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16. Abstract

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TEXAS HIGHWAY COST ALLOCATION ANALYSIS AND ESTIMATES, 1992–1994

Research Report 1919-2 / 1910-3

Prepared by

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Research Study 1919

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Research Study 1910

— *"Cost Allocation Procedure Enhancement"* —

Prepared for the

TEXAS DEPARTMENT OF TRANSPORTATION

November 1993

IMPLEMENTATION STATEMENT

The cost recovery analysis provides a policy tool for evaluating changes in user fees and charges in Texas. The model can be adjusted for a variety of traffic and cost conditions. Implementation of these changes, however, is contingent on action by the state legislature. The cost recovery analysis should be updated annually to reflect basic changes in traffic, as well as changes in user fee and tax rates.

Prepared in cooperation with the Texas Department of Transportation

DISCLAIMERS

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PREFACE

Highway cost responsibility analysis for Texas began with a coordinated research effort by the Center for Transportation Research (CTR) and the Texas Transportation Institute (TTI) — research studies 362 and 332, respectively. Two research reports summarizing this work were presented in Research Reports 332-1 and 332/362-2F. The cost responsibility methodologies and models were improved in subsequent studies by CTR and TTI. A list of the studies and the responsible institution, period of analysis, and products for each is given below:

Research Study	Institution	Base Period of Analysis	Product
332	TTI	1980	332-1
362	CTR	1980	332/362-2F
390	CTR/TTI	1985	390-1F
974	CTR/TTI	1985	Videotape
1937	CTR	1988	1937-1F and Videotape
1910	TTI	1988	1910-1
		1990	1910-2 (Briefing Report)
1919	CTR	1990	1919-1

This report (1919-2) summarizes the continuations of research studies 1910 and 1919. The base year of analysis is 1992, with estimates included for 1993 and 1994.

ABSTRACT

A summary of the 1992 analysis of cost responsibility, including estimates for 1993 and 1994, is presented. The methodological process is described. The process involves 1) designation of vehicle classes and fleet estimation; 2) revenue estimation and allocation; 3) cost estimation and allocation; and 4) revenue/cost comparison. Based on the analysis, combination trucks pay about 50 percent of their assigned costs and buses 27 percent of their assigned costs. Other single-unit vehicles contribute more than their assigned costs.

STATEMENT REGARDING METRIC EQUIVALENT VALUES

In preparing this report, the researchers for Studies 1919 (CTR) and 1910 (TTI) conferred with and sought the guidance of their TxDOT Research Project Director regarding metric equivalents for the numerical values (expressed in customary English units) given throughout this report. It was decided that, for ease of comparison with previous highway cost allocation (HCA) reports (on research studies 332, 364, 390, and 1937), these values would stand as they were originally written — e.g., $/vehicle mile, ¢/gallon, vehicle weight in pounds, and so forth. Corresponding metric equivalents are now provided in parentheses after the customary units.

Data from all the TxDOT HCA studies, then, are expressed in the same or in similar terms, and trends since 1980 can be more easily discerned. It is hoped that this will facilitate understanding and use by the reader of the information presented herein.

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SUMMARY

The goal of planners, engineers, and administrators in the highway transportation sector of government is to manage available public funds in the most efficient and equitable manner possible. Because of the enormous financial and social consequences of highway investments, the use of economic analyses of existing and proposed policies is of paramount importance. These analyses are important tools in the decision- and policy-making process. In the development of the tools involved, basic principles suggest that the price incurred by users of the highway facilities should equal the cost responsibility of each user. Given this fundamental assumption, the problem becomes how to fairly distribute these costs and then recover the costs through user charges and fees. In evaluating the total cost of highway transportation, the following overall factors must be considered:

- The cost of operating vehicles on a facility.
- The cost of providing a facility.

Obviously, the cost of operating vehicles is the direct responsibility of the users of the facilities. Fuel and oil consumption, tire wear, maintenance, repair, insurance, and depreciation are the types of costs in which equitable distribution, as reflected in the price to specific users, already exists. These costs comply with the basic principle stated above.

The cost of providing a facility, however, does not directly follow this rule. Constructing, rehabilitating, maintaining, and administering highways requires great financial investments. These investments are the responsibility of the Texas Department of Transportation (TxDOT). The equitable distribution of these costs and subsequent pricing strategies set to generate revenues are achieved by applying the process of highway user cost responsibility and road cost recovery.

The principal objective of the study is to determine whether each vehicle or class of vehicles contributes fairly to the cost of providing highway systems. Traditionally, equity is used as the fairness criterion. The cost of supporting a highway is deemed fair if there is an equitable distribution of costs and revenues among different groups of vehicles. Under a cost-occasioned approach, equity occurs when each group's percentage of total assigned costs is equal to that group's percentage of total contributed revenues. A revenue/cost equity ratio is used for this purpose. A ratio with a value greater than one means that the vehicle class is contributing more in user taxes and fees than its

responsible costs. A value less than one means the vehicle class is not paying enough. The results for 1991 to 1994 are shown below:

Revenue/Cost Equity Ratio

Vehicle Class	1991 Actual	1992 Preliminary	1993 Estimate	1994 Estimate
Passenger Car	1.22	1.16	1.18	1.15
Pickup Truck	1.56	1.75	1.76	1.87
Buses:	.27	.29	.30	.30
2-Axle	.36	.40	.41	.40
3-Axle	.16	.17	.18	.18
Single-Unit Trucks:	1.04	1.15	1.07	1.06
2-Axle	.93	1.04	.96	.95
3- or more Axle	1.27	1.39	1.33	1.31
Combination Trucks:	.53	.52	.50	.51
3-Axle	.10	.09	.10	.10
4-Axle	.16	.13	.12	.12
5-Axle	.63	.61	.60	.61
6-Axle	.27	.20	.18	.17
5-Axle Twin	.50	.46	.44	.43
6-Axle Twin	.23	.17	.18	.17

These results represent the most accurate estimates to date. Previous studies on Texas Highway Cost Allocation have served to define and refine the methodologies used to estimate and allocate Texas highway costs and revenues. The Preface to this report provides a summary of the previous studies that have served as a foundation for the results presented in this report.

SECTION 1. INTRODUCTION

OVERVIEW

The goal of planners, engineers, and administrators in the highway transportation sector of government is to manage available public funds in the most efficient and equitable manner possible. Because of the enormous financial and social consequences of highway investments, the use of economic analyses of existing and proposed policies is of paramount importance. These analyses are important tools in the decision- and policy-making process. In the development of the tools involved, basic principles suggest that the price incurred by users of the transportation facilities should equal the cost responsibility of each user. Given this fundamental assumption, the problem becomes how to fairly distribute these costs and then recover the costs through user charges and fees. In evaluating the total cost of highway transportation, the following overall factors must be considered:

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The cost of providing a facility, however, does not directly follow this rule. Constructing, rehabilitating, maintaining, and administering highways requires great financial investments. These investments are the responsibility of the Texas Department of Transportation (TxDOT). The equitable distribution of these costs and subsequent pricing strategies set to generate revenues are achieved by applying the process of highway user cost responsibility and road cost recovery.

PRINCIPLES OF HIGHWAY USER COST ALLOCATION

The principal objective of the study is to determine whether each vehicle or class of vehicles contributes fairly to the cost of providing highway systems. Traditionally, equity is used as the fairness criterion. The cost of supporting a highway is deemed fair if there is an equitable distribution of costs and revenues among different groups of vehicles. Under a cost-occasioned approach, equity occurs when each group's percentage of total assigned costs is equal to that group's percentage of total contributed revenues.

Although equity is a goal for most highway cost allocation studies, it is not necessarily synonymous with fairness. It is possible to have an unfair, yet equitable, system. This outcome can be avoided by including certain principles into the overall design of the cost/revenue allocation methodology. These three principles are completeness, rationality, and marginality. Inclusion of these principles establishes a context for a fair and equitable highway support system.

The principle of completeness suggests that the provision and upkeep of highways are entirely financed by the various users of the system. This is a traditional component of the user-pay method for highway finance and is accepted by most transportation departments. Basically, it argues that the highway system is designed principally to meet the needs of the motoring public and, therefore, should be financed by vehicle operators.

A logical element in a fair distribution of costs is an allocation mechanism that ensures efficiency, i.e., vehicle groups will not pay more by participating in a joint or common facility than they would pay for their own exclusive facility. This concept is known as the rationality principle. A major problem with traditional methods of cost allocation is that they overlook other strategic alternatives which may exist for the users. The rationality principle constitutes as essential element of fairness, and provides an incentive for an individual vehicle class to share a common facility. An allocation of system costs which violates this principle would bring about strong objections, since a given vehicle class might not be willing to participate in the financing of the common facility when it is economically more attractive to participate in another type of facility. In practice, an exclusive facility is not a real option; however, inclusion of this principle into design of cost allocation helps assure a fairer distribution of system costs.

The third principle is marginality. The marginality principle states that no individual vehicle class should be charged less than the marginal cost, or separate cost, of including it in the joint project. For example, the marginal class cost for vehicle class A is the cost of the facility for all vehicle classes less the cost of the facility for all but vehicle class A. Assuming the completeness principle is met, violation of this marginality concept implies the existence of cross subsidization among the vehicle classes.

The preceding three principles guide the framework of the cost allocation structure used in Texas as developed in previous studies. Inclusion of these principles helps establish a reasonable and fair mechanism for distributing costs to various groups of users.[1]

REPORT OUTLINE

Figure 1-1 illustrates the basic design used in the Texas highway cost responsibility study. The study focuses on the state highway and farm-to-market road system. (City and local roads are outside the scope of this analysis.)

The first step in the cost responsibility process is the classification of vehicles into meaningful groups for analysis. The significant challenge in this part of the analysis is determining the relationship between registered vehicles and operational data. For example, combination trucks are registered according to the heaviest load that they will carry, which is not necessarily identical with their operating load. Procedures for adjusting the registration data and operational data were developed, with the results summarized in Section 2.

The revenue analysis is concerned with the identification of user-generated fees and taxes that support the highway system and the allocation of these revenues to specific groups of vehicles. Both state and federal revenues are included in the study, although the two are reported separately. A discussion of revenue analysis is presented in Section 3.

The cost analysis is presented in Section 4 and is concerned with the estimation of system costs and allocation of those costs to vehicle groups.

Section 5, equity analysis, combines the previous chapters to determine the relationship of user cost responsibility and user-generated revenues. Revenue/cost equity ratios are used to compare these elements. Sensitivity analysis is performed on a number of variables to determine their impact on user equity.

Conclusions of the study and future implications of the results are presented in Section 6. Appendix B details the new methodology for allocation of bridge costs, while Appendix A summarizes two additional state highway allocation studies.

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[1]For a more complete discussion on the cost allocation methodology, see Garcia-Diaz et al, *Analysis of Truck Use and Highway Cost Allocation in Texas*, SDHPT Research Report 332-1, Texas Transportation Institute, Texas A&M University, College Station, Texas, 1985, and Villareal-Cavazos et al, *The Texas Highway Cost Allocation Study*, SDHPT Research Report 390-1F, Center for Transportation Research/Texas Transportation Institute, Austin, Texas, 1988.

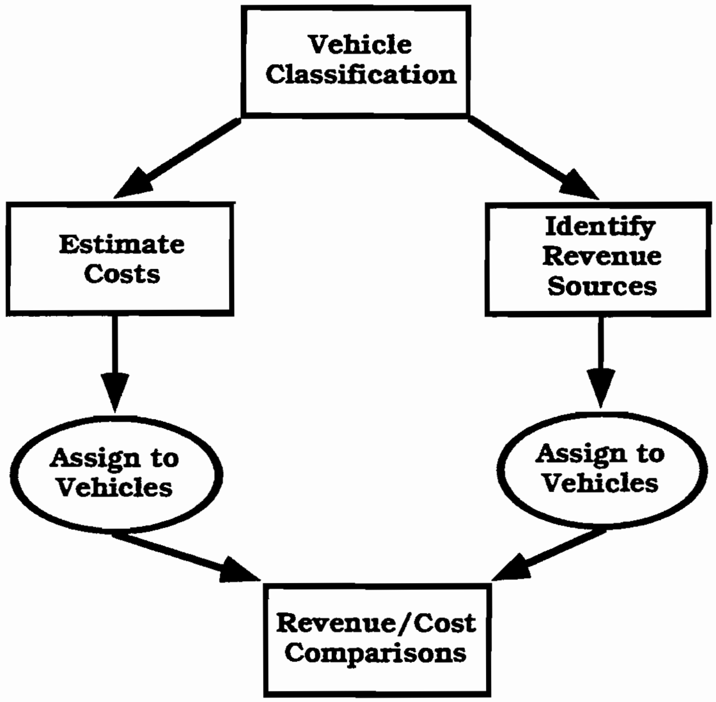

Figure 1-1
Texas Cost Allocation Procedure

SECTION 2. VEHICLE CLASSIFICATION

Ideally, it would be beneficial to know the amount of revenues and costs associated with each vehicle operating on the highway system. Only then is it possible to develop a perfectly equitable highway financing scheme. Individual vehicle cost-revenue allocation, however, is impractical. Generally, it is deemed acceptable to classify vehicles according to similar characteristics. Only if the vehicle classification scheme is chosen with care is it possible to use average values for vehicle groups and not sacrifice, significantly, measures of accuracy. Any vehicle classification scheme is a trade-off between what is desirable to know and what is possible to do, given time, personnel, and data constraints.

Based on data from the TxDOT registration files, Highway Performance Monitoring System (HPMS) data, vehicle classification data, and the 1987 Texas Truck Inventory Use Survey, vehicles are classified into five major categories: passenger cars, motorcycles, buses, single-unit trucks, and combination trucks. The bus category consists of 2-axle and 3-axle groups, and, for revenue allocation purposes, buses also are identified as either intercity-motor, private, transit, or school. Single-unit trucks include pickups, other 2-axle trucks, and 3- or more axle trucks. Combination trucks are categorized as tractor-semitrailers with 3 axles, 4 axles, 5 axles, or 6 or more axles and tractor-semitrailer-trailer combinations with 5 axles or 6 or more axles. The single-unit trucks and combination trucks are further categorized by weight and type of registration. Table 2-1 shows the number of vehicles in each of the various vehicle groups used for the 1992 cost allocation analysis.

