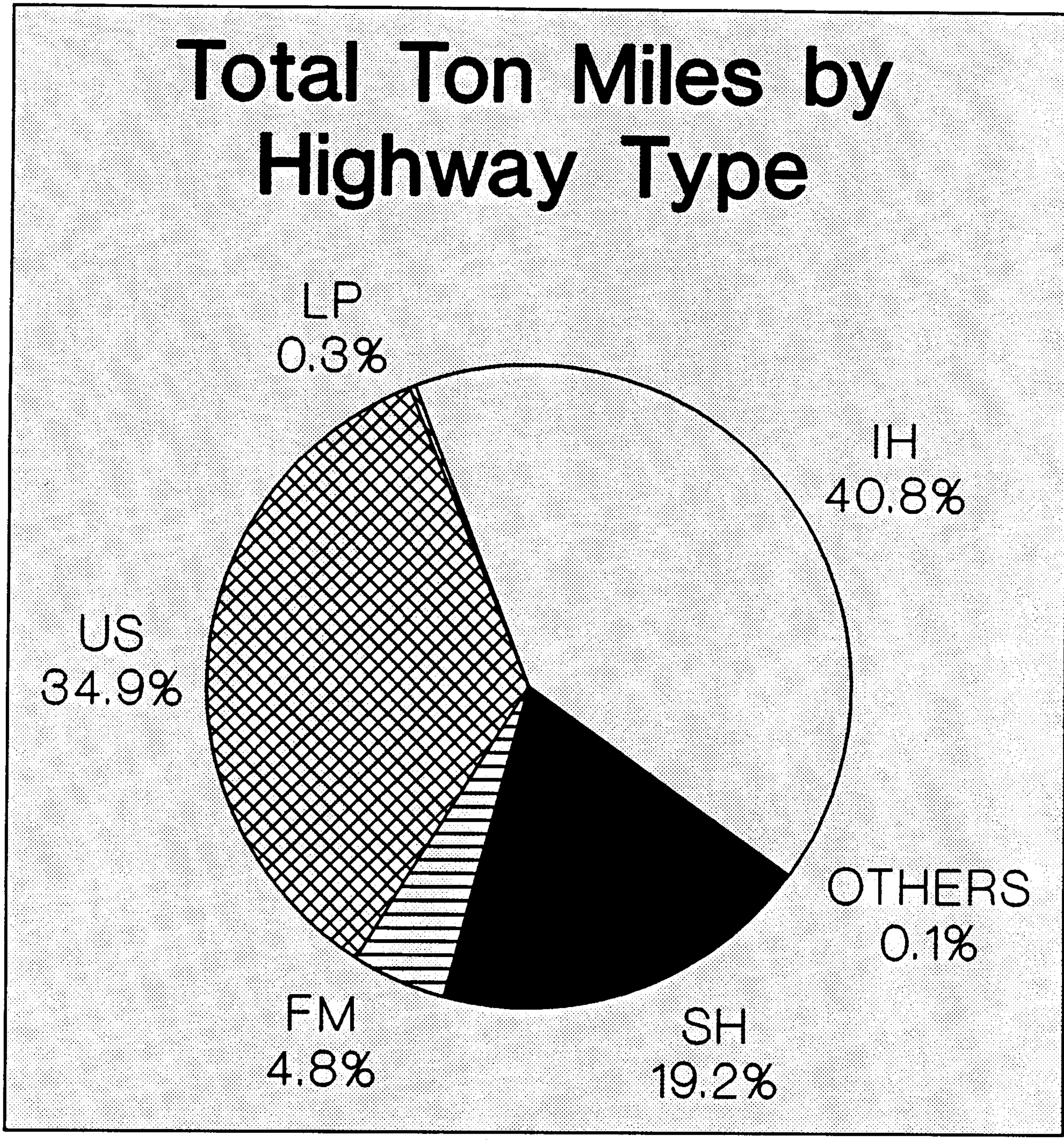


Figure 5.18

Table 5.12 on the preceding pages presents a more through and detailed review of the ton miles broken down by highway type, and commodity.