The weight units for categorizing trucks in Table 2-1, as well as those in the tables in Section 3, are in English units. These weight groups are presented as such because they represent the existing registered weights used for Texas vehicle registration. The metric equivalents for the single-unit trucks and combination trucks are as follows:

Single-Unit Trucks		*Combination Trucks*	
<u>lbs</u>	<u>kg</u>	<u>lbs</u>	<u>kg</u>
0 – 6,000	0 – 2,724	0 – 18,000	0 – 8,172
6,001 – 8,000	2,724 – 3,632	18,001 – 36,000	8,172 – 16,344
8,001 – 10,000	3,632 – 4,540	36,001 – 42,000	16,344 – 19,068
10,001 – 17,000	4,540 – 7,718	42,001 – 62,000	19,068 – 28,148
17,001 – 24,000	7,718 – 10,896	Over 62,000	Over 28,148
24,001 – 31,000	10,896 – 14,674		
Over 31,000	Over 14,674		

Table 2-1
1992 Vehicle Distribution

	Number of Vehicles	Percent of Total Vehicles
PASSENGER CARS	8,682,731	67.34226%
0-3 years	1,790,537	13.88719%
4-6 years	1,926,085	14.93849%
More than 6 years	4,903,698	38.03252%
Over 6000 lbs	62,411	0.48405%
MOTORCYCLES	164,139	1.27304%
BUSES	62,182	0.48228%
2 Axle	60,546	0.46959%
Transit	5,214	0.04044%
Private	8,745	0.06783%
School	46,587	0.36132%
3 Axle	1,636	0.01269%
SINGLE UNIT TRUCKS	3,861,860	29.95214%
Pickup	3,311,061	25.68021%
0 - 6000 lbs	3,200,770	24.82480%
6001 - 8000 lbs	96,189	0.74603%
8001 - 10000 lbs	12,355	0.09582%
10001 - 17000 lbs	1,747	0.01355%
17001 - 24000 lbs	0	0.00000%
24001 - 31000 lbs	0	0.00000%
Over 31000 lbs	0	0.00000%
Other 2 axle	435,789	3.37993%
0 - 6000 lbs	84,603	0.65617%
6001 - 8000 lbs	267,495	2.07466%
8001 - 10000 lbs	43,596	0.33813%
10001 - 17000 lbs	26,132	0.20268%
17001 - 24000 lbs	9,365	0.07263%
24001 - 31000 lbs	4,216	0.03270%
Over 31000 lbs	382	0.00296%
3 or more axle	115,010	0.89200%
0 - 6000 lbs	0	0.00000%
6001 - 8000 lbs	0	0.00000%
8001 - 10000 lbs	5,669	0.04397%
10001 - 17000 lbs	25,856	0.20054%
17001 - 24000 lbs	25,902	0.20089%
24001 - 31000 lbs	26,061	0.20212%
Over 31000 lbs	31,522	0.24448%

	Number of Vehicles	Percent of Total Vehicles
COMBINATION TRUCKS	122,524	0.95028%
3 axle, Single Trailer	3,933	0.03050%
0 - 18000 lbs	2,419	0.01876%
18001 - 36000 lbs	1,381	0.01071%
36001 - 42000 lbs	86	0.00066%
42001 - 62000 lbs	46	0.00036%
Over 62000 lbs	1	0.00001%
4 axle, Single Trailer	7,695	0.05968%
0 - 18000 lbs	3,551	0.02754%
18001 - 36000 lbs	2,982	0.02313%
36001 - 42000 lbs	428	0.00332%
42001 - 62000 lbs	641	0.00497%
Over 62000 lbs	93	0.00072%
5 Axle, Single Trailer	104,415	0.80983%
0 - 18000 lbs	2,756	0.02137%
18001 - 36000 lbs	16,955	0.13150%
36001 - 42000 lbs	3,456	0.02681%
42001 - 62000 lbs	14,835	0.11506%
Over 62000 lbs	66,413	0.51509%
6 or More Axle, Single Trailer	1,642	0.01273%
0 - 18000 lbs	5	0.00004%
18001 - 36000 lbs	131	0.00102%
36001 - 42000 lbs	72	0.00056%
42001 - 62000 lbs	256	0.00198%
Over 62000 lbs	1,178	0.00913%
5 Axle, Twin Trailer	3,933	0.03050%
0 - 18000 lbs	90	0.00070%
18001 - 36000 lbs	343	0.00266%
36001 - 42000 lbs	153	0.00119%
42001 - 62000 lbs	1,087	0.00843%
Over 62000 lbs	2,259	0.01752%
6 or More Axle, Twin Trailer	907	0.00703%
0 - 18000 lbs	14	0.00011%
18001 - 36000 lbs	56	0.00044%
36001 - 42000 lbs	41	0.00032%
42001 - 62000 lbs	252	0.00195%
Over 62000 lbs	544	0.00422%
TOTAL VEHICLES	12,893,436	100.00000%

SECTION 3. REVENUE ANALYSIS[2]

OVERVIEW

The first step in the analysis of revenues is to identify the revenue sources supporting the highway system. Importantly, the Texas highway cost responsibility study is concerned with users; revenue sources that are not contributed by highway users, as well as user contributions not used for transportation purposes, are excluded. For example, the state vehicle sales tax paid by vehicle purchasers is not currently distributed to the State Highway Fund; instead, it is deposited into the State General Fund. Consequently, the state vehicle sales tax is not included in the revenue analysis. Additionally, about 25 percent of the state fuel tax is deposited into the State Available School Fund. Likewise, only the state fuel tax portion deposited into the State Highway Fund is included in this analysis.

Texas highway expenditures include funds from state and federal sources. In 1992, state sources accounted for nearly $2.2 billion and federal sources $1.2 billion. The taxes and fees for these two sources are highlighted in the following sections.

STATE HIGHWAY USER TAXES AND FEES

Motor fuel taxes and registration fees account for nearly 98 percent of the non-federal revenues to the Texas State Highway Fund 6. (See Figure 3-1.) The third largest revenue source (lubricants sales tax) accounts for about 1 percent of the total. These three sources of revenue are the only state sources allocated in the Texas highway cost responsibility study.

Motor Fuel Taxes

During 1992, motor vehicles paid approximately $1,188.0 million in gasoline taxes. Diesel and other fuel tax collections amounted to $226.7 million. The tax rates for diesel and gasoline are both 20¢ per gallon (5.3¢ per liter). For transit vehicles, the rates are 19¢/gallon (5.2¢/liter) for gasoline and 19.5¢/gallon (5.2¢/liter) for diesel. Fuel distributors may receive a 4¢/gallon (1.1¢/liter) credit for gasohol sales. Liquefied petroleum gas (LPG), commonly known as propane, and natural gas receipts are included in the diesel collections. The listed rate is 15¢/gallon (4.0¢/liter); however, the tax is collected through the sale of decal permits based on the weight and number of miles of travel of the vehicle.

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[2]The 1992 figures are preliminary. Actual numbers are dependent on data printed in *Highway Statistics 1992*, which has not yet been published.

Therefore, the actual rate is a function of the vehicle's operating characteristics. Motor fuels sold to the federal government and public school districts are exempt from the above motor fuel taxes. Additionally, county governments are exempt from propane taxes.

Registration Fees

Registration fees, amounting to $716.7 million in 1992, represent nearly 33 percent of state user taxes and fees. Vehicle registrations are based principally on weight, except those for passenger cars under 6,000 pounds (2,724 kg), which are registered according to vehicle age. State- and federal-owned vehicles are exempt from registration fees. Table 3-1 presents a summary of the number of exempt vehicles in Texas. Farm trucks register at one-half the normal truck registration rate. A summary of farm trucks is shown in Table 3-2. Vehicles registered as apportioned are included in the appropriate vehicle groups.

State Oil Lubricating Sales Tax

Each year the Comptroller of Public Accounts estimates the amount of sales for oil lubricants and deposits a portion of the state sales tax into the State Highway Fund, accordingly. This amounted to $18.9 million in 1992 or about 1 percent of total state user tax collections.

Total State User Taxes and Fees

Overall, nearly $2.2 billion was collected in 1992 from state user taxes and fees. Table 3-3 presents a summary of the state user tax and fee distributions to the various vehicle groups. Fuel taxes and the oil lubricants sales tax are distributed on the basis of fuel/oil consumption and miles traveled. Registration fees are allocated on the basis of the 1992 registration fee rates and the average weight for each of the vehicle classes, with the exception of automobiles under 6,000 pounds (2,724 kg), fees for which are based on the age of the vehicle.

FEDERAL HIGHWAY USER TAXES AND FEES

Texas highway users paid $1.2 billion in 1992 to the Federal Highway Trust Fund. The sources of the trust fund receipts are motor fuel taxes, truck and trailer sales taxes, federal heavy use tax, and the tire tax. The relative distribution of these taxes is shown in Figure 3-2.

Historically, states have been concerned with the ratio of federal highway trust fund apportionments to state payments into the trust fund. Since 1957, only one state has fared worse than Texas with respect to federal highway trust fund apportionments and payments. From 1956 to 1991 (the most recent year reported in *Federal Highway Statistics*), Texas has paid $17.7 billion into the Federal Highway Trust Fund and received only $15.1 billion in federal highway aid.

The structure of the Federal Highway Trust Fund raises an important question. Should the amount paid into the fund by users, or the amount the state receives from the fund, be allocated? Some state highway cost responsibility studies allocate the federal funds returned to the state and not the amount paid into the trust fund. At a glance, it would seem that this approach is consistent with the allocation of Texas state revenues. However, in fact, there is a subtle but important difference. The motor fuel tax receipts, for example, that are not allocated to the State Highway Fund are distributed to areas outside the Texas Department of Transportation. One-fourth of the fuel tax is allocated for education purposes, and a much smaller percentage is allocated to county and district highways (outside the scope of the Texas highway cost responsibility study). The amounts contributed by Texas in excess of what the state was reimbursed still went into the Federal Highway Trust Fund. Although the amount contributed was not expended in a particular year, the excess funds are still available for transportation purposes. In addition, these excess funds can be used in future years. In 1983 and 1985, Texas was apportioned more than what was actually paid into the trust fund by users. This is an important difference and the reason why the Texas highway cost responsibility study allocates the amount contributed by users into the Federal Highway Trust Fund and not the amount that was apportioned to the state.

Motor Fuel Taxes

In a manner similar to that for state taxes, federal fuel taxes are the predominant source of federal revenues. During 1992, $823.7 million was deposited by Texas highway users in the Federal Trust Fund for gasoline use. Texas vehicle operators also contributed $249.5 million in diesel taxes. Like state fuel taxes, the diesel tax includes LPG and the gasoline tax includes gasohol. These collections exclude the 1.5¢/gallon (0.4¢/liter) tax allocated to mass transit, the 0.1¢/gallon (0.03¢/liter) tax for the leaking underground storage fund, and the 2.5¢/gallon (0.7¢/liter) tax for reducing the national debt. Excluding these amounts, the tax rates were 10¢ and 16¢ per gallon (2.6¢/liter and 4.2¢/liter) for gasoline and diesel, respectively.

Truck and Trailer Sales Tax

A 12 percent sales tax is assessed on the retail sales price of trucks and trailers. A number of different vehicles are excluded from this tax, including: house trailers; school buses; camper bodies; motor homes; truck and trailer bodies designed for seed, feed, and fertilizer; trucks under 33,000 pounds (14,982 kg) gross vehicle weight; and trailers under 26,000 pounds (11,809 kg) gross vehicle weight. During 1992, $66.7 million was collected.

Tire Tax

The federal tire tax is based on the weight of the tire. The rate is 15¢/pound (33¢/kg) from 40 to 70 pounds (18 to 32 kg); $4.50 plus 30¢/pound (66¢/kg) from 71 to 90 pounds (32 to 41 kg); and $10.50 plus 50¢/pound ($1.10/kg) over 90 pounds (41 kg). Tire weights under 40 pounds (18 kg) are exempt. Additionally, buses with fixed route service, including school buses, are excluded from the tax. Slightly more than $19.6 million was collected in 1992.

Heavy Use Tax

The heavy use tax is basically similar to the vehicle registration fee. It is an annual fee on motor vehicles over 55,000 pounds (24,970 kg) gross vehicle weight. The fee rate is $100 plus $22 per 1,000 pounds (454 kg) over 55,000 pounds (24,970 kg) for vehicles with gross weights from 55,000 to 75,000 pounds (24,970 to 34,050 kg); and $550 for vehicles over 75,000 pounds (34,050 kg) gross weight. There are a few minor exemptions for logging trucks and farm vehicles traveling less than 7,500 miles (12,068 km) per year. Collections in 1992 totaled $47.3 million.

Total Federal User Taxes and Fees

The distribution of federal user taxes and fees is shown in Table 3-4. The gasoline and diesel taxes are distributed on the basis of vehicle fuel consumption and miles traveled. The heavy use tax is distributed on the basis of gross vehicle weights, similarly to the state registration fee. The truck and trailer sales tax was allocated to the vehicle groupings in proportion to the dollar sales per vehicle. The new vehicle sales price and the percent of new vehicles are forecast values from the federal highway cost allocation study (Reno, 1981). The tire tax is allocated in a similar manner.

TOTAL HIGHWAY USER TAXES AND FEES

As shown in Table 3-5, $3.4 billion was paid by vehicle operators on Texas roads and highways in 1992. Based on the vehicle classification in Section 2, this amounts to an average of $260 per vehicle. Motorcycles contributed the smallest amount ($41 per vehicle), and the 5-axle tractor-semitrailer-trailer combination contributed the most per vehicle ($7,801). Overall, passenger vehicles (automobiles and pickups) accounted for 72 percent of total highway user taxes and fees. Combination trucks, which account for 1 percent of the Texas registered vehicles, contributed nearly 18 percent of total highway user taxes and fees.

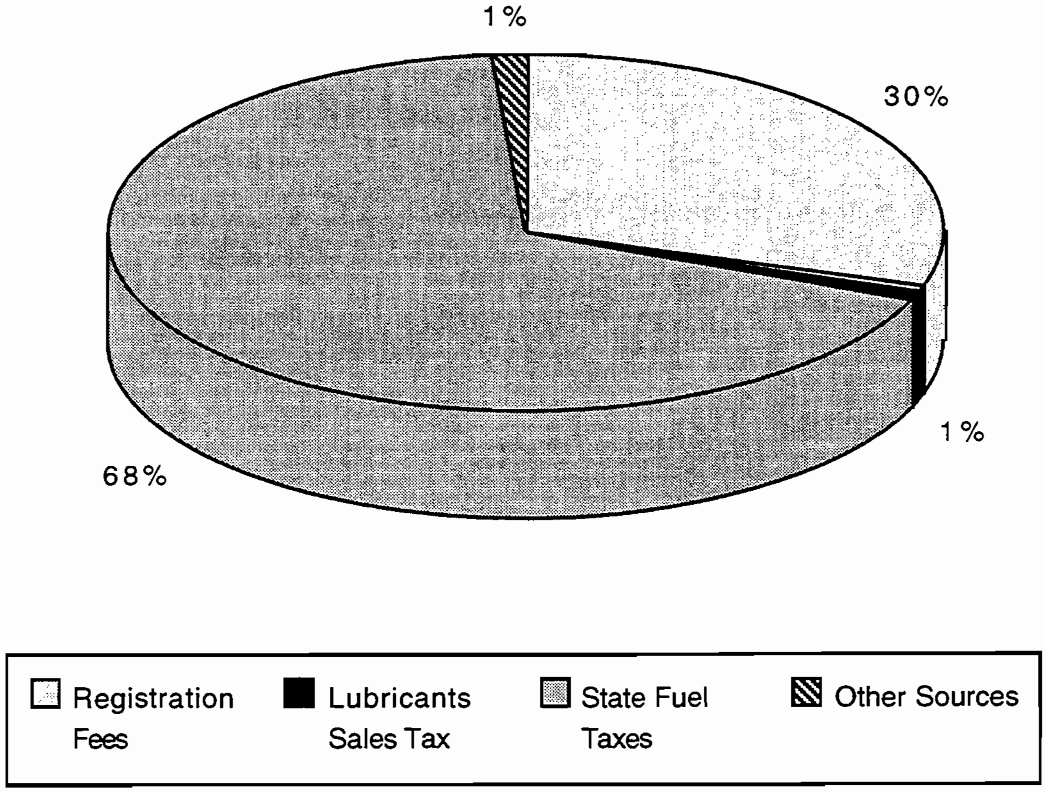

Figure 3-1
Distribution of 1992 State User Taxes and Fees

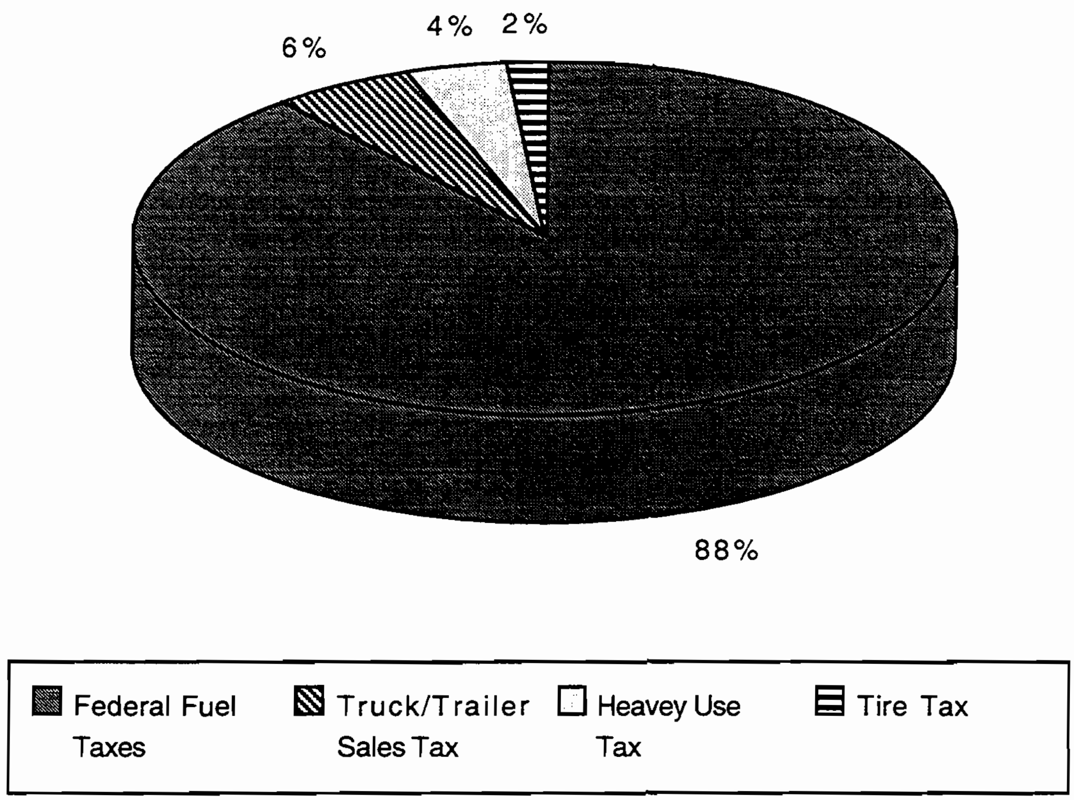

Figure 3-2
Distribution of 1992 Federal User Taxes and Fees

Table 3-1
1992 Distribution of Exempt Vehicles

	Number of Exempt Vehicles	Percent of Total Vehicles
PASSENGER CARS	150,843	38.56102%
0-3 years	31,107	7.95198%
4-6 years	33,461	8.55397%
More than 6 years	85,191	21.77790%
Over 6000 lbs	1,084	0.27718%
MOTORCYCLES	3,961	1.01258%
BUSES	51,447	13.15175%
2 Axle	51,447	13.15175%
Transit	4,860	1.24239%
Private	0	0.00000%
School	46,587	11.90935%
3 Axle	0	0.00000%
SINGLE UNIT TRUCKS	182,367	46.61971%
Pickup	156,357	39.97056%
0 - 6000 lbs	152,755	39.04972%
6001 - 8000 lbs	3,168	0.80974%
8001 - 10000 lbs	421	0.10765%
10001 - 17000 lbs	13	0.00345%
17001 - 24000 lbs	0	0.00000%
24001 - 31000 lbs	0	0.00000%
Over 31000 lbs	0	0.00000%
Other 2 axle	20,579	5.26077%
0 - 6000 lbs	4,189	1.07079%
6001 - 8000 lbs	12,844	3.28327%
8001 - 10000 lbs	2,100	0.53688%
10001 - 17000 lbs	952	0.24333%
17001 - 24000 lbs	324	0.08291%
24001 - 31000 lbs	156	0.04001%
Over 31000 lbs	14	0.00358%
3 or more axle	5,431	1.38838%
0 - 6000 lbs	0	0.00000%
6001 - 8000 lbs	0	0.00000%
8001 - 10000 lbs	280	0.07163%
10001 - 17000 lbs	1,219	0.31170%
17001 - 24000 lbs	1,210	0.30926%
24001 - 31000 lbs	1,233	0.31528%
Over 31000 lbs	1,488	0.38051%

	Number of Exempt Vehicles	Percent of Tot Vehicles
COMBINATION TRUCKS	2,562	0.65494
3 axle, Single Trailer	82	0.02102
0 - 18000 lbs	50	0.01285
18001 - 36000 lbs	29	0.00746
36001 - 42000 lbs	2	0.00046
42001 - 62000 lbs	1	0.00025
Over 62000 lbs	0	0.00001
4 axle, Single Trailer	161	0.04113
0 - 18000 lbs	74	0.01879
18001 - 36000 lbs	63	0.01607
36001 - 42000 lbs	9	0.00231
42001 - 62000 lbs	13	0.00345
Over 62000 lbs	2	0.00051
5 Axle, Single Trailer	2,183	0.55814
0 - 18000 lbs	53	0.01346
18001 - 36000 lbs	344	0.08792
36001 - 42000 lbs	71	0.01806
42001 - 62000 lbs	299	0.07644
Over 62000 lbs	1,417	0.36226
6 or More Axle, Single Trailer	34	0.00878
0 - 18000 lbs	0	0.00002
18001 - 36000 lbs	3	0.00067
36001 - 42000 lbs	1	0.00037
42001 - 62000 lbs	5	0.00129
Over 62000 lbs	25	0.00642
5 Axle, Twin Trailer	82	0.02102
0 - 18000 lbs	2	0.00045
18001 - 36000 lbs	7	0.00179
36001 - 42000 lbs	3	0.00081
42001 - 62000 lbs	22	0.00565
Over 62000 lbs	48	0.01233
6 or More Axle, Twin Trailer	19	0.00485
0 - 18000 lbs	0	0.00007
18001 - 36000 lbs	1	0.00029
36001 - 42000 lbs	1	0.00022
42001 - 62000 lbs	5	0.00130
Over 62000 lbs	12	0.00297
TOTAL VEHICLES	391,180	100.00000

Table 3-2
1992 Distribution of Farm Vehicles

	Number of Farm Vehicles	Percent of Total Vehicles
SINGLE UNIT TRUCKS	188,324	98.44278%
Pickup	161,464	84.40235%
0 - 6000 lbs	123,734	64.67948%
6001 - 8000 lbs	32,383	16.92773%
8001 - 10000 lbs	3,872	2.02394%
10001 - 17000 lbs	1,475	0.77120%
17001 - 24000 lbs	0	0.00000%
24001 - 31000 lbs	0	0.00000%
Over 31000 lbs	0	0.00000%
Other 2 axle	21,251	11.10871%
0 - 6000 lbs	227	0.11859%
6001 - 8000 lbs	8,780	4.58956%
8001 - 10000 lbs	1,291	0.67492%
10001 - 17000 lbs	6,959	3.63745%
17001 - 24000 lbs	2,831	1.47986%
24001 - 31000 lbs	1,064	0.55622%
Over 31000 lbs	100	0.05210%
3 or more axle	5,608	2.93172%
0 - 6000 lbs	0	0.00000%
6001 - 8000 lbs	0	0.00000%
8001 - 10000 lbs	25	0.01307%
10001 - 17000 lbs	1,294	0.67650%
17001 - 24000 lbs	1,533	0.80135%
24001 - 31000 lbs	1,217	0.63640%
Over 31000 lbs	1,539	0.80440%

	Number of Farm Vehicles	Percent of Total Vehicles
COMBINATION TRUCKS	2,979	1.55722%
3 axle, Single Trailer	96	0.04999%
0 - 18000 lbs	74	0.03860%
18001 - 36000 lbs	20	0.01044%
36001 - 42000 lbs	1	0.00056%
42001 - 62000 lbs	1	0.00039%
Over 62000 lbs	0	0.00000%
4 axle, Single Trailer	187	0.09779%
0 - 18000 lbs	121	0.06333%
18001 - 36000 lbs	48	0.02522%
36001 - 42000 lbs	6	0.00312%
42001 - 62000 lbs	12	0.00606%
Over 62000 lbs	0	0.00006%
5 Axle, Single Trailer	2,539	1.32706%
0 - 18000 lbs	298	0.15581%
18001 - 36000 lbs	906	0.47385%
36001 - 42000 lbs	160	0.08377%
42001 - 62000 lbs	883	0.46136%
Over 62000 lbs	291	0.15226%
6 or More Axle, Single Trailer	40	0.02087%
0 - 18000 lbs	1	0.00037%
18001 - 36000 lbs	9	0.00468%
36001 - 42000 lbs	4	0.00222%
42001 - 62000 lbs	19	0.01010%
Over 62000 lbs	7	0.00349%
5 Axle, Twin Trailer	96	0.04999%
0 - 18000 lbs	9	0.00447%
18001 - 36000 lbs	16	0.00836%
36001 - 42000 lbs	6	0.00323%
42001 - 62000 lbs	56	0.02946%
Over 62000 lbs	9	0.00448%
6 or More Axle, Twin Trailer	22	0.01152%
0 - 18000 lbs	1	0.00072%
18001 - 36000 lbs	3	0.00145%
36001 - 42000 lbs	2	0.00093%
42001 - 62000 lbs	14	0.00727%
Over 62000 lbs	2	0.00115%
TOTAL VEHICLES	191,303	100.00000%

Table 3-3
1992 State User Tax and Fee Allocations

	State Gasoline Tax	State Diesel Tax	State Reg. Fee	State Oil Lub Tax	Total State	% of Total	Tax Per Vehicle
PASSENGER CARS	$697,620,027	$7,277,146	$402,803,648	$8,407,379	$1,116,108,200	51.904158%	$128.54
0-3 years	$175,092,352	$98,807	$63,521,653	$2,207,855	$240,920,668	11.203918%	$134.55
4-6 years	$161,284,126	$563,071	$85,078,059	$2,086,688	$249,011,945	11.580199%	$129.28
More than 6 years	$354,610,337	$6,557,574	$250,714,523	$4,052,406	$615,934,840	28.643799%	$125.61
Over 6000 lbs	$6,633,212	$57,693	$3,489,412	$60,431	$10,240,748	0.476242%	$164.08
MOTORCYCLES	$1,088,702	$0	$4,830,240	$46,490	$5,965,432	0.277420%	$36.34
BUSES	$1,568,753	$10,295,710	$1,107,460	$327,752	$13,299,676	0.618496%	$213.88
2 Axle	$1,568,753	$8,674,023	$725,042	$293,734	$11,261,552	0.523714%	$186.00
Transit	$0	$8,274,028	$50,325	$179,115	$8,503,469	0.395450%	$1,630.89
Private	$1,568,753	$399,995	$674,717	$15,769	$2,659,234	0.123667%	$304.09
School	$0	$0	$0	$98,850	$98,850	0.004597%	$2.12
3 Axle	$0	$1,621,687	$382,418	$34,019	$2,038,124	0.094782%	$1,245.80
SINGLE UNIT TRUCKS	$484,052,534	$42,201,336	$193,718,337	$6,723,143	$726,695,350	33.794671%	$188.17
Commercial	$471,647,686	$41,073,893	$187,995,003	$6,550,604	$707,267,186	32.891173%	$192.53
Pickup	$381,950,852	$6,802,227	$133,474,764	$4,804,901	$527,032,744	24.509443%	$167.33
0 - 6000 lbs	$371,667,396	$6,619,087	$129,286,852	$4,680,983	$512,254,319	23.822179%	$166.48
6001 - 8000 lbs	$9,040,585	$161,005	$3,533,222	$108,945	$12,843,757	0.597294%	$201.30
8001 - 10000 lbs	$1,201,947	$21,406	$624,887	$14,484	$1,862,724	0.086625%	$219.58
10001 - 17000 lbs	$40,924	$729	$29,803	$489	$71,944	0.003346%	$264.67
17001 - 24000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
24001 - 31000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
Over 31000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
Other 2 axle	$78,344,983	$11,993,473	$25,518,556	$1,210,758	$117,067,770	5.444189%	$282.41
0 - 6000 lbs	$16,010,382	$2,350,711	$3,598,976	$244,596	$22,204,665	1.032619%	$263.16
6001 - 8000 lbs	$49,091,518	$7,207,822	$14,543,689	$749,988	$71,593,018	3.329404%	$276.73
8001 - 10000 lbs	$8,027,489	$1,178,630	$3,163,657	$122,639	$12,492,414	0.580955%	$295.29
10001 - 17000 lbs	$3,638,218	$534,178	$2,134,106	$55,582	$6,362,085	0.295866%	$331.81
17001 - 24000 lbs	$1,219,359	$279,464	$1,127,720	$21,323	$2,647,866	0.123138%	$405.28
24001 - 31000 lbs	$328,623	$406,324	$813,990	$15,264	$1,564,200	0.072743%	$496.19
Over 31000 lbs	$29,394	$36,344	$136,418	$1,365	$203,521	0.009465%	$721.79
3 or more axle	$11,351,851	$22,278,194	$29,001,683	$534,945	$63,166,673	2.937540%	$577.38
0 - 6000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
6001 - 8000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
8001 - 10000 lbs	$651,164	$763,384	$442,361	$18,981	$1,875,889	0.087237%	$332.34
10001 - 17000 lbs	$2,833,537	$3,321,858	$2,865,051	$82,594	$9,103,039	0.423333%	$370.62
17001 - 24000 lbs	$2,811,285	$3,295,771	$4,375,238	$81,945	$10,564,239	0.491286%	$433.51
24001 - 31000 lbs	$3,247,794	$3,838,963	$6,407,811	$102,289	$13,596,858	0.632316%	$547.30
Over 31000 lbs	$1,808,071	$11,058,218	$14,911,222	$249,136	$28,026,647	1.303368%	$934.74
Farm	$12,404,848	$1,127,442	$5,723,334	$172,540	$19,428,164	0.903499%	$103.16
Pickup	$10,152,290	$180,804	$3,868,706	$126,395	$14,328,194	0.666327%	$88.74
0 - 6000 lbs	$7,472,744	$133,083	$2,719,926	$94,116	$10,419,870	0.484572%	$84.21
6001 - 8000 lbs	$2,294,186	$40,858	$918,681	$27,646	$3,281,371	0.152599%	$101.33
8001 - 10000 lbs	$274,302	$4,885	$146,119	$3,306	$428,611	0.019932%	$110.70
10001 - 17000 lbs	$111,058	$1,978	$83,980	$1,327	$198,343	0.009224%	$134.44
17001 - 24000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
24001 - 31000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
Over 31000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
Other 2 axle	$1,962,061	$375,930	$1,117,996	$32,450	$3,488,436	0.162228%	$164.15
0 - 6000 lbs	$21,525	$3,160	$5,063	$329	$30,077	0.001399%	$132.57
6001 - 8000 lbs	$833,005	$122,305	$252,858	$12,726	$1,220,895	0.056777%	$139.05
8001 - 10000 lbs	$122,499	$17,986	$49,466	$1,871	$191,822	0.008921%	$148.57
10001 - 17000 lbs	$660,197	$96,933	$402,110	$10,086	$1,169,326	0.054379%	$168.04
17001 - 24000 lbs	$264,178	$60,547	$245,775	$4,620	$575,120	0.026746%	$203.15
24001 - 31000 lbs	$55,462	$68,575	$140,122	$2,576	$266,735	0.012404%	$250.68
Over 31000 lbs	$5,195	$6,424	$22,602	$241	$34,462	0.001603%	$345.74
3 or more axle	$290,497	$570,708	$736,633	$13,695	$1,611,533	0.074944%	$287.34
0 - 6000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
6001 - 8000 lbs	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
8001 - 10000 lbs	$1,443	$1,691	$1,004	$42	$4,180	0.000194%	$167.14
10001 - 17000 lbs	$74,650	$87,515	$78,375	$2,176	$242,716	0.011287%	$187.55
17001 - 24000 lbs	$88,427	$103,667	$138,438	$2,578	$333,109	0.015491%	$217.29
24001 - 31000 lbs	$79,579	$94,064	$160,145	$2,506	$336,295	0.015639%	$276.23
Over 31000 lbs	$46,398	$283,771	$358,671	$6,393	$695,233	0.032332%	$451.79
COMBINATION TRUCKS	$3,665,251	$166,961,525	$114,225,570	$3,404,235	$288,256,582	13.405255%	$2,352.65
Comm./Apport.	$3,559,562	$165,167,941	$112,212,124	$3,366,881	$284,306,508	13.221558%	$2,378.24
3 axle, Single Trailer	$360,315	$1,226,978	$1,082,130	$25,087	$2,694,510	0.125307%	$702.17
0 - 18000 lbs	$218,451	$735,013	$534,937	$14,991	$1,503,391	0.069915%	$641.09
18001 - 36000 lbs	$126,802	$426,644	$467,099	$8,702	$1,029,246	0.047865%	$756.13
36001 - 42000 lbs	$9,743	$42,008	$43,518	$897	$96,167	0.004472%	$1,137.92
42001 - 62000 lbs	$5,204	$22,439	$34,712	$479	$62,835	0.002922%	$1,391.91
Over 62000 lbs	$115	$874	$1,864	$18	$2,872	0.000134%	$1,946.10