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TONMILE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	IH TONMILES	PERCENT OF IH TONMILES	PERCENT OF TOTAL TONMILES
1	AGRICULTURE & RELATED	182,507	9.418%	3.844%
2	HAZARDOUS MATERIALS	213,517	11.019%	4.498%
3	CONSTRUCTION MATERIALS	503,955	26.007%	10.616%
4	FOOD & RELATED PRODUCTS	296,677	15.310%	6.249%
5	MANUFACTURING SUPPLIES	295,880	15.269%	6.233%
6	MACHINERY & EQUIPMENT	92,861	4.792%	1.956%
7	MIXED FREIGHT SHIPMENTS	352,357	18.184%	7.422%
8	EMPTY	0	0.000%	0.000%
	TOTAL	1,937,754	100.000%	40.819%

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TONMILE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	US TONMILES	PERCENT OF US TONMILES	PERCENT OF TOTAL TONMILES
1	AGRICULTURE & RELATED	336,032	20.292%	7.078%
2	HAZARDOUS MATERIALS	214,912	12.978%	4.527%
3	CONSTRUCTION MATERIALS	482,288	29.124%	10.159%
4	FOOD & RELATED PRODUCTS	169,826	10.255%	3.577%
5	MANUFACTURING SUPPLIES	195,705	11.818%	4.123%
6	MACHINERY & EQUIPMENT	119,742	7.231%	2.522%
7	MIXED FREIGHT SHIPMENTS	137,500	8.303%	2.896%
8	EMPTY	0	0.000%	0.000%
	TOTAL	1,656,005	100.000%	34.884%

TABLE 5.12

PART I of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TONMILE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	SH TONMILES	PERCENT OF SH TONMILES	PERCENT OF TOTAL TONMILES
1	AGRICULTURE & RELATED	160,711	17.674%	3.385%
2	HAZARDOUS MATERIALS	135,015	14.848%	2.844%
3	CONSTRUCTION MATERIALS	315,118	34.655%	6.638%
4	FOOD & RELATED PRODUCTS	75,715	8.327%	1.595%
5	MANUFACTURING SUPPLIES	97,756	10.751%	2.059%
6	MACHINERY & EQUIPMENT	81,004	8.908%	1.706%
7	MIXED FREIGHT SHIPMENTS	43,974	4.836%	0.926%
8	EMPTY	0	0.000%	0.000%
	TOTAL	909,293	100.000%	19.154%

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TONMILE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	FM TONMILES	PERCENT OF FM TONMILES	PERCENT OF TOTAL TONMILES
1	AGRICULTURE & RELATED	34,762	15.398%	0.732%
2	HAZARDOUS MATERIALS	54,903	24.320%	1.157%
3	CONSTRUCTION MATERIALS	84,325	37.353%	1.776%
4	FOOD & RELATED PRODUCTS	5,062	2.242%	0.107%
5	MANUFACTURING SUPPLIES	13,798	6.112%	0.291%
6	MACHINERY & EQUIPMENT	26,096	11.559%	0.550%
7	MIXED FREIGHT SHIPMENTS	6,808	3.016%	0.143%
8	EMPTY	0	0.000%	0.000%
	TOTAL	225,754	100.000%	4.755%

TABLE 5.12

PART II of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TONMILE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	LP TONMILES	PERCENT OF LP TONMILES	PERCENT OF TOTAL TONMILES
1	AGRICULTURE & RELATED	1,707	11.194%	0.036%
2	HAZARDOUS MATERIALS	1,774	11.634%	0.037%
3	CONSTRUCTION MATERIALS	6,231	40.862%	0.131%
4	FOOD & RELATED PRODUCTS	706	4.630%	0.015%
5	MANUFACTURING SUPPLIES	2,431	15.942%	0.051%
6	MACHINERY & EQUIPMENT	1,140	7.476%	0.024%
7	MIXED FREIGHT SHIPMENTS	1,260	8.263%	0.027%
8	EMPTY	0	0.000%	0.000%
	TOTAL	15,249	100.000%	0.321%

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TONMILE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	PR & RR TONMILES	PERCENT OF PR & RR TONMILE	PERCENT OF TOTAL TONMILES
1	AGRICULTURE & RELATED	1932	60.946%	0.041%
2	HAZARDOUS MATERIALS	52	1.640%	0.001%
3	CONSTRUCTION MATERIALS	1144	36.088%	0.024%
4	FOOD & RELATED PRODUCTS	40	1.262%	0.001%
5	MANUFACTURING SUPPLIES	2	0.063%	0.000%
6	MACHINERY & EQUIPMENT	0	0.000%	0.000%
7	MIXED FREIGHT SHIPMENTS	0	0.000%	0.000%
8	EMPTY	0	0.000%	0.000%
	TOTAL	3,170	100.000%	0.067%