Table 3-3
1992 State User Tax and Fee Allocations, continued

	State Gasoline Tax	State Diesel Tax	State Reg. Fee	State Oil Lub Tax	Total State	% of Total	Tax Per Vehicle
4 axle, Single Trailer	$453,672	$2,766,385	$2,607,759	$46,971	$5,874,786	0.273205%	$782.53
0 - 18000 lbs	$238,045	$1,072,113	$782,393	$17,127	$2,109,678	0.098110%	$615.09
18001 - 36000 lbs	$203,591	$916,939	$1,006,609	$14,648	$2,141,786	0.099603%	$730.13
36001 - 42000 lbs	$6,516	$217,485	$217,233	$4,118	$445,352	0.020711%	$1,055.69
42001 - 62000 lbs	$5,204	$467,918	$483,625	$9,181	$965,928	0.044920%	$1,535.76
Over 62000 lbs	$317	$91,930	$117,898	$1,898	$212,043	0.009861%	$2,272.25
5 Axle, Single Trailer	$2,696,630	$146,476,547	$102,031,925	$2,981,743	$254,186,844	11.820856%	$2,495.05
0 - 18000 lbs	$1,118,596	$1,450,780	$560,593	$43,582	$3,173,551	0.147585%	$1,291.36
18001 - 36000 lbs	$484,576	$19,334,964	$5,506,934	$396,509	$25,722,983	1.196237%	$1,602.86
36001 - 42000 lbs	$99,527	$3,971,209	$1,697,321	$81,439	$5,849,496	0.272028%	$1,774.65
42001 - 62000 lbs	$265,661	$20,120,691	$10,728,489	$408,482	$31,523,323	1.465979%	$2,259.34
Over 62000 lbs	$728,270	$101,598,903	$83,538,587	$2,051,731	$187,917,492	8.739026%	$2,841.98
6 or More Axle, Single Trailer	$48,945	$2,823,078	$1,738,956	$54,481	$4,665,460	0.216965%	$2,912.45
0 - 18000 lbs	$2,647	$800	$1,040	$39	$4,526	0.000210%	$992.62
18001 - 36000 lbs	$9,770	$122,879	$42,049	$2,375	$177,074	0.008235%	$1,445.04
36001 - 42000 lbs	$5,392	$67,813	$34,823	$1,311	$109,338	0.005085%	$1,616.83
42001 - 62000 lbs	$12,344	$335,583	$181,615	$6,381	$535,922	0.024923%	$2,269.01
Over 62000 lbs	$18,793	$2,296,004	$1,479,428	$44,376	$3,838,601	0.178513%	$3,278.09
5 Axle, Twin Trailer	$0	$9,886,296	$3,842,737	$220,907	$13,949,941	0.648736%	$3,635.26
0 - 18000 lbs	$0	$77,661	$18,593	$1,264	$97,518	0.004535%	$1,196.41
18001 - 36000 lbs	$0	$539,315	$112,367	$11,745	$663,427	0.030852%	$2,026.00
36001 - 42000 lbs	$0	$242,065	$75,684	$5,272	$323,020	0.015022%	$2,197.79
42001 - 62000 lbs	$0	$2,712,810	$792,614	$59,525	$3,564,949	0.165786%	$3,458.43
Over 62000 lbs	$0	$6,314,447	$2,843,479	$143,101	$9,301,027	0.432540%	$4,132.59
6 or More Axle, Twin Trailer	$0	$1,988,657	$908,618	$37,691	$2,934,966	0.136489%	$3,317.72
0 - 18000 lbs	$0	$9,954	$2,806	$137	$12,897	0.000600%	$1,048.46
18001 - 36000 lbs	$0	$74,110	$18,302	$1,350	$93,763	0.004360%	$1,757.96
36001 - 42000 lbs	$0	$54,833	$20,321	$999	$76,153	0.003541%	$1,929.76
42001 - 62000 lbs	$0	$454,092	$182,993	$8,398	$645,482	0.030018%	$2,712.30
Over 62000 lbs	$0	$1,395,668	$684,196	$26,807	$2,106,671	0.097970%	$3,890.07
Farm Combinations	$105,689	$1,793,584	$2,013,446	$37,355	$3,950,074	0.183697%	$1,325.97
3 axle, Single Trailer	$4,474	$15,152	$30,432	$309	$50,368	0.002342%	$526.72
0 - 18000 lbs	$3,440	$11,574	$21,467	$236	$36,717	0.001708%	$497.17
18001 - 36000 lbs	$930	$3,129	$7,583	$64	$11,705	0.000544%	$586.30
36001 - 42000 lbs	$61	$265	$705	$6	$1,037	0.000048%	$972.45
42001 - 62000 lbs	$43	$184	$674	$4	$905	0.00004210%	$1,221.06
Over 62000 lbs	$0	$0	$3	$0	$3	0.000000%	$1,870.14
4 axle, Single Trailer	$5,973	$32,385	$68,213	$538	$107,108	0.004981%	$572.52
0 - 18000 lbs	$4,204	$18,934	$35,216	$302	$58,657	0.002728%	$484.17
18001 - 36000 lbs	$1,674	$7,542	$18,328	$120	$27,664	0.001287%	$573.31
36001 - 42000 lbs	$46	$1,540	$3,948	$29	$5,563	0.000259%	$931.34
42001 - 62000 lbs	$48	$4,310	$10,539	$85	$14,981	0.000697%	$1,292.98
Over 62000 lbs	$0	$59	$183	$1	$243	0.00001132%	$2,033.22
5 Axle, Single Trailer	$93,950	$1,590,771	$1,784,963	$33,260	$3,502,944	0.162903%	$1,379.82
0 - 18000 lbs	$67,838	$87,983	$86,645	$2,643	$245,109	0.011399%	$822.30
18001 - 36000 lbs	$13,686	$546,078	$344,303	$11,199	$915,265	0.042564%	$1,009.67
36001 - 42000 lbs	$2,419	$96,539	$105,924	$1,980	$206,862	0.009620%	$1,290.82
42001 - 62000 lbs	$8,402	$636,386	$802,777	$12,920	$1,460,485	0.067919%	$1,654.77
Over 62000 lbs	$1,604	$223,785	$445,314	$4,519	$675,222	0.031401%	$2,318.09
6 or More Axle, Single Trailer	$1,293	$26,954	$34,198	$518	$62,963	0.002928%	$1,577.28
0 - 18000 lbs	$208	$63	$208	$3	$481	0.000022%	$672.94
18001 - 36000 lbs	$357	$4,489	$3,400	$87	$8,333	0.000388%	$930.76
36001 - 42000 lbs	$170	$2,132	$2,811	$41	$5,154	0.000240%	$1,211.91
42001 - 62000 lbs	$505	$13,729	$17,578	$261	$32,072	0.001492%	$1,659.61
Over 62000 lbs	$54	$6,541	$10,201	$126	$16,922	0.000787%	$2,536.14
5 Axle, Twin Trailer	$0	$108,492	$76,993	$2,363	$187,848	0.008736%	$1,964.41
0 - 18000 lbs	$0	$4,070	$2,484	$66	$6,620	0.000308%	$774.83
18001 - 36000 lbs	$0	$13,164	$6,072	$287	$19,522	0.000908%	$1,221.24
36001 - 42000 lbs	$0	$5,086	$4,082	$111	$9,278	0.000431%	$1,502.39
42001 - 62000 lbs	$0	$74,153	$51,256	$1,627	$127,036	0.005908%	$2,254.32
Over 62000 lbs	$0	$12,020	$13,100	$272	$25,392	0.001181%	$2,963.39
6 or More Axle, Twin Trailer	$0	$19,830	$18,648	$365	$38,843	0.001806%	$1,762.03
0 - 18000 lbs	$0	$558	$401	$8	$966	0.000045%	$700.85
18001 - 36000 lbs	$0	$1,934	$1,057	$35	$3,026	0.000141%	$1,087.22
36001 - 42000 lbs	$0	$1,231	$1,172	$22	$2,425	0.000113%	$1,368.37
42001 - 62000 lbs	$0	$13,268	$12,649	$245	$26,162	0.001217%	$1,881.26
Over 62000 lbs	$0	$2,840	$3,369	$55	$6,264	0.000291%	$2,842.13
ALL VEHICLES	$1,187,995,268	$226,735,717	$716,685,255	$18,909,000	$2,150,325,240	100.000000%	$166.78

Table 3-4
1992 Federal User Tax and Fee Allocations

	Federal Gasoline Tax	Federal Diesel Tax	Federal Sales Tax	Federal Use Tax	Federal Tire Tax	Total Federal	% of Total	Tax Per Vehicle
PASSENGER CARS	$495,344,164	$8,514,604	$0	$0	$0	$503,858,767	41.756101%	$58.03
0-3 years	$124,324,090	$115,609	$0	$0	$0	$124,439,699	10.312645%	$69.50
4-6 years	$114,519,577	$658,820	$0	$0	$0	$115,178,397	9.545137%	$59.80
More than 6 years	$251,790,593	$7,672,671	$0	$0	$0	$259,463,264	21.502403%	$52.91
Over 6000 lbs	$4,709,903	$67,504	$0	$0	$0	$4,777,407	0.395916%	$76.55
MOTORCYCLES	$767,714	$0	$0	$0	$0	$767,714	0.063622%	$4.68
BUSES	$1,133,585	$2,045,222	$4,302,693	$0	$138,486	$7,619,986	0.631488%	$122.54
2 Axle	$1,133,585	$476,287	$2,333,312	$0	$131,485	$4,074,669	0.337679%	$67.30
Transit	$0	$0	$0	$0	$0	$0	0.000000%	$0.00
Private	$1,133,585	$476,287	$2,333,312	$0	$131,485	$4,074,669	0.337679%	$465.94
School	$0	$0	$0	$0	$0	$0	0.000000%	$0.00
3 Axle	$0	$1,568,935	$1,969,381	$0	$7,001	$3,545,317	0.293810%	$2,167.06
SINGLE UNIT TRUCKS	$323,894,514	$46,480,093	$11,405,927	$2,006,551	$1,928,255	$385,715,341	31.965245%	$99.88
Commercial	$323,894,514	$46,480,093	$10,824,082	$1,962,618	$1,853,678	$385,014,985	31.907205%	$104.81
Pickup	$262,297,026	$7,697,545	$0	$0	$59,611	$270,054,183	22.380101%	$85.74
0 - 6000 lbs	$255,235,071	$7,490,300	$0	$0	$0	$262,725,371	21.772743%	$85.38
6001 - 8000 lbs	$6,208,439	$182,197	$0	$0	$51,864	$6,442,500	0.533907%	$100.97
8001 - 10000 lbs	$825,413	$24,223	$0	$0	$6,895	$856,531	0.070983%	$100.97
10001 - 17000 lbs	$28,103	$825	$0	$0	$852	$29,780	0.002468%	$109.56
17001 - 24000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
24001 - 31000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
Over 31000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
Other 2 axle	$53,801,834	$13,572,069	$87,097	$18,285	$437,466	$67,916,750	5.628440%	$163.84
0 - 6000 lbs	$10,994,806	$2,660,115	$0	$0	$0	$13,654,921	1.131619%	$161.83
6001 - 8000 lbs	$33,712,608	$8,156,525	$0	$0	$282,284	$42,151,417	3.493199%	$162.93
8001 - 10000 lbs	$5,512,716	$1,333,762	$0	$0	$69,239	$6,915,717	0.573124%	$163.47
10001 - 17000 lbs	$2,498,473	$604,488	$0	$0	$31,381	$3,134,341	0.259751%	$163.47
17001 - 24000 lbs	$837,370	$316,247	$0	$0	$32,553	$1,186,170	0.098301%	$181.55
24001 - 31000 lbs	$225,676	$459,804	$0	$0	$17,624	$703,104	0.058268%	$223.04
Over 31000 lbs	$20,185	$41,127	$87,097	$18,285	$4,385	$171,079	0.014178%	$606.74
3 or more axle	$7,795,654	$25,210,479	$10,736,986	$1,944,333	$1,356,601	$47,044,053	3.898664%	$430.01
0 - 6000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
6001 - 8000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
8001 - 10000 lbs	$447,174	$863,861	$0	$0	$14,456	$1,325,491	0.109847%	$234.83
10001 - 17000 lbs	$1,945,874	$3,759,085	$0	$0	$144,160	$5,849,119	0.484732%	$238.14
17001 - 24000 lbs	$1,930,593	$3,729,565	$0	$0	$143,028	$5,803,186	0.480925%	$238.14
24001 - 31000 lbs	$2,230,357	$4,344,252	$0	$0	$184,244	$6,758,853	0.560124%	$272.06
Over 31000 lbs	$1,241,656	$12,513,715	$10,736,986	$1,944,333	$870,713	$27,307,403	2.263036%	$910.76
Farm	$0	$0	$581,845	$43,933	$74,577	$700,356	0.058040%	$3.72
Pickup	$0	$0	$0	$0	$17,047	$17,047	0.001413%	$0.11
0 - 6000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	$0.00
6001 - 8000 lbs	$0	$0	$0	$0	$13,161	$13,161	0.001091%	$0.41
8001 - 10000 lbs	$0	$0	$0	$0	$1,574	$1,574	0.000130%	$0.41
10001 - 17000 lbs	$0	$0	$0	$0	$2,312	$2,312	0.000192%	$1.57
17001 - 24000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
24001 - 31000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
Over 31000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
Other 2 axle	$0	$0	$30,789	$2,673	$22,343	$55,805	0.004625%	$2.63
0 - 6000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	$0.00
6001 - 8000 lbs	$0	$0	$0	$0	$4,790	$4,790	0.000397%	$0.55
8001 - 10000 lbs	$0	$0	$0	$0	$1,057	$1,057	0.000088%	$0.82
10001 - 17000 lbs	$0	$0	$0	$0	$5,694	$5,694	0.000472%	$0.82
17001 - 24000 lbs	$0	$0	$0	$0	$7,053	$7,053	0.000584%	$2.49
24001 - 31000 lbs	$0	$0	$0	$0	$2,974	$2,974	0.000246%	$2.80
Over 31000 lbs	$0	$0	$30,789	$2,673	$775	$34,237	0.002837%	$343.48
3 or more axle	$0	$0	$551,056	$41,261	$35,187	$627,504	0.052003%	$111.88
0 - 6000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
6001 - 8000 lbs	$0	$0	$0	$0	$0	$0	0.000000%	#DIV/0!
8001 - 10000 lbs	$0	$0	$0	$0	$32	$32	0.000003%	$1.28
10001 - 17000 lbs	$0	$0	$0	$0	$3,798	$3,798	0.000315%	$2.93
17001 - 24000 lbs	$0	$0	$0	$0	$4,499	$4,499	0.000373%	$2.93
24001 - 31000 lbs	$0	$0	$0	$0	$4,514	$4,514	0.000374%	$3.71
Over 31000 lbs	$0	$0	$551,056	$41,261	$22,344	$614,660	0.050939%	$399.43
COMBINATION TRUCKS	$2,517,023	$192,456,081	$50,955,380	$45,275,449	$17,505,259	$308,709,191	25.583543%	$2,519.58
Comm./Apport.	$2,517,023	$192,456,081	$50,202,070	$45,079,099	$17,365,688	$307,619,961	25.493275%	$2,573.26
3 axle, Single Trailer	$254,785	$1,429,693	$34,864	$2,753	$62,302	$1,784,396	0.147878%	$465.00
0 - 18000 lbs	$154,470	$856,447	$0	$0	$20,759	$1,031,676	0.085498%	$439.94
18001 - 36000 lbs	$89,663	$497,132	$0	$0	$34,379	$621,174	0.051478%	$456.34
36001 - 42000 lbs	$6,889	$48,949	$22,280	$0	$3,411	$81,529	0.006756%	$964.71
42001 - 62000 lbs	$3,680	$26,147	$11,901	$1,818	$3,622	$47,169	0.003909%	$1,044.88
Over 62000 lbs	$82	$1,019	$683	$934	$131	$2,848	0.000236%	$1,930.19

Table 3-4
1992 Federal User Tax and Fee Allocations, continued

	Federal Gasoline Tax	Federal Diesel Tax	Federal Sales Tax	Federal Use Tax	Federal Tire Tax	Total Federal	% of Total	Tax Per Vehicle
4 axle, Single Trailer	$320,799	$3,223,432	$430,674	$84,413	$126,427	$4,185,745	0.346884%	$557.55
0 - 18000 lbs	$168,325	$1,249,242	$0	$0	$36,213	$1,453,780	0.120479%	$423.86
18001 - 36000 lbs	$143,962	$1,068,431	$0	$0	$30,972	$1,243,365	0.103041%	$423.86
36001 - 42000 lbs	$4,608	$253,416	$107,568	$0	$7,093	$372,685	0.030885%	$883.44
42001 - 62000 lbs	$3,679	$545,225	$270,500	$25,336	$42,560	$887,301	0.073533%	$1,410.75
Over 62000 lbs	$224	$107,118	$52,605	$59,078	$9,589	$228,614	0.018946%	$2,449.83
5 Axle, Single Trailer	$1,906,830	$170,676,597	$46,548,917	$42,422,305	$15,635,270	$277,189,919	22.971458%	$2,720.85
0 - 18000 lbs	$790,977	$1,690,470	$0	$0	$81,818	$2,563,264	0.212424%	$1,043.02
18001 - 36000 lbs	$342,651	$22,529,380	$0	$0	$719,741	$23,591,773	1.955112%	$1,470.06
36001 - 42000 lbs	$70,377	$4,627,310	$1,362,195	$0	$147,828	$6,207,710	0.514449%	$1,883.33
42001 - 62000 lbs	$187,853	$23,444,921	$7,136,774	$562,032	$2,137,565	$33,469,145	2.773676%	$2,398.80
Over 62000 lbs	$514,972	$118,384,516	$38,049,948	$41,860,273	$12,548,318	$211,358,027	17.515796%	$3,196.49
6 or More Axle, Single Trailer	$34,610	$3,289,491	$828,387	$750,840	$270,138	$5,173,466	0.428739%	$3,229.57
0 - 18000 lbs	$1,872	$932	$0	$0	$110	$2,914	0.000241%	$639.05
18001 - 36000 lbs	$6,909	$143,180	$0	$0	$5,204	$155,293	0.012870%	$1,267.30
36001 - 42000 lbs	$3,813	$79,016	$30,928	$0	$2,872	$116,629	0.009665%	$1,724.64
42001 - 62000 lbs	$8,728	$391,026	$124,081	$9,514	$16,024	$549,373	0.045528%	$2,325.96
Over 62000 lbs	$13,289	$2,675,337	$673,378	$741,325	$245,928	$4,349,257	0.360434%	$3,714.18
5 Axle, Twin Trailer	$0	$11,519,656	$1,903,016	$1,466,359	$1,096,365	$15,985,395	1.324752%	$4,165.69
0 - 18000 lbs	$0	$90,491	$0	$0	$2,928	$93,419	0.007742%	$1,146.11
18001 - 36000 lbs	$0	$628,417	$0	$0	$21,568	$649,985	0.053866%	$1,984.95
36001 - 42000 lbs	$0	$282,057	$62,017	$0	$9,680	$353,755	0.029317%	$2,406.90
42001 - 62000 lbs	$0	$3,161,005	$510,209	$41,523	$308,705	$4,021,441	0.333267%	$3,901.28
Over 62000 lbs	$0	$7,357,685	$1,330,790	$1,424,837	$753,483	$10,866,796	0.900560%	$4,828.28
6 or More Axle, Twin Trailer	$0	$2,317,212	$456,212	$352,430	$175,187	$3,301,041	0.273566%	$3,731.54
0 - 18000 lbs	$0	$11,598	$0	$0	$388	$11,986	0.000993%	$974.41
18001 - 36000 lbs	$0	$86,354	$0	$0	$2,959	$89,313	0.007402%	$1,674.53
36001 - 42000 lbs	$0	$63,893	$18,530	$0	$2,189	$84,611	0.007012%	$2,144.08
42001 - 62000 lbs	$0	$529,115	$125,950	$9,586	$21,090	$685,741	0.056829%	$2,881.47
Over 62000 lbs	$0	$1,626,253	$311,732	$342,843	$148,562	$2,429,390	0.201330%	$4,485.99
Farm Combinations	$0	$0	$753,310	$196,350	$139,571	$1,089,230	0.090267%	$365.64
3 axle, Single Trailer	$0	$0	$478	$10	$630	$1,118	0.000093%	$11.69
0 - 18000 lbs	$0	$0	$0	$0	$327	$327	0.000027%	$4.43
18001 - 36000 lbs	$0	$0	$0	$0	$252	$252	0.000021%	$12.63
36001 - 42000 lbs	$0	$0	$281	$0	$22	$303	0.000025%	$283.82
42001 - 62000 lbs	$0	$0	$195	$9	$30	$235	0.000019%	$316.42
Over 62000 lbs	$0	$0	$1	$1	$0	$2	0.000000%	$1,102.61
4 axle, Single Trailer	$0	$0	$6,574	$218	$1,343	$8,134	0.000674%	$43.48
0 - 18000 lbs	$0	$0	$0	$0	$640	$640	0.000053%	$5.28
18001 - 36000 lbs	$0	$0	$0	$0	$255	$255	0.000021%	$5.28
36001 - 42000 lbs	$0	$0	$1,523	$0	$50	$1,573	0.000130%	$263.39
42001 - 62000 lbs	$0	$0	$4,983	$147	$392	$5,522	0.000458%	$476.57
Over 62000 lbs	$0	$0	$67	$71	$6	$145	0.000012%	$1,210.48
5 Axle, Single Trailer	$0	$0	$685,299	$184,601	$124,130	$994,030	0.082378%	$391.55
0 - 18000 lbs	$0	$0	$0	$0	$4,962	$4,962	0.000411%	$16.65
18001 - 36000 lbs	$0	$0	$0	$0	$20,328	$20,328	0.001685%	$22.42
36001 - 42000 lbs	$0	$0	$66,229	$0	$3,594	$69,823	0.005786%	$435.69
42001 - 62000 lbs	$0	$0	$451,450	$11,174	$67,608	$530,232	0.043942%	$600.77
Over 62000 lbs	$0	$0	$167,620	$173,427	$27,639	$368,686	0.030554%	$1,265.72
6 or More Axle, Single Trailer	$0	$0	$15,934	$4,217	$1,645	$21,797	0.001806%	$546.03
0 - 18000 lbs	$0	$0	$0	$0	$9	$9	0.000001%	$12.06
18001 - 36000 lbs	$0	$0	$0	$0	$190	$190	0.000016%	$21.23
36001 - 42000 lbs	$0	$0	$1,945	$0	$90	$2,035	0.000169%	$478.58
42001 - 62000 lbs	$0	$0	$10,152	$245	$656	$11,053	0.000916%	$571.92
Over 62000 lbs	$0	$0	$3,837	$3,973	$701	$8,510	0.000705%	$1,275.45
5 Axle, Twin Trailer	$0	$0	$35,565	$5,815	$10,756	$52,136	0.004321%	$545.20
0 - 18000 lbs	$0	$0	$0	$0	$153	$153	0.000013%	$17.96
18001 - 36000 lbs	$0	$0	$0	$0	$526	$526	0.000044%	$32.93
36001 - 42000 lbs	$0	$0	$2,606	$0	$203	$2,809	0.000233%	$454.89
42001 - 62000 lbs	$0	$0	$27,892	$713	$8,438	$37,044	0.003070%	$657.36
Over 62000 lbs	$0	$0	$5,067	$5,102	$1,434	$11,602	0.000962%	$1,354.07
6 or More Axle, Twin Trailer	$0	$0	$9,461	$1,488	$1,067	$12,016	0.000996%	$545.06
0 - 18000 lbs	$0	$0	$0	$0	$22	$22	0.000002%	$15.75
18001 - 36000 lbs	$0	$0	$0	$0	$77	$77	0.000006%	$27.74
36001 - 42000 lbs	$0	$0	$832	$0	$49	$881	0.000073%	$497.29
42001 - 62000 lbs	$0	$0	$7,360	$176	$616	$8,152	0.000676%	$586.21
Over 62000 lbs	$0	$0	$1,269	$1,312	$302	$2,883	0.000239%	$1,308.18
ALL VEHICLES	$823,657,000	$249,496,000	$66,664,000	$47,282,000	$19,572,000	$1,206,671,000	100.000000%	$93.59

Table 3-5
1992 Total User Tax and Fee Allocations

	Federal Revenues	State Revenues	Total State & Federal Rev	% of Total	Revenue Per Vehicle
PASSENGER CARS	$503,858,767	$1,116,108,200	$1,619,966,967	48.256443%	$186.57
0-3 years	$124,439,699	$240,920,668	$365,360,366	10.883550%	$204.05
4-6 years	$115,178,397	$249,011,945	$364,190,342	10.848697%	$189.08
More than 6 years	$259,463,264	$615,934,840	$875,398,104	26.076827%	$178.52
Over 6000 lbs	$4,777,407	$10,240,748	$15,018,155	0.447369%	$240.63
MOTORCYCLES	$767,714	$5,965,432	$6,733,147	0.200571%	$41.02
BUSES	$7,619,986	$13,299,676	$20,919,662	0.623166%	$336.43
2 Axle	$4,074,669	$11,261,552	$15,336,221	0.456844%	$253.30
Transit	$0	$8,503,469	$8,503,469	0.253306%	$1,630.89
Private	$4,074,669	$2,659,234	$6,733,902	0.200593%	$770.03
School	$0	$98,850	$98,850	0.002945%	$2.12
3 Axle	$3,545,317	$2,038,124	$5,583,441	0.166323%	$3,412.86
SINGLE UNIT TRUCKS	$385,715,341	$726,695,350	$1,112,410,691	33.137085%	$288.05
Commercial	$385,014,985	$707,267,186	$1,092,282,171	32.537486%	$297.34
Pickup	$270,054,183	$527,032,744	$797,086,926	23.744052%	$253.08
0 - 6000 lbs	$262,725,371	$512,254,319	$774,979,690	23.085510%	$251.86
6001 - 8000 lbs	$6,442,500	$12,843,757	$19,286,257	0.574509%	$302.27
8001 - 10000 lbs	$856,531	$1,862,724	$2,719,255	0.081003%	$320.56
10001 - 17000 lbs	$29,780	$71,944	$101,724	0.003030%	$374.23
17001 - 24000 lbs	$0	$0	$0	0.000000%	#DIV/0!
24001 - 31000 lbs	$0	$0	$0	0.000000%	#DIV/0!
Over 31000 lbs	$0	$0	$0	0.000000%	#DIV/0!
Other 2 axle	$67,916,750	$117,067,770	$184,984,520	5.510418%	$446.24
0 - 6000 lbs	$13,654,921	$22,204,665	$35,859,586	1.068205%	$425.00
6001 - 8000 lbs	$42,151,417	$71,593,018	$113,744,435	3.388280%	$439.65
8001 - 10000 lbs	$6,915,717	$12,492,414	$19,408,132	0.578140%	$458.76
10001 - 17000 lbs	$3,134,341	$6,362,085	$9,496,426	0.282885%	$495.29
17001 - 24000 lbs	$1,186,170	$2,647,866	$3,834,036	0.114210%	$586.83
24001 - 31000 lbs	$703,104	$1,564,200	$2,267,304	0.067540%	$719.23
Over 31000 lbs	$171,079	$203,521	$374,600	0.011159%	$1,328.53
3 or more axle	$47,044,053	$63,166,673	$110,210,726	3.283016%	$1,007.40
0 - 6000 lbs	$0	$0	$0	0.000000%	#DIV/0!
6001 - 8000 lbs	$0	$0	$0	0.000000%	#DIV/0!
8001 - 10000 lbs	$1,325,491	$1,875,889	$3,201,381	0.095364%	$567.18
10001 - 17000 lbs	$5,849,119	$9,103,039	$14,952,158	0.445403%	$608.76
17001 - 24000 lbs	$5,803,186	$10,564,239	$16,367,425	0.487562%	$671.65
24001 - 31000 lbs	$6,758,853	$13,596,858	$20,355,711	0.606367%	$819.36
Over 31000 lbs	$27,307,403	$28,026,647	$55,334,051	1.648320%	$1,845.50
Farm	$700,356	$19,428,164	$20,128,519	0.599599%	$106.88
Pickup	$17,047	$14,328,194	$14,345,241	0.427324%	$88.84
0 - 6000 lbs	$0	$10,419,870	$10,419,870	0.310393%	$84.21
6001 - 8000 lbs	$13,161	$3,281,371	$3,294,532	0.098139%	$101.74
8001 - 10000 lbs	$1,574	$428,611	$430,185	0.012815%	$111.11
10001 - 17000 lbs	$2,312	$198,343	$200,655	0.005977%	$136.01
17001 - 24000 lbs	$0	$0	$0	0.000000%	#DIV/0!
24001 - 31000 lbs	$0	$0	$0	0.000000%	#DIV/0!
Over 31000 lbs	$0	$0	$0	0.000000%	#DIV/0!
Other 2 axle	$55,805	$3,488,436	$3,544,241	0.105578%	$166.78
0 - 6000 lbs	$0	$30,077	$30,077	0.000896%	$132.57
6001 - 8000 lbs	$4,790	$1,220,895	$1,225,684	0.036511%	$139.60
8001 - 10000 lbs	$1,057	$191,822	$192,878	0.005746%	$149.38
10001 - 17000 lbs	$5,694	$1,169,326	$1,175,020	0.035002%	$168.86
17001 - 24000 lbs	$7,053	$575,120	$582,173	0.017342%	$205.64
24001 - 31000 lbs	$2,974	$266,735	$269,709	0.008034%	$253.47
Over 31000 lbs	$34,237	$34,462	$68,699	0.002046%	$689.22
3 or more axle	$627,504	$1,611,533	$2,239,037	0.066698%	$399.22
0 - 6000 lbs	$0	$0	$0	0.000000%	#DIV/0!
6001 - 8000 lbs	$0	$0	$0	0.000000%	#DIV/0!
8001 - 10000 lbs	$32	$4,180	$4,212	0.000125%	$168.42
10001 - 17000 lbs	$3,798	$242,716	$246,514	0.007343%	$190.48
17001 - 24000 lbs	$4,499	$333,109	$337,608	0.010057%	$220.23
24001 - 31000 lbs	$4,514	$336,295	$340,810	0.010152%	$279.94
Over 31000 lbs	$614,660	$695,233	$1,309,893	0.039020%	$851.23
COMBINATION TRUCKS	$308,709,191	$288,256,582	$596,965,773	17.782736%	$4,872.24
Comm./Apport.	$307,619,961	$284,306,508	$591,926,469	17.632622%	$4,951.49
3 axle, Single Trailer	$1,784,396	$2,694,510	$4,478,906	0.133420%	$1,167.17
0 - 18000 lbs	$1,031,676	$1,503,391	$2,535,067	0.075516%	$1,081.03
18001 - 36000 lbs	$621,174	$1,029,246	$1,650,420	0.049164%	$1,212.47
36001 - 42000 lbs	$81,529	$96,167	$177,695	0.005293%	$2,102.63
42001 - 62000 lbs	$47,169	$62,835	$110,003	0.003277%	$2,436.79
Over 62000 lbs	$2,848	$2,872	$5,720	0.000170%	$3,876.29