TABLE 5.12

PART III of IV

COMMODITY REPRESENTATION IN ALL SURVEYS
INTER-CITY TONMILE BREAKDOWN BY COMMODITY AND HIGHWAY TYPE

COMM CODE	COMMODITY NAME	TOTAL TONMILES	PERCENT OF TOTAL TONMILES
1	AGRICULTURE & RELATED	717,651	15.117%
2	HAZARDOUS MATERIALS	620,173	13.064%
3	CONSTRUCTION MATERIALS	1,393,061	29.345%
4	FOOD & RELATED PRODUCTS	548,026	11.544%
5	MANUFACTURING SUPPLIES	605,572	12.756%
6	MACHINERY & EQUIPMENT	320,843	6.759%
7	MIXED FREIGHT SHIPMENTS	541,899	11.415%
8	EMPTY	0	0.000%
	TOTAL	4,747,225	100.000%

TABLE 5.12

PART IV of IV

5.7 Data Collection Problems Encountered

Based on the information presented in the previous section, it is apparent that the most significant problem encountered in the data collection phase was the response rate associated with intercity commodity movements. Although the overall response rate of returned questionnaires was relatively high for a survey of this type, this was still a significant problem.

It was recognized in formulating the project that not all of the trucks sampled would be utilized for intercity service. The results of the pilot survey confirmed this and as a result the sample size was progressively increased for each of the four surveys. In addition, the minimum GVW category was increased from 10,000 to 26,000 pounds since vehicles of this type are not commodity carrying vehicles and do not contribute to structural highway needs to the extent of the larger trucks.

In order to achieve the extent of geographic and commodity coverage attempted in an economical and efficient manner for this project, it was necessary to rely upon a mail survey sent to trucks registered in Texas. The tasks of identifying vehicles on the highways and then sending a questionnaire, or that of stopping and interviewing drivers in order to secure the data are time consuming, labor intensive and expensive given the geographic coverage encompassed by this study. While only trucks in intercity traffic would be targeted this, in itself, is no guarantee that the quality or quantity would improve.

Another problem encountered had to do with leased trucks. Truck leasing firms own the vehicles which are registered in their name but have no information regarding the activity of the vehicles selected in the sample. The number of vehicles owned by leasing companies and the number selected in the sample was not determined. The majority of questionnaires sent to leasing firms were either returned with a letter stating that the company had no information regarding the activities of the truck or were not returned. Some, however, did forward the questionnaire to the leaseholder.

The staff could determine no effective method to resolve the problem of collecting commodity information on leased trucks. By dealing directly with the larger leasing firms, a procedure to forward the questionnaire to the leaseholder might be developed. However, if the commodities carried by leased trucks are not different than those transported by leaseholders, the failure to obtain responses from the leaseholder may not significantly effect the estimated flows.

The questionnaire was designed to be as short, simple and concise as possible and still provide essential data. The questionnaire could easily be completed by the driver during the day in a relatively short period of time. However, some drivers may have considered the questionnaire complex and time consuming which might account for some of the non-responses. When compared to similar questionnaires sent to motor carrier firms by the Bureau of the Census and FHWA for the Nationwide Commodity Flow study, the questionnaire developed for the project was very concise and straight forward.

By relying on a mail questionnaire sent to a randomly selected group of carriers, it is impossible to determine if the sample vehicles are actually in service beforehand. This is a basic shortcoming of the approach used in this study. However, it would be virtually impossible to obtain both the geographic, commodity, and highway facility without utilizing the data collection approach selected and outline in this document. While conducting data collection, efforts in one specific corridor - such as IH 45 between Houston and Dallas may provide detailed information on commodity movements within a limited area. The work would need to be replicated at numerous sites to furnish the results obtained by mail questionnaire.

5.8 Conclusion

Previous attempts to collect data on the movements and characteristics of intercity freight traffic have met with mixed success. The results of this current effort are viewed by this staff as unparalleled in success as a multiple phase integrated origin destination commodity flow study. Unlike studies undertaken by the United States Bureau of the Census, this study, as have many others, relied upon voluntary cooperation and response. The fact that over 40 percent of the questionnaires were returned was viewed as a good and acceptable response rate. However, not all of the responses indicate intercity travel on the sample day, and the extent of information regarding intercity commodity flows is considered limited. Even with these limitations, the study does provide heretofore unavailable and uncompromised insights into the commodity flows over the highways and throughout the state of Texas.

Information is presented in Table 5.7 on the distribution of returned surveys indicating sample vehicle "in fleet" by vehicle type. As in the previous table, it is apparent that the large truck types are most often involved in intercity movements. The largest percentage of all vehicle types indicated "not in use" on the sample days. However, vehicle types tractor-semi-trailer, truck-trailer and tractor-semi-full trailer indicated high percentages of intercity travel.

Table 5.8 shows the distribution of reported tons and ton-miles by gross vehicle weight and Table 5.9 presents the same distribution by truck type. As seen in 5.8, the vast majority of tons and ton-miles were reported by the larger GVW trucks. Also, it appears that the larger vehicles tend to make somewhat longer trips as the percentage of ton miles is considerably greater than the percentage of tons transported. Conversely, the lighter GVW trucks tend to make shorter trips. The information presented in 5.9 also confirms that longer trips are reported by the larger vehicle categories.

Table 5.10 on the distribution of reported trips by loaded/empty status and indicated truck type. The loaded/empty ratios are relatively constant across all of the truck types with between 57 and 60 percent of the trips reported as loaded. Slightly more than 58 percent of all trips were loaded. The coverage length of all loaded trips was 63.4 miles while the average length of empty trips was 51.9 miles with loaded trips approximately 22 percent longer mileage than empty trips.

The distribution of ton miles by highway type is presented in Table 5.11. One third of the reported ton miles of travel occurred on interstate highways and 35.4 percent on U.S. highways. It is probable that the distribution of ton miles of travel reported is biased against interstate facilities due to the failure to identify through Texas truck movements.

Table 5.12 shows the distribution of ton miles of truck traveled by seven commodity groups. These groups were developed by combining similar two digit STCC's. This was necessary due to the limited number of observations in several STCC categories.

APPENDIX A

THE FINAL SURVEY FORM

Texas Highway Commodity Flow Study

TEXAS TRANSPORTATION INSTITUTE ▪ COLLEGE STATION, TEXAS 77843 ▪ TEXAS A&M UNIVERSITY

March 14, 1990

Dear Sir,

The Texas Transportation Institute at Texas A&M University, in cooperation with the State Department of Highways and Public Transportation, is conducting a research study of commodity movements on the highways of Texas. The purpose of this study is to develop information indicating the types and volumes of commodities by origin and destination moving over the highway system.

This information will be of significant benefit to the State Department of Highways and Public Transportation in activities such as project evaluation, system improvements, and strategic planning efforts. Areas such as highway maintenance and rehabilitation needs, capacity improvement projects, truck traffic forecasts for designation of large truck networks and access requirements, and information for highway safety improvements can benefit from the results of this study.

In addition, the availability of commodity flow data will aid local and state officials in economic development programs, industrial location activities, and efforts to increase employment opportunities. Public officials will have information that reflects the important role of the trucking industry to the economic well being of Texas. In turn, the trucking industry will have information which documents the breadth and depth of its activities throughout the State.

The questions on the following pages have been designed to minimize the time and effort necessary for completion. The questionnaire is being sent in advance of the sample day in order to reduce the need to retrieve the requested information from your files. No proprietary information (such as customers' names and addresses, rates or charges, or more than a 2-digit commodity code) is required to complete the questionnaire. **Only information related to the vehicle identified by the license registration number and/or the vehicle identification number (VIN) located in the upper right hand corner of the next page is requested.** [If you receive more than one questionnaire, please complete each for the vehicle identified.] Also information requested is for **activities only during the 24-hour period - March 21, 1990.**

If the specified vehicle is not currently registered or no longer in your fleet please check the box in Section A and return. If the vehicle was not in service at all during the 24-hour period, you are asked to complete only questions 1 and 2 (Section A) and return the questionnaire. If the specified vehicle was in service, complete either Section B or Section C. Section B of the questionnaire is to be completed for truck operations and travel within a city. Section C should be completed for trucks making trips outside and between cities. It is not necessary to provide information regarding city travel for trucks operating between cities.