Table 3-5
1992 Total User Tax and Fee Allocations, continued

	Federal Revenues	State Revenues	Total State & Federal Rev	% of Total	Revenue Per Vehicle
4 axle, Single Trailer	$4,185,745	$5,874,786	$10,060,531	0.299688%	$1,340.08
0 - 18000 lbs	$1,453,780	$2,109,678	$3,563,458	0.106150%	$1,038.95
18001 - 36000 lbs	$1,243,365	$2,141,786	$3,385,151	0.100839%	$1,153.99
36001 - 42000 lbs	$372,685	$445,352	$818,037	0.024368%	$1,939.13
42001 - 62000 lbs	$887,301	$965,928	$1,853,229	0.055205%	$2,946.50
Over 62000 lbs	$228,614	$212,043	$440,657	0.013127%	$4,722.08
5 Axle, Single Trailer	$277,189,919	$254,186,844	$531,376,763	15.828935%	$5,215.90
0 - 18000 lbs	$2,563,264	$3,173,551	$5,736,815	0.170891%	$2,334.38
18001 - 36000 lbs	$23,591,773	$25,722,983	$49,314,755	1.469014%	$3,072.92
36001 - 42000 lbs	$6,207,710	$5,849,496	$12,057,206	0.359167%	$3,657.99
42001 - 62000 lbs	$33,469,145	$31,523,323	$64,992,468	1.936030%	$4,658.13
Over 62000 lbs	$211,358,027	$187,917,492	$399,275,519	11.893833%	$6,038.47
6 or More Axle, Single Trailer	$5,173,466	$4,665,460	$9,838,926	0.293087%	$6,142.02
0 - 18000 lbs	$2,914	$4,526	$7,439	0.000222%	$1,631.67
18001 - 36000 lbs	$155,293	$177,074	$332,367	0.009901%	$2,712.33
36001 - 42000 lbs	$116,629	$109,338	$225,967	0.006731%	$3,341.47
42001 - 62000 lbs	$549,373	$535,922	$1,085,296	0.032329%	$4,594.98
Over 62000 lbs	$4,349,257	$3,838,601	$8,187,858	0.243904%	$6,992.26
5 Axle, Twin Trailer	$15,985,395	$13,949,941	$29,935,336	0.891730%	$7,800.95
0 - 18000 lbs	$93,419	$97,518	$190,937	0.005688%	$2,342.52
18001 - 36000 lbs	$649,985	$663,427	$1,313,411	0.039125%	$4,010.94
36001 - 42000 lbs	$353,755	$323,020	$676,775	0.020160%	$4,604.69
42001 - 62000 lbs	$4,021,441	$3,564,949	$7,586,390	0.225987%	$7,359.71
Over 62000 lbs	$10,866,796	$9,301,027	$20,167,823	0.600770%	$8,960.87
6 or More Axle, Twin Trailer	$3,301,041	$2,934,966	$6,236,007	0.185762%	$7,049.26
0 - 18000 lbs	$11,986	$12,897	$24,883	0.000741%	$2,022.87
18001 - 36000 lbs	$89,313	$93,763	$183,076	0.005454%	$3,432.50
36001 - 42000 lbs	$84,611	$76,153	$160,765	0.004789%	$4,073.84
42001 - 62000 lbs	$685,741	$645,482	$1,331,224	0.039655%	$5,593.77
Over 62000 lbs	$2,429,390	$2,106,671	$4,536,061	0.135123%	$8,376.06
Farm Combinations	$1,089,230	$3,950,074	$5,039,304	0.150113%	$1,691.61
3 axle, Single Trailer	$1,118	$50,368	$51,486	0.001534%	$538.41
0 - 18000 lbs	$327	$36,717	$37,044	0.001103%	$501.60
18001 - 36000 lbs	$252	$11,705	$11,957	0.000356%	$598.93
36001 - 42000 lbs	$303	$1,037	$1,340	0.000040%	$1,256.27
42001 - 62000 lbs	$235	$905	$1,140	0.000034%	$1,537.48
Over 62000 lbs	$2	$3	$5	0.000000%	$2,972.75
4 axle, Single Trailer	$8,134	$107,108	$115,242	0.003433%	$616.00
0 - 18000 lbs	$640	$58,657	$59,296	0.001766%	$489.45
18001 - 36000 lbs	$255	$27,664	$27,919	0.000832%	$578.59
36001 - 42000 lbs	$1,573	$5,563	$7,136	0.000213%	$1,194.73
42001 - 62000 lbs	$5,522	$14,981	$20,503	0.000611%	$1,769.55
Over 62000 lbs	$145	$243	$388	0.0000116%	$3,243.70
5 Axle, Single Trailer	$994,030	$3,502,944	$4,496,974	0.133958%	$1,771.37
0 - 18000 lbs	$4,962	$245,109	$250,071	0.007449%	$838.95
18001 - 36000 lbs	$20,328	$915,265	$935,593	0.027870%	$1,032.10
36001 - 42000 lbs	$69,823	$206,862	$276,685	0.008242%	$1,726.52
42001 - 62000 lbs	$530,232	$1,460,485	$1,990,717	0.059301%	$2,255.54
Over 62000 lbs	$368,686	$675,222	$1,043,908	0.031096%	$3,583.81
6 or More Axle, Single Trailer	$21,797	$62,963	$84,759	0.002525%	$2,123.31
0 - 18000 lbs	$9	$481	$490	0.000015%	$685.00
18001 - 36000 lbs	$190	$8,333	$8,523	0.000254%	$952.00
36001 - 42000 lbs	$2,035	$5,154	$7,189	0.000214%	$1,690.49
42001 - 62000 lbs	$11,053	$32,072	$43,125	0.001285%	$2,231.53
Over 62000 lbs	$8,510	$16,922	$25,432	0.000758%	$3,811.58
5 Axle, Twin Trailer	$52,136	$187,848	$239,984	0.007149%	$2,509.61
0 - 18000 lbs	$153	$6,620	$6,774	0.000202%	$792.79
18001 - 36000 lbs	$526	$19,522	$20,048	0.000597%	$1,254.17
36001 - 42000 lbs	$2,809	$9,278	$12,087	0.000360%	$1,957.28
42001 - 62000 lbs	$37,044	$127,036	$164,080	0.004888%	$2,911.68
Over 62000 lbs	$11,602	$25,392	$36,994	0.001102%	$4,317.46
6 or More Axle, Twin Trailer	$12,016	$38,843	$50,859	0.001515%	$2,307.10
0 - 18000 lbs	$22	$966	$988	0.000029%	$716.61
18001 - 36000 lbs	$77	$3,026	$3,103	0.000092%	$1,114.96
36001 - 42000 lbs	$881	$2,425	$3,307	0.000099%	$1,865.66
42001 - 62000 lbs	$8,152	$26,162	$34,315	0.001022%	$2,467.47
Over 62000 lbs	$2,883	$6,264	$9,147	0.000272%	$4,150.31
ALL VEHICLES	$1,206,671,000	$2,150,325,240	$3,356,996,240	100.000000%	$260.36

SECTION 4. COST ANALYSIS

OVERVIEW

Analysis of highway costs, a critical element in user cost responsibility studies, endeavors to answer two basic questions: 1) What level of funding is needed to develop and support a highway system during a specified planning horizon? and 2) What fraction of the total cost should be charged to the vehicles operating on the system? The former question is addressed by identifying and applying procedures to estimate the cost of constructing and maintaining the highway system and is termed cost estimation. The latter question is addressed by cost allocation methodologies, typically incremental or consumption methods. The purpose of the allocation methodologies is to allocate the estimated costs to the various vehicle groups operating on the system.

DISCUSSION OF COST ALLOCATION METHODOLOGY

Highway cost allocation procedures applicable to the Texas highway system have been in existence since 1985. Beginning with Research Report 332-1 and continuing with research studies 1910 and 1919, the techniques and methods used to allocate highway-associated costs to the major vehicle classes have undergone continual refinement and enhancement in order to accurately reflect, within data and technical constraints, the costs occasioned by the major vehicle classes.

The Texas method of assigning costs to vehicle classes, however, is unique in two respects. First, methodologically it is theoretically superior to the standard methods employed among the states and federal government. The theoretical inconsistencies of the traditional Incremental and Proportional methods are absent. Second, the Texas method does not take a line-item by line-item approach in allocating costs, but uses a game-theory approach. With the use of TTI-developed computer software, all possible highway cost combinations of 12 vehicle classes (i.e., 4,095 combinations) can be evaluated. The specific cost responsibilities for each of the vehicle classes are, therefore, capable of being determined.

HISTORICAL DEVELOPMENT OF HIGHWAY COST ALLOCATION PROCEDURES IN TEXAS

The current research study is a continuation of several previous research projects. The results in this report represent the most accurate and up-to-date results for highway cost/revenue analysis in Texas. The following provides a brief history of the development of highway cost allocation procedures in Texas.

Research Report 332-1

This report presented the conceptual framework for a Texas Highway Cost Allocation Model. The major cost allocation procedures used in the U.S. were evaluated, which culminated in the development of a technique embracing the following qualities:

a. Completeness: all highway costs are shared by users;
b. Rationality: all vehicle classes are better off using a common facility rather than using an exclusive one; and
c. Marginality: vehicle classes are charged at least enough to cover their marginal costs.

Two procedures were incorporated in this technique: (1) the Modified Incremental Approach (MIA) and (2) the Generalized Method (GM). The MIA refines the traditional incremental method by estimating separable and common costs at a greater level of detail, thereby allowing the MIA to overcome the inconsistencies of the more traditional incremental approach. On the other hand, the GM, with foundations in game theory, takes into account possible "coalitions" as strategic alternatives available to the various user classes. Both approaches have been shown to be conceptually superior to the familiar incremental and proportional methods of cost allocation.

In the Texas Highway Cost Allocation Method the MIA is used to allocate construction costs among specified vehicle classes. Maintenance and rehabilitation costs, which are driven by axle loads, are allocated via the Generalized Method.

Research Report 390-1F

After establishing a conceptual framework, Report 390-1F reported the development of engineering solutions to some practical problems. The following is a list of model improvements:

- Construction Cost Function Improvement. A construction cost model, which addressed the problems of capacity and axle loads, was based on a rigid pavement design. Costs per centerline mile were assumed to be the summation of excavation, right of way, and pavement costs and other fixed costs such as landscaping and traffic protection. Structures, however, were not included in the cost model.
- Data Enhancement. More complete data were gathered from this study. Weigh-in-motion data for 1985 were collected specifically for this study at several sites in the state.

Research Study 974

Texas' results and allocation techniques were compared with those of other states, including California, Oregon, and the states included in the 1982 FHWA study. These results confirmed that heavy 5+-axle combinations significantly do not pay their fair share of highway costs, while passenger cars pay more than their fair share. The difference in equity ratios between Texas and the other states reviewed reflected the system of taxation in these states and the methodology employed. Additionally, the cost responsibilities of the various vehicle classes were updated to utilize 1986 data. A videotape was subsequently created explaining the Texas HCA study and methodology.

Research Study 974 – Continuation

Weigh-in-motion data from 1988 was used to update the cost responsibilities of the vehicle classes. The number of vehicle classes was changed back to 8 to reflect the 390 report composition. Sensitivity analyses were performed which illustrated that, as the Texas highway system expenditures become more rehabilitation- and maintenance-oriented, large combination vehicles assume higher cost responsibilities. A new video was developed to reflect the 1988 data.

Research Study 1910

The objectives of this study were to: reclassify vehicles comprising the 2D classification to achieve more homogeneity within this specific vehicle class; incorporate environmental pavement damage into the cost allocation procedure; and evaluate the Trucking Research Institute's assessment of cost allocation methodologies. Cost responsibilities for 1988 were made after incorporating the enhancements. (Refer to Research Report 1910-1 for more details.)

Research Study 1910 – Continuation

In this continuation, the cost allocation procedures were converted from BASIC to FORTRAN to allow the evaluation of 12 vehicle classes. Cost responsibilities for 1990 were obtained, as well as a forecast for 1991. Six other Highway Cost Allocation Studies were reviewed, and these studies depicted that the Texas cost responsibilities were similar when adjusted for VMT. The results are summarized in Briefing Report 1910-2.

CURRENT OBJECTIVES OF STUDY 1910

The emphasis of the current study is to improve the model to obtain more realistic cost responsibility estimates attributable to each vehicle class, as well as to upgrade the capability of the model to provide timely analysis. Thus, the following tasks were undertaken: development of a bridge cost equation; development of forecasts of cost responsibilities; and monitoring HCA developments. A brief description of the methodology follows:

- Step 1: Obtain the blueprints and costs of representative HS 20 pre-stressed concrete bridges in the climatic regions and calculate the appropriate costs. This was done with the assistance of the TxDOT Bridge Division personnel.

- Step 2: Calculate the bridge costs for hypothetical lower load bridges (i.e., H2.5, H5, H10, H15, H20, HS15). This was achieved by applying percentage of cost factors (developed in the 1981 Federal Highway Administration bridge cost attribution study by Sinclair and Associates) to the HS 20 pre-stressed costs.

- Step 3: Design and estimate the cost of pre-stressed concrete HS25 and HS30 bridges for each climatic region, using the applicable HS20 bridge as a prototype. This was done according to the TxDOT Bridge Design Guide.

- Step 4: Develop regression equations relating bridge costs to vehicle weights for each region.

- Step 5: Use the weight data for each vehicle class to obtain bridge costs from the regression equations and use results as input for the Modified Incremental Approach to obtain attributable cost percentages.

Table 4-1 depicts the bridge cost responsibilities for each vehicle class. For each year, about 80 percent of the cost is attributable to 3 vehicle classes: passenger cars (45 percent to 48 percent); pickups and vans (16 percent to 18 percent); and 5-axle combinations (19 percent to 20 percent). More detailed information concerning the bridge cost equation development is contained in a technical report appended to this briefing.

COST RESPONSIBILITY RESULTS FOR 1991-1994

The Texas Highway Cost Allocation study recognizes four categories of costs: Construction; Rehabilitation and Maintenance; Common; and Bridge Costs. The overall cost responsibility for each vehicle class is determined by multiplying these costs by the estimated percentages expended in these cost categories for the relevant year. Thus, the cost responsibility is the weighted-average percent. The "weights" were derived from information submitted directly to TTI by TxDOT and the SF series tables of *Highway Statistics 1991* [USDOT, Federal Highway Administration]. For 1991-92 these "weights" were:

a.	Construction Costs	0.53
b.	Rehabilitation and Maintenance Costs	0.27
c.	Common Costs	0.13
d.	Bridge Costs	0.07

The above weights were also used for estimates and forecasts for the 1993 and 1994 years, respectively.

Table 4-2 shows the cost responsibilities of the 12 vehicle classes for the years 1991 through 1994. For comparative purposes, the actual 1990 and forecast 1991 results are also included. Three vehicle group categories are depicted: passenger vehicles, single units, and combinations. The cost responsibilities in these groups do not vary by more than 3 percent for the years 1990-94. Cost responsibilities attributed to passenger vehicles range from 54 percent to 56 percent; to single units, from 10 percent to 11 percent; and to combinations, from 34 percent to 36 percent. The consistency is attributable mainly to relatively stable weighting factors, stable distribution of VMT, and stability in vehicle weights for these years.

The forecasting method employed was based on the exponential smoothing technique, and estimated VMT for each vehicle class by region. Since exponential smoothing is applicable for only one future period, it was applied in obtaining 1993 year estimates. Forecasts for 1994 vehicle class VMT used estimates of increases via a simple growth model. Load equivalent factors for each vehicle class were estimated for 1993 and 1994 based on regression techniques.

Table 4-3 presents a sensitivity analysis for 1992 representing various changes in the weighting factor. The boxes denote vehicle class values that are the maximum for each weighting factor scenario, while values that are underlined are minimum values for each scenario. As can be seen, passenger vehicles have the highest cost responsibilities when construction costs have the highest weights and Rehabilitation and Maintenance costs have the lowest weight. Note that, under these conditions, minimal cost responsibilities occur for both single-unit trucks and combinations. The reverse — high weights on Rehabilitation and Maintenance, low weights on construction — produces just the opposite effect on the vehicle classes: single units and combinations experience their maximum cost responsibility, while passenger vehicles experience their lowest cost responsibility. It is expected that future TxDOT expenditures will have more emphasis on Rehabilitation and Maintenance; therefore, higher cost responsibilities would be attributed to single-unit and combination vehicles.