Please take the time necessary to complete the questionnaire and return it in the postage paid envelope by March 28, 1990. This information is vital to an improved highway system, necessary for economic development programs and reflects the role of trucking to the State's economy. If you have any questions regarding the questionnaire or the research objectives, call me at 409-845-5815.

Sincerely,

Jack T. Lamkin

Jack T. Lamkin
Study Supervisor

* **SEE IMPORTANT NOTE ON PAGE 4**

The purpose of this questionnaire is to obtain an estimate of the commodity flow on Texas highways to use in planning future improvements. The information requested here will be used to benefit Texas highways and their users and WILL NOT BE USED FOR TAX OR REGULATORY PURPOSES.

The following questions concern the commodity or commodities transported by one of your trucks during the 24-hour period starting at 2 a.m. on **WEDNESDAY, MARCH 21, 1990**. This includes any trip originating or ending in the State of Texas.

SECTION A

☐ If the vehicle with this registration number is no longer in your fleet, please check this box and return the questionnaire.

1. The vehicle with this registration number is a:

____ single unit truck
____ tractor and semitrailer
____ truck and trailer
____ tractor, semi, and full trailer

2. Was the truck with this registration number in use within the state of Texas at any time during the 24-hour period starting at 2 a.m. on MARCH 21, 1990?

____ YES (please complete section B or section C)
____ NO (please stop here and return the questionnaire in the postage-paid envelope)

If, during the 24-hour period on MARCH 21, 1990, the truck with this registration number was used only for within city travel, please complete section B. If the truck was used for between city travel, please complete section C.

SECTION B

PLEASE COMPLETE THIS SECTION IF THE TRUCK WAS USED ONLY FOR TRAVEL WITHIN THE CITY LIMITS ON MARCH 21, 1990.

Please provide the following information relating to the activity of the truck on the 24-hour period starting at 2 a.m. on MARCH 21, 1990. Use the 2-digit commodity code from page 4 which best describes the commodity transported.

EXAMPLE:
The truck carried gravel to various locations within the city of La Grange on March 21.

CITY	PRINCIPAL COMMODITY	MILES TRAVELED ON MARCH 21
La Grange	14	48

CITY	PRINCIPAL COMMODITY	MILES TRAVELED ON MARCH 21
____	____	____

SECTION C

PLEASE COMPLETE THIS SECTION IF THE TRUCK MADE ANY TRIPS OUTSIDE THE CITY LIMITS ON MARCH 21, 1990.

Please provide the following information relating to the vehicle with this registration number. A "trip" begins and ends with a stop to pick up or deliver. Do not count rest stops as beginnings or endings of trips. Trips with an origin or destination in Texas should be entered. Please use the commodity code from page 4 which best describes the commodity transported. Enter commodity weight (net weight) rather than gross vehicle weight. Please use the complete highway route designation (such as US 287, FM 102, etc.) for "ROUTE TAKEN". Do not include city streets or county roads.

EXAMPLE:
The truck carried a load of gravel from Houston to Bryan, unloaded, and returned empty to Houston.

	TRIP ORIGIN (city)	DESTINATION (city)	COMMODITY CODE	WEIGHT (tons)	ROUTE TAKEN
1.	Houston	Bryan	14	15	US 290, SH 6
2.	Bryan	Houston	00	0	SH 6, US 290

	TRIP ORIGIN (city)	DESTINATION (city)	COMMODITY CODE (See page 4)	WEIGHT (tons)	ROUTE(S) TAKEN
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

Please mail this questionnaire using the enclosed prepaid envelope before March 28, 1990.

Highway Commodity Flow Study, Texas Transportation Institute, Policy and Management Program, Texas A&M University, College Station, Texas 77843.

COMMODITY
GROUP

STCC CODE	DESCRIPTION
01	Farm Products
08	Forest Products
09	Fish and other Marine Products
10	Metallic Ores
11	Coal
13	Crude Petroleum, Natural Gas and Gasoline
14	Non Metallic Minerals, Except Fuels (includes sand and gravel)
19	Ordnance and Accessories
20	Food and Kindred Products
21	Tobacco Products
22	Textile Mill Products
23	Apparel and Other Finished Textile Products
24	Lumber and Wood Products, Except Furniture
25	Furniture and Fixture
26	Pulp, Paper, and Allied Products
27	Printed Matter
28	Chemicals and Allied Products
29	Petroleum and Coal Products
30	Rubber and Miscellaneous Plastics Products
31	Leather and Leather Products
32	Stone, Clay, Glass and Concrete Products
33	Primary Metal Products
34	Fabricated Metal Products
35	Machinery, Except Electrical
36	Electrical Machinery, Equipment and Supplies
37	Transportation Equipment
38	Instruments, Photographic and Medical Goods, Watches and Clocks
39	Miscellaneous Products of Manufacturing
40	Waste and Scrap Materials
41	Miscellaneous Freight Shipments
42	Containers, Shipping, Returned Empty
43	Mail and Express Traffic
44	Freight Forwarder Traffic
45	Shipper Association and Similar Traffic
46	Miscellaneous Mixed Shipments
47	Small Packaged Freight Shipments
00	Empty

If the commodity carried cannot be classified using a 2-digit STCC Code, please provide a written description of the commodity under the Commodity Code heading on page 2 or 3.

* This is the last of a 4-part survey measuring Texas commodity flow on a specific date. Sample vehicles were selected randomly using a database provided by the Texas State Highway Department. It is possible that your firm may already have completed one of the former surveys. Since the results of the survey are based upon the information provided by the sample vehicles, your participation and cooperation are vital to the overall success of the study.

APPENDIX B

HOW THE SAMPLE WAS SELECTED

HOW THE SAMPLES ARE SELECTED

The "raw material" for the commodity flow study are the registration tapes (reels) obtained from the SDHPT. All the samples used in the surveys were drawn from these tapes. For each survey, the samples are drawn *without replacement*, meaning data that has been used in any given survey does not qualify for any other survey. This is made possible by manipulating the random number variable.

All programs for sampling were written in SAS language and processed on a mainframe. There are two input files: **NEW.OVER26K** (which is the master file), **IRP.MASTTI** (contains ACCOUNT and CONTROL information). The second file, is further divided into two data sets: ACCOUNT data and CONTROL data. A total of three data sets should be prepared for the input. There are also three output data sets, however, one of them is an intermediary file. (*see diagram 1 for details*). The other two output files are the samples, one is for regular trucks and the other is for apportioned trucks.

To make the discussion more comprehensive and more understandable, an actual process of sampling is presented in the steps below:

1. Create a new directory to hold related files together. Name the directory TY (TK for the first sample, TX for the second, and TY for the third)

2. Modify program TX.REGCREAT to suit the current need and save it as TY.REGCREAT. Modifications are as follows:

    - Calculate the limits for RANUNI (the random generator) range for 8,000 samples, starting from 0.0947693 as the lower limit (lower boundaries have been used for the previous surveys and the sampling is without replacement, thus the limit now starts from .0947693). The upper limit is estimated based on previous outcome. Since the previous limits are .03565577 through .0947693, or .059113526 range for 7500 samples, thus 8000 samples requires (8000/7500)* .059113526 = .0630544277 range. This number is then added to .0947693 to get the upper limit, that is .157823727.

- Modify the RANUNI statement to: "*IF RANUNI .GT. .0947693 .AND. RANUNI .LE. .157823727*"

3. Run REGREATE

Results: 191636 lines were read from NEW.OVER26K
Data TEXASTRK has 7944 observations
Data IRP49 has 3649 observations

Analysis: From previous experience, the yield of IRP49 is usually about 12%, thus, 3649 observations will produce about 440 samples. This gives a total of 8384 samples, which is too many for the desired 8000 samples. Therefore, the RANUNI limits needs to be revised. The upper limit should be (8000/8384)* .0630544277 = .0601632762. Thus, the new upper limit is .0947693 +.0601632762 = .1549325762.