Table 4-1
Bridge Cost Allocations

	1991	1992	1993	1994
PASSENGER CARS	45.04%	47.73%	46.94%	47.92%
BUSES	0.56%	0.56%	0.50%	0.50%
2 Axle	0.40%	0.40%	0.36%	0.36%
3 Axle	0.16%	0.16%	0.14%	0.14%
SINGLE UNIT TRUCKS	25.86%	24.08%	24.14%	23.10%
Pickup & Panel	18.44%	17.11%	16.91%	16.00%
Other 2 Axle	5.01%	5.22%	5.24%	5.16%
3 or more Axle	2.41%	1.75%	1.99%	1.94%
COMBINATIONS	28.53%	27.63%	28.43%	28.48%
3 Axle, Single Trailer	0.52%	0.71%	0.54%	0.51%
4 Axle, Single Trailer	1.64%	1.66%	1.74%	1.71%
5 Axle, Single Trailer	18.88%	20.34%	19.55%	19.63%
6 Axle, Single Trailer	5.79%	3.89%	5.27%	5.23%
5 Axle, Twin Trailer	0.61%	0.70%	0.67%	0.69%
6 Axle, Twin Trailer	1.09%	0.33%	0.66%	0.71%

Table 4-2
Cost Responsibilities, 1990-1994

Vehicle Type	No Bridge Cost Equation			With Bridge Cost Equation			
	Actual 1990	**Forecast 1991**	**Actual 1991**	**Actual 1991**	**Actual 1992**	**Estimated 1993**	**Forecast 1994**
PASSENGER CARS	37.61%	34.86%	41.10%	40.58%	41.72%	41.18%	42.20%
BUSES	2.90%	2.63%	2.18%	2.20%	2.14%	2.11%	2.17%
2 Axle	1.56%	1.39%	1.17%	1.18%	1.14%	1.14%	1.18%
3 Axle	1.34%	1.24%	1.01%	1.02%	1.00%	0.97%	0.99%
SINGLE UNIT TRUCKS	24.80%	26.58%	23.08%	23.18%	21.66%	22.28%	21.63%
Pickup & Panel	16.23%	18.27%	14.97%	14.94%	13.84%	13.87%	13.17%
Other 2 Axle	5.93%	5.63%	5.60%	5.65%	5.41%	5.88%	5.89%
3 or more Axle	2.64%	2.68%	2.51%	2.59%	2.41%	2.53%	2.57%
COMBINATIONS	34.71%	35.94%	33.64%	34.04%	34.48%	34.42%	34.01%
3 Axle, Single Trailer	1.54%	1.78%	1.34%	1.35%	1.46%	1.34%	1.37%
4 Axle, Single Trailer	2.09%	3.26%	2.27%	2.31%	2.40%	2.53%	2.56%
5 Axle, Single Trailer	26.01%	26.05%	25.34%	25.26%	26.06%	25.91%	25.27%
6 Axle, Single Trailer	1.88%	1.91%	1.58%	1.96%	1.49%	1.63%	1.67%
5 Axle, Twin Trailer	2.15%	1.95%	2.01%	2.00%	1.97%	1.97%	2.05%
6 Axle, Twin Trailer	1.04%	0.99%	1.10%	1.16%	1.10%	1.04%	1.09%
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 4-3
Cost Responsibility, Sensitivity Analysis

	1992 Results	Scenario 1	2	3	4	5	6	7	8	9	10	11	12
COST DISTRIBUTION													
Construction	53%	63%	43%	58%	48%	58%	48%	53%	53%	53%	53%	53%	53%
Rehab. & Maint.	27%	17%	37%	27%	27%	27%	27%	32%	22%	32%	22%	27%	27%
Common	13%	13%	13%	8%	18%	13%	13%	8%	18%	13%	13%	18%	8%
Bridge	7%	7%	7%	7%	7%	2%	12%	7%	7%	2%	12%	2%	12%
ALLOCATED COSTS													
PASSENGER CAR	41.73%	46.77%	**36.70%**	40.98%	42.49%	42.04%	41.43%	38.46%	45.01%	39.52%	43.95%	42.79%	40.67%
BUSES	2.14%	**1.47%**	2.80%	2.14%	2.13%	2.13%	2.15%	2.48%	1.79%	2.46%	1.82%	2.12%	2.15%
2 Axle	1.14%	**0.80%**	1.47%	1.14%	1.13%	1.13%	1.15%	1.31%	0.96%	1.30%	0.98%	1.12%	1.15%
3 Axle	1.00%	**0.67%**	1.33%	1.00%	1.00%	1.00%	1.00%	1.17%	0.83%	1.16%	0.84%	1.00%	1.00%
SINGLE UNIT TRUCKS	21.66%	22.05%	**21.27%**	21.63%	21.68%	21.58%	21.73%	21.43%	21.88%	21.38%	21.93%	21.60%	21.71%
Pick up & Panel	13.84%	15.24%	**12.45%**	13.72%	13.96%	13.85%	13.83%	13.02%	14.66%	13.15%	14.53%	13.97%	13.71%
Other 2 Axle	5.41%	**4.88%**	5.94%	5.48%	5.34%	5.35%	5.47%	5.75%	5.07%	5.62%	5.20%	5.28%	5.54%
3 or more Axle	2.41%	**1.93%**	2.88%	2.43%	2.38%	2.38%	2.43%	2.66%	2.15%	2.61%	2.20%	2.35%	2.46%
COMBINATIONS	34.48%	**29.72%**	39.25%	35.25%	33.71%	34.27%	34.69%	37.64%	31.32%	36.66%	32.31%	33.48%	35.47%
3 Axle, Single Trailer	1.46%	**1.10%**	1.82%	1.47%	1.45%	1.45%	1.47%	1.65%	1.27%	1.63%	1.29%	1.44%	1.48%
4 Axle, Single Trailer	2.40%	**1.93%**	2.87%	2.42%	2.37%	2.37%	2.42%	2.66%	2.13%	2.61%	2.19%	2.34%	2.45%
5 Axle, Single Trailer	26.06%	**23.31%**	28.80%	26.76%	25.36%	26.07%	26.05%	28.13%	23.99%	27.44%	24.68%	25.37%	26.75%
6 Axle, Single Trailer	1.49%	**1.12%**	1.87%	1.50%	1.49%	1.31%	1.68%	1.69%	1.30%	1.50%	1.49%	1.30%	1.68%
5 Axle, Twin Trailer	1.97%	**1.49%**	2.45%	1.99%	1.94%	1.97%	1.96%	2.23%	1.70%	2.21%	1.72%	1.94%	1.99%
6 Axle, Twin Trailer	1.10%	**0.77%**	1.44%	1.11%	1.10%	1.10%	1.11%	1.28%	0.93%	1.27%	0.94%	1.09%	1.12%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Note: shaded boxes denote maximum values, bold values denote minimum values

SECTION 5. EQUITY ANALYSIS

OVERVIEW

As indicated in Section 1, one of the principal objectives of the Texas cost responsibility study is to determine whether classes of vehicles contribute equitably to the highway system. A revenue/cost ratio is used for this purpose and is defined as the ratio between revenue contributed by a vehicle to the cost responsibility associated with its operation. An equitable highway user fee structure requires that revenue contributions match cost responsibility. A revenue/cost ratio with a value greater than one indicates that a vehicle is contributing more dollars to the highway system than its assigned costs, and a ratio of less than one indicates that a vehicle is contributing less than its assigned costs. When this inequity occurs, it amounts to a subsidy from one vehicle class to another.

In order to develop a truly equitable taxing structure, the amount of revenue generated by each vehicle and its related highway cost responsibility should be known. However, given that efficiency is also an important objective of the highway system, this ideal becomes unrealistic. A more practical approach involves the grouping of similar vehicles. This approach does raise questions, however, with respect to both horizontal equity (within the same vehicle group), and vertical equity (between different vehicle groups). Although it is possible for a tax structure to provide equitable distribution of taxes among the various groups, there can be inequity within the vehicle group itself. This is particularly significant for vehicles in the same class with different weights.

The analysis of equity is performed at two levels: the state system with federal aid included and the state system without federal aid. From the user's perspective, this makes little difference; i.e., users are more concerned about the level of taxation and not the source. For example, few persons know what percentage of their fuel tax is state-levied versus federal-levied. From the state perspective, the separation of state and federal revenues is important. In addition to correcting for any inequities in the state tax structure, the state must also be sensitive to changes in federal tax rates. It is possible for state-generated user taxes and fees to be equitably distributed among the different vehicle groups. Inequity may occur in the federal tax rates, which are outside the domain of state policy. The development of state tax strategies to correct for inequity may be a frustrating process if the federal government alters or changes its taxes.

The analysis of the state portion of the highway system provides useful information to state decision-makers. Analysis of user revenues is a very straightforward process, since highway user taxes are accounted for by separate legal entities. An analysis of costs, however, is much more difficult. Separation of the federal-supported costs from state costs requires an assumption that may or may not be accurate. It is assumed that the construction and operation of the highway system would be identical under a state-only funded strategy, an assumption that may not be entirely accurate. State decisions regarding the construction and operation of highways are influenced by the availability of federal aid. Federal highway aid is designed to meet national transportation priorities as reflected in the types of system assistance — primary, interstate, secondary, and urban. The removal of federal dollars from the cost/expenditure side of the cost/revenue allocation equation assumes the state would continue to support or develop the same highway system that is supported or designated by federal authorities. Assuming the state-funded portion of the highways reflects the state transportation policy, then an analysis of state revenues and costs is a valuable exercise for determining the level of support by various user classes.

EQUITY ANALYSIS - STATE FUNDS ONLY

Table 5-1 presents a summary of the revenue/cost equity ratios using state funds only. The automobile, as shown in the table, contributes nearly 25 percent more than it costs the highway system. Pickup trucks contribute nearly 82 percent more than their assigned cost responsibility, while other single-unit trucks contribute about 10 percent more. Buses and combination trucks contribute significantly less than their assigned costs.

EQUITY ANALYSIS - COMBINED STATE AND FEDERAL FUNDS

When including federal user taxes and fees in the analysis of equity, there are some important changes, as shown in Table 5-2. The ratios for automobiles and pickup trucks are adjusted downward from 1.251 to 1.161 and from 1.819 to 1.746, respectively. The ratio for other single-unit trucks increases from 1.102 to 1.147. The ratios for combination trucks and buses also increase from 0.389 to 0.516 and from 0.289 to 0.291, respectively. Federal user taxes and fees improve the equity ratios, i.e., move them towards a value of one, for the heavier vehicles.

CURRENT ESTIMATES/FORECASTS

In an effort to keep abreast with policy changes, estimates for 1993 and 1994 have been developed. Simple trend analysis is used to adjust vehicle descriptors and parameters. Table 5-3 presents a summary of revenue/cost equity ratios for various periods. The purpose for development of these estimates is to determine if there are significant annual changes in the results over a brief period of time. As indicated in Table 5-3, there are no significant annual variations.

SUMMARY

Based on the analysis of costs and revenues for Texas vehicles, and on various sensitivity tests, one can conclude that combination trucks and buses operating on Texas highways are not paying their fair share of highway costs.[3] These vehicles are being subsidized by lighter vehicles, principally pickup trucks and automobiles. These results have important implications for evaluating future changes in financing highway improvements. If equity is an important goal for financing highway improvements, then structural changes in the financing of highways will be necessary.

[3] Buses are exempt from many of the user charges and fees. Previous analysis indicates that, accounting for exemptions, buses pay about 60 percent of their assigned costs (Research Report 1937-1F).

Table 5-1
1992 Revenue/Cost Equity Analysis - State Revenues

	Number of Vehicles	% of Revenues	% of Costs	Rev/Cost Ratio
Passenger Car	8,846,870	52.18%	41.72%	1.251
Pickups	3,311,061	25.18%	13.84%	1.819
Buses	62,182	0.62%	2.14%	0.289
2 Axle	60,546	0.52%	1.14%	0.459
3 Axle	1,636	0.09%	1.00%	0.095
Single Unit Trucks	550,799	8.62%	7.82%	1.102
2 Axle	435,789	5.61%	5.41%	1.036
3 or more Axle	115,010	3.01%	2.41%	1.250
Combinations	122,524	13.41%	34.48%	0.389
3 Axle	3,933	0.13%	1.46%	0.087
4 Axle	7,695	0.28%	2.40%	0.116
5 Axle	104,415	11.98%	26.06%	0.460
6 Axle	1,642	0.22%	1.49%	0.148
5 Axle Twin	3,933	0.66%	1.97%	0.334
6 Axle Twin	907	0.14%	1.10%	0.126
TOTAL	12,893,436	100.00%	100.00%	1.000

Table 5-2
1992 Revenue/Cost Equity Analysis - State and Federal Revenues

	Number of Vehicles	% of Revenues	% of Costs	Rev/Cost Ratio
Passenger Car	8,846,870	48.46%	41.72%	1.161
Pickups	3,311,061	24.17%	13.84%	1.746
Buses	62,182	0.62%	2.14%	0.291
2 Axle	60,546	0.46%	1.14%	0.401
3 Axle	1,636	0.17%	1.00%	0.166
Single Unit Trucks	550,799	8.97%	7.82%	1.147
2 Axle	435,789	5.62%	5.41%	1.038
3 or more Axle	115,010	3.35%	2.41%	1.390
Combinations	122,524	17.78%	34.48%	0.516
3 Axle	3,933	0.13%	1.46%	0.092
4 Axle	7,695	0.30%	2.40%	0.126
5 Axle	104,415	15.96%	26.06%	0.613
6 Axle	1,642	0.30%	1.49%	0.198
5 Axle Twin	3,933	0.90%	1.97%	0.456
6 Axle Twin	907	0.19%	1.10%	0.170
TOTAL	12,893,436	100.00%	100.00%	1.000

Table 5-3
Revenue/Cost Equity Ratio Trends

	1991 Actual	1992 Preliminary	1993 Estimate	1994 Forecast
Passenger Car	1.217	1.161	1.181	1.149
Pickups	1.561	1.746	1.761	1.868
Buses	0.267	0.291	0.304	0.300
2 Axle	0.363	0.401	0.410	0.400
3 Axle	0.155	0.166	0.180	0.181
Single Unit Trucks	1.039	1.147	1.068	1.060
2 Axle	0.933	1.038	0.955	0.951
3 or more Axle	1.270	1.390	1.331	1.311
Combinations	0.534	0.516	0.503	0.509
3 Axle	0.098	0.092	0.098	0.096
4 Axle	0.155	0.126	0.116	0.115
5 Axle	0.628	0.613	0.600	0.614
6 Axle	0.268	0.198	0.176	0.172
5 Axle Twin	0.503	0.456	0.443	0.425
6 Axle Twin	0.231	0.170	0.175	0.167

SECTION 6. CONCLUSIONS

The principal goal of the Texas Highway Cost Responsibility Study is to determine whether vehicle users are paying their fair share of highway system costs. The costs of the highway system are typically assigned to vehicle operators in cost allocation studies. However, since both highway users and non-users benefit from the transportation road system, the allocation of highway costs can assume a larger audience. There are a variety of approaches for determining an appropriate level of highway cost responsibility for users and non-users. In practice, however, the distinction generally relates to the jurisdictional level of the system. The costs of constructing and maintaining the state's primary roads, arterials, and collectors, are generally the responsibility of users through registration fees, fuel taxes, vehicle excise taxes, tolls, and other user charges. Non-users are generally responsible for local roads supported through property taxes and other general revenue sources. A problem with including non-user costs in cost allocation is that it complicates the question of equity. The cost-occasioned approach to cost allocation (costs are assigned on the basis of system use) are considered appropriate for allocating system costs to highway system users. Other approaches, particularly the benefit approach (costs are assigned on the basis of benefits received from the system) and the ability-to-pay approach (costs are assigned on the basis of need, merit, or ability to pay), may be more appropriate when attempting to allocate costs to non-users as well. Nearly all recent highway cost allocation studies focus on user costs only. This is the method used for the Texas study.

On the basis of the cost-occasioned approach, combination trucks and buses "consume" more of the highway system on a per vehicle basis. This becomes a problem only if user taxes and fees are below the level of highway system costs. This is the case for Texas, where combination trucks pay 17.8 percent of the highway user taxes and fees but are responsible for 34.5 percent of the highway system costs. Automobiles, on the other hand, contribute nearly 48.5 percent of the state's user taxes and fees and are responsible for only 41.7 percent of the highway system costs. Likewise, pickup trucks account for 24.2 percent of highway user taxes and fees but are responsible for only 13.8 percent of the highway costs.