Note: *This run extracted 7944 regular truck samples and 3649 apportioned trucks. Since the registration tape is somewhat outdated, not all of the apportioned are still active. When these 3649 records are matched to the IRP files, normally, only 11% to 12% are found. Therefore, initially, it is necessary to extract more samples than what is needed, so after the matching the total will come close to the desired number.*

4. ReRun REGCREAT.

Results: 191636 lines were read from NEW.OVER26K
Data TEXASTRK has 7586 observations
Data IRP49 has 3478 observations

Analysis: The yield of IRP49 would be 12% * 3478 = 418, thus, the total sample is estimated at 7586 + 418 = 8004, which is very close to 8000. So, it is okay to continue to the next step.

5. Modify program TX.IRPSEARC and name it TY.IRPSEARC. Remember to adjust the SEQT number for the apportioned to 27586 (the regular starts at 20001 and run through 27586). This program is the most expensive one to run, thus, double check before running it.

6. Run IRPSEARC.

Results: Data set A has 6695 observations
Data set C has 9462 observations
Data set IRP has 3478 observations
Data set APORTION has 390 observations

Analysis: The yield of IRP file is 390 samples, thus giving a total of 7586 + 390 = 7976 samples - which is close to the desired 8000 samples.

7. Now the samples are ready for printing. The regular truck samples are stored in file TEXASTRK, while the apportioned truck samples are stored in file APORTION. There are 4 programs necessary for printing. Two programs are for printing the hard copy of samples, REGPRINT for printing the regular

and IRPPRINT for printing the apportioned. Two other programs are used for printing the labels, REGLABEL for printing the regular and IRPLABEL for printing the apportioned.

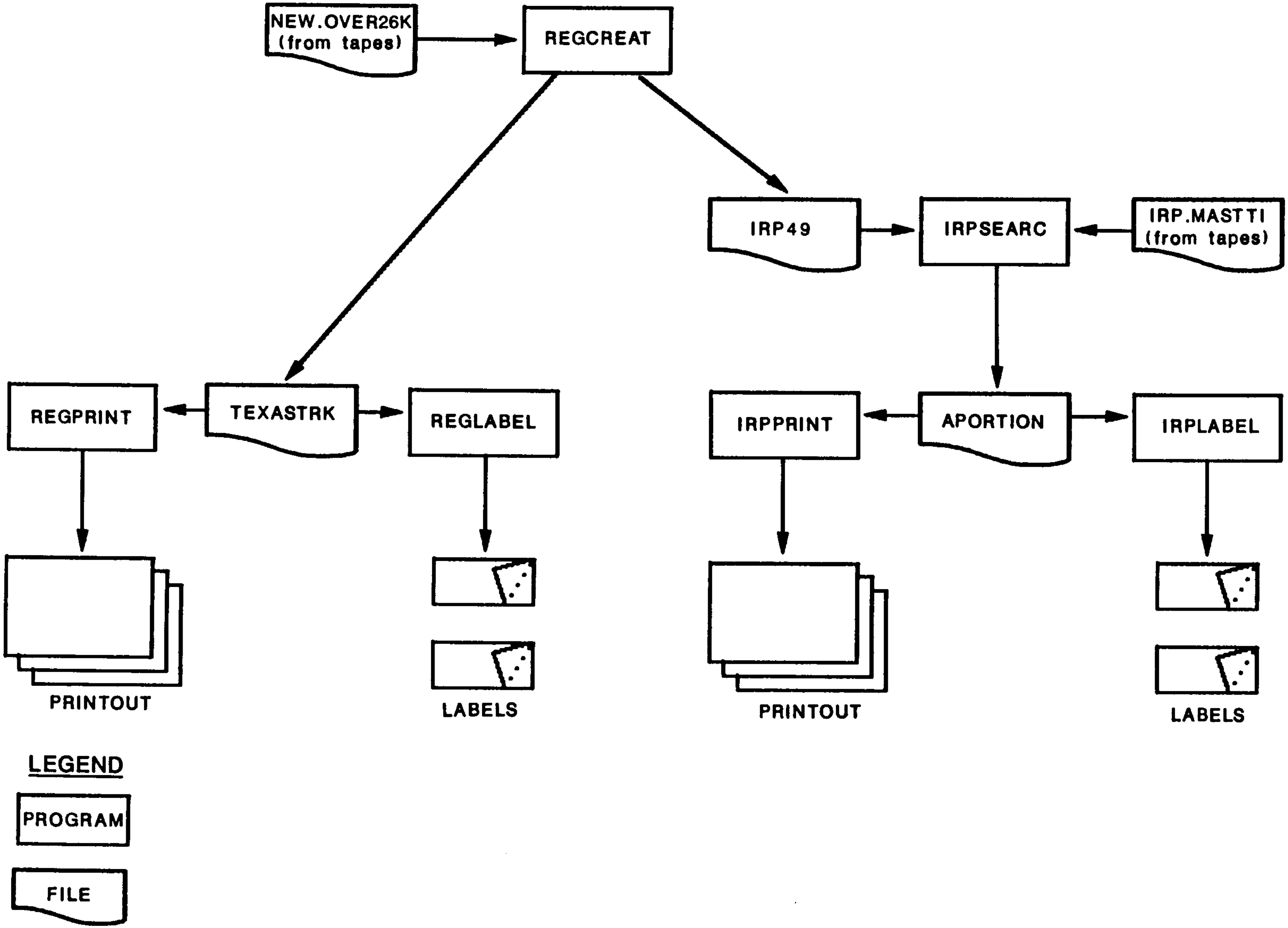
8. Modify TX.REGPRINT, TX.REGLABEL, TX.IRPPRINT, TX.IRPLABEL, TY.IRPPRINT, TY.IRPLABEL, respectively.

9. Run each of these programs, hold the output, verify the output on the screen, release the output for printing, and pick up the output (labels and hard copy).

10. Run another copy of labels, but only the address part for both REGLABEL and IRPLABEL. This part will be used for reminder cards.

The first set of tapes provide the information for the first three surveys. For the fourth survey, a set of new tapes was acquired because the old tapes were outdated.

SAMPLING PROCEDURE



APPENDIX C

DERIVATION OF n

Estimation of Sample Size

Let p be the probability that a questionnaire has an acceptable response. A questionnaire has an acceptable response when it has been appropriately filled out with intercity commodity flow information. Let $\hat{p}$ be an estimator of p. In other words, $\hat{p}$ is the rate of response with flow information divided by 100. Let α be the risk which is considered acceptable when the actual sampling error is larger than d. That is,

$$P_o \{ \mid \hat{p} - p \mid \geq d \} \leq \alpha$$

Assuming that $\hat{p}$ is normally distributed, it can be shown that the corresponding sample size is given by:

$$n_o = \frac{\hat{p}\,\hat{q}\left[\frac{Z_{\alpha/2}}{d}\right]^2}{1 + \frac{1}{N}\left\{\hat{p}\,\hat{q}\left[\frac{Z_{\alpha/2}}{d}\right]^2 - 1\right\}}$$

where: $\hat{q} = 1 - \hat{p}$

In the above equation N is the total number of trucks with GVW over 50,000 lb; $Z_{\alpha/2}$ is the abscissa associated with a given α of the normal curve. Thus, if $\alpha = 5\%$, then $Z_{\alpha/2} = 1.96$ .A reasonable sampling error, d, is 1% since $\hat{p} = 0.1$ The population size N = 57,935. Hence the actual sample size, n_o , can be calculated as follows:

$$n_o = \frac{(0.1)(0.9)(196)^2}{1 + \frac{1}{57935}\left\{(0.1)(0.9)(196)^2 - 1\right\}}$$

= 3262.

Let n be the total number of questionnaires that should be mailed. Based on results of the pilot survey, the following relationship is true:

$$n = \frac{n_o}{0.9} = 3624 \approx 3600$$

For purposes of measuring the gain of the pilot survey. Let us compute the sample size required to obtain the equivalent amount of commodity flow information when N is defined as the total number of trucks with GVW equal or larger than 10,000 lb.

Thus, if 3,600 questionnaires are mailed, then the actual sample size is 3,262. If the rate of response with flow information is 10.1%, then the expected number of questionnaires with flow information

is:

$$3262(0.101) = 329$$

If the overall rate of response with flow information is 3.5% when N = 265,154 then the required sample size

is:

$$\frac{329}{0.035} = 9400$$

and the equivalent number of mailing questionnaire

is:

$$\frac{9400}{0.9} = 1044$$

In other words, the expected commodity flow information that can be obtained from 3,600 trucks with GVW over 50,000 lb is equivalent to the information from 1,044 trucks with a GVW over 10,000 lb.