Cost responsibility is the first step in developing a program of cost recovery. The next step should include an expansion of the cost function to system costs. Analysis of full system costs is necessary for a more complete multimodal analysis. Full system costs include the facility costs as currently done in highway cost allocation studies, but also include vehicle operating costs, time savings, accident costs, and other externalities such as air and noise pollution. These other elements must be included in a life-cycle analysis of system costs in order to effectively evaluate strategic alternatives for transportation. The reality is that future transportation problems will not be solved by building new highways, alone. Other modes will play an active role in addressing the state's transportation problems. Analysis of full system costs on a life-cycle basis is the kind of tool necessary to guide investments into the most efficient and productive areas.

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APPENDIX A. HCA DEVELOPMENTS IN OTHER STATES

1991 DELAWARE DOT HIGHWAY COST ALLOCATION STUDY

Delaware has traditionally used general revenues to fund its state highway system. In an effort to fund the system by users, DelDOT contracted the University of Delaware's Bureau of Economic Research (BER) to conduct a highway cost allocation study in which the costs occasioned and the revenues generated were to be attributed to the vehicle classes operating within the State. This study is noteworthy in that the BER instituted a Reallocation Advisory Group comprised of business interests, state highway and other public officials, and various user groups. The American Trucking Association, though not a member of the group, met with the group during its deliberations. The result was a consensus on the methodological approach employed in the study.

Eight vehicle classes, and one class for trailers, were identified for allocation purposes: motorcycles, autos, buses, 2-axle–4-tire single-unit trucks, 2-axle–6-tire single-unit trucks, 3- or more axle single-unit trucks, 4- or less axle combinations, and 5- or more axle combinations. The highway cost allocation methodology agreed to by the Reallocation Advisory Group, can best be termed a mixed approach. Common costs (i.e., costs which cannot be attributed to specific vehicle characteristics) were allocated on either a registration or vehicle miles of travel (VMT) basis. Occasioned costs (i.e., costs caused by one or more vehicle classes over and above the costs of the basic facility) were allocated on a passenger car equivalent (PCE) mile or equivalent single axle load (ESAL) mile basis. New bridge costs were based on the Pennsylvania Transportation Institute's incremental method for structural analysis of bridges. Replacement bridge costs were separated into two categories: structure-related and obsolescence-related. Structure-related costs were allocated using the new bridge cost methodology, while obsolescence-related costs were allocated by VMT.

The 1991 analysis found that passenger vehicles, representing 90 percent of the highway systems VMT, were responsible for about 80 percent of DelDOT costs. Other single-unit vehicles, representing 5 percent of the VMT, accounted for about 10 percent of the system's costs. Combination vehicles accounted for the remaining 5 percent and 10 percent of costs and VMT, respectively.

1990 PENNSYLVANIA HIGHWAY COST ALLOCATION STUDY

A preliminary highway cost allocation study was prepared for the Pennsylvania Department of Transportation by Pennsylvania State University's Pennsylvania Transportation Institute. This study is based on the concept of cost occasioning and included 13 vehicle classes for analysis: passenger cars, motorcycles, buses, 2-axle–4-tire single-unit trucks (including vans and ambulances), 2-axle–6-tire single unit trucks, 3-axle single-unit trucks, 4- or more axle single-unit trucks, 4- or less axle combinations, 5-axle combinations, 5- or less axle multi-trailer combinations, 6-axle multi-trailer combinations, and 7- or more axle multi-trailer combinations. A significant amount of data, such as VMT, was available for only 9 of the vehicle classes.

Most of the allocation is dependent upon VMT and ESAL miles. The costs are allocated by either VMT, ESAL miles, or other activity-based measures, depending upon the cost group being analyzed.

The study found that basic vehicles (i.e., passenger cars, motorcycles, buses, and 2-axle–4-tire single unit trucks) were responsible for 65.7 percent of the overall costs and 90.6 percent of the VMT; single-unit trucks accounted for 16.2 percent of the costs and 5.3 percent of the VMT; and combination trucks were responsible for 18.1 percent of the highway costs and 4.1 percent of the VMT.

COMPARISON WITH TEXAS COST RESULTS

A comparison of these studies with the 1991 Texas highway cost allocation results, Tables A-1 and A-2, shows a wide variation between the studies. In some respects this is due to the allocation methodology used. However, notice that in Texas the VMT of combination trucks is almost twice that in Delaware and in Pennsylvania. Also, notice that the ratios of cost responsibility to VMT for single units and combinations are almost identical in both Texas and Pennsylvania; the difference in passenger vehicle cost responsibilities is the residual effect (i.e., the percentages must add to 100).

Table A-1
Percent of Cost Responsibility

Vehicle Group	1991 Delaware	1990 Penn	1991 Texas
Passenger Vehicles*	79.0	65.7	55.5
Single Unit Trucks	10.5	16.2	10.5
Combinations	9.7	18.1	34.0
Trailers	0.8	--	--
Total	100.0	100.0	100.0

*includes pickup trucks

Table A-2
Percent of Total VMT

Vehicle Group	1991 Delaware	1990 Penn	1991 Texas
Passenger Vehicles*	89.6	90.6	88.5
Single Unit Trucks	4.8	5.3	3.7
Combinations	4.9	4.1	7.8
Trailers	0.7	--	--
Total	100.0	100.0	100.0

*includes pickup trucks

APPENDIX B

INCREMENTAL BRIDGE COST TASK REPORT

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Fiscal Year 1993

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PART I. INTRODUCTION

The Surface Transportation Assistance Act of 1982 allowed the trucking industry to utilize the productivity potential of large trucks. The current trend is towards higher truck sizes and load limits, causing concern among highway agencies for highway maintenance and safety. Thus, the issue of truck weight limits is highly volatile. This Appendix is a part of the Texas highway cost allocation procedure enhancement and focuses on estimating incremental bridge construction costs due to a potential increase in truck weight limits.

SIGNIFICANCE OF THE TASK

Recent favorable changes in Mexico's foreign trade and investment policies are increasing U.S. trade with Mexico. Currently over 30 percent of Texas exports are destined for Mexico. An estimated 85 percent of all freight between the U.S. and Mexico moves on the ground, with trucks as the major transportation mode. This trade volume is likely to increase in the near future with the ratification of the North American Free Trade Agreement (NAFTA). Increased cross-border trade will certainly increase freight movement between Texas and Mexico, placing additional strain on Texas highways. Under such circumstances, highway agencies are pressured to allow heavier trucks on highways to mitigate congestion and reduce operating costs.

The most recent national bridge inventory of deficient bridges conducted by the Federal Highway Administration (FHWA) indicates that a rapidly growing number of bridges are approaching the termination of their service lives (TRR 1290; 1990). The state of Texas has 45,862 bridges, of which 6,898 bridges are on the Interstate system, 19,471 bridges are on other federal-aid systems, and the rest of the bridges are off federal-aid systems (Hudson et al, 1987). If a new truck weight regulation were introduced allowing heavier loads, the number of bridges that cannot carry legal loads would increase, thereby increasing the number of bridges to be replaced, rehabilitated, or posted. Therefore, any increase in truck weight limits should precede strengthening existing bridges and precede any increase in new bridge design loadings. The maximum design load anticipated on the bridge governs the bridge design, making the bridge construction cost a function of the heaviest design vehicle weight. This scenario necessitates a serious evaluation of costs involved in allowing heavier vehicles on Texas highways.

TASK OBJECTIVE

The primary objectives of this task are to:

- estimate the incremental bridge costs in Texas designed for groups of vehicles which are incremented from the lightest (H2.5) to the heaviest design loading (HS30); and
- allocate the estimated bridge construction costs among groups of vehicles based on increased structural costs related to increased design vehicle weight.

PART II. METHODOLOGY

The selected methodology falls into four major sections. First, four concrete bridges were selected in different geographical regions of Texas in consultation with Texas state highway bridge engineers at TxDOT's Bridge Division. A list of the selected bridges is shown in Table B2-1. All the bridges were designed for HS20 loading and are currently in service.

Second, based on AASHTO classifications, nine design vehicle classes were selected for bridge construction cost estimation: (1) H2.5, (2) H5, (3) H10, (4) H15, (5) H20, (6) HS15, (7) HS20, (8) HS25, and (9) HS30 representing combination trucks. The gross vehicle weight (GVW) of these design vehicle classes is shown in Table B2-2. The smallest vehicle considered in the present study weighs 5,000 pounds (2,270 kg) or 2.5 tons (2.27 metric tons), termed as H2.5 class loading. Below this size, snow, wind, and the weight of the bridge itself almost totally obscure the effect of further weight reductions.

Third, bridge construction costs for various design vehicle classes were computed based upon results from a 1982 Federal Highway Administration's (FHWA) Highway Cost Allocation Study. The FHWA study selected twelve representative bridge types and redesigned them for design vehicle classes: HS20, HS15, H20, H15, H10, H5, and H2.5. Considering the bridge cost corresponding to vehicle class HS20 for each bridge type as a comparison base, the costs of bridges for other design vehicle classes were expressed as percentages of the base cost for each bridge type. Table B2-2 contains a summary of the FHWA study findings. The first row shows the gross vehicle weight (GVW) in kips, the second row shows the design load classification, and the last row shows allocation cost percentages.

Fourth, all the selected bridges are designed for HS20, HS25, and HS30 class loadings, and total bridge construction costs under each loading are computed. Finally, bridge construction costs are allocated among the design vehicle groups using the modified incremental approach.

A significant portion of Texas bridge expenditures (about 88 percent) is spent on new bridge construction and replacement and about 12 percent on maintenance, repair, and rehabilitation (Hudson et al, NCHRP 300, 1987). Therefore, only new bridge construction costs are considered in the present study. In ideal terms, a potential increase in truck weights and their regulation should be evaluated for each bridge in Texas. This requires computing the bridge costs, including inspection, maintenance, and rehabilitation costs associated with the potential regulations for each bridge. Such detailed cost comparisons are not only beyond the scope of the budget and the time frame of this study, but are also impractical. Therefore, the incremental design and analysis is limited to a representative set of bridges.

Table B2-1
Selected Texas Bridges

Bridge	County	Region	Length (ft/m)	Width (ft/m)
1) IH37 South 6-span prestr. concrete 1-lane exit ramp	Bexar	Central	660/201	26/8
II) Loop 375, Zaragosa Road 4-span prestr. concrete 2-lane divided overpass	El Paso	Western	284/87	40/12
III) Royal Lane Bridge 11-span prestr. concrete 4-lane divided hwy.	Dallas	Panhandle	1100/335	88.25/27
IV) IH40/FM 291 Underpass 4-span prestr. concrete 2-lane divided hwy.	Gray	Eastern	280/85	36/11

Table B2-2
Variation of Bridge Costs With Live Load (FHWA)

GVW	5	10	20	30	40	54	72
Class	H2.5	H5	H10	H15	H20	HS15	HS20
Cost %	80.78	82.61	86.52	90.43	95.8	94.59	100

PART III. STRUCTURAL DESIGN AND ANALYSIS OF BRIDGES

Several assumptions are made in this study: 1) selected bridges represent all the bridge types in their respective geographical regions; 2) the design load will be a "HS" model with a minimum HS level selected to envelop increases in truck weight regulations; and 3) the truck width will not vary under higher truck weight limits.

Starting with the bridge designed for HS20 class loading, a structural analysis based on the TxDOT Bridge Design Guide is performed. This process is continued for the hypothetical bridges of HS25 and HS30 loading. The bridge elements that can vary significantly under HS25 and HS30 loadings from HS20 loading include: (1) superstructure (slab and beams), (2) substructure, (3) piers and abutments, and (4) pilings/drill shafts. Among these identified variables, the slab and beam are selected for incremental design and analysis.

SLAB DESIGN

Concrete bridge deck slabs are designed for HS20, HS25, and HS30 loadings for all the selected bridges adopting the TxDOT's Bridge Design Guide's slab design procedure. These designs conform to the AASHTO 1983 specifications (see Design Guide for further details). Increments in slab thickness (in inches) and reinforcement details, followed by the bar type for each bridge under different loadings, is computed. The results are presented in Table B3-1. Temperature and distribution reinforcement remain the same as those for HS20 loading for HS25 and HS30 loadings. For ease of comparison, consistent bar types are provided under different loadings.

BEAM DESIGN

Pre-stressed concrete beams are designed for HS20, HS25, and HS30 loadings for all the selected bridges using the TxDOT Bridge division computer program, **PSTRS14**, pre-stressed concrete beam design/analysis program. The input for the program includes: beam type; center to center bearing length (ft/m); beam spacing (ft/m); slab thickness (in./cm); and the relative humidity of the geographical region where the bridge is located. The output of the program is comprised of ultimate design stresses, ultimate moment, compressive strength, the number of strands, and the strand pattern. A summary of the results is shown in Table B3-2. In Table B3-2, column [1] shows the beam span number, column [2] shows the number of beams, and column [3] shows the beam type in the bridge span. The number of 1/2 size strands for HS20, HS25, and HS30 loadings and the incremental reinforcement are shown in the following columns. The total number of strands required under each class of loading are also shown for each bridge. For instance, the IH37 bridge, under HS25 and under HS30 loading, requires an additional number of strands — 24 (9.23 percent) and 62 (23.84 percent), respectively — than it requires under HS20 loading. Similar incremental reinforcement percentages are shown for all other bridges. The incremental beam reinforcement ranged from 9 to 18 percent under HS25 loading and from 23 to 36 percent under HS30 loading. The same reinforcement type (1/2 size strands) is provided in all beams under different loadings for ease of comparison.

Table B3-1
Slab Reinforcement Details

IH37 South, Bexar County, Control #0073-08-117

	HS20	HS25	HS30
Thickness (in)	7.5	7.5	8
Top Reinforcement (#5)	1320	1440	1584
Bottom Reinforcement (#5)	660	792	880
Bottom Reinforcement (#4)	660	792	880
Distribution Reinforcement (#5)	27	27	27
Temperature Reinforcement (#4)	28	28	28

Loop 375, Zaragosa Rd. El Paso County, Control #2552-03-013

	HS20	HS25	HS30
Thickness (in)	8	8.25	8.75
Top Reinforcement (#5)	682	757	757
Bottom Reinforcement (#5)	341	379	426
Bottom Reinforcement (#4)	341	379	426
Distribution Reinforcement (#5)	42	42	42
Temperature Reinforcement (#4)	42	42	42

Royal Lane Bridge (MH 539), Dallas County, Control #879-18-007

	HS20	HS25	HS30
Thickness (in)	8	8.25	8.75
Top Reinforcement (#5)	2640	2937	3300
Bottom Reinforcement (#5)	1390	1650	1760
Bottom Reinforcement (#4)	1390	1650	1760
Distribution Reinforcement (#5)	96	96	96
Temperature Reinforcement (#4)	91	91	91

IH40/FM291 Underpass, Gray County, Control #0275-11-061

	HS20	HS25	HS30
Thickness (in)	7.5	7.5	7.75
Top Reinforcement (#5)	432	432	432
Bottom Reinforcement (#5)	180	216	240
Bottom Reinforcement (#4)	180	216	240
Distribution Reinforcement (#5)	41	41	41
Temperature Reinforcement (#4)	38	38	38

Table B3-2
Beam Reinforcement Details

[1] SPAN	[2] BEAM	[3] TY	NO. OF 1/2 SIZE STRANDS [4] HS20	[5] HS25	[6] HS30	[7]=[5]-[4] HS25-HS20	[8]=[6]-[4] HS30-HS20	[9]=[6]-[5] HS30-HS25
IH37 South. Bexar County, Control #0073-08-117								
1	1-4	IV	50	56	64	6	14	8
2	1-4	IV	36	40	44	4	8	4
3	1-4	IV	18	20	22	2	4	2
4	1-4	IV	52	56	64	4	12	8
5	1-4	IV	52	56	64	4	12	8
6	1-4	IV	52	56	64	4	12	8
Sum			260	284	322	9.23%	23.84%	13.38%
Loop 375, Zaragosa Road, El Paso County, Control #2552-03-013								
1	1-5	IV	14	16	18	2	4	2
2	1-5	IV	22	24	28	2	6	4
3	1-5	IV	30	34	38	4	8	4
4	1-5	IV	14	16	18	2	4	2
Sum			80	90	102	12.50%	27.50%	13.33%
Royal Lane Bridge (MH 539), Dallas County, Control #879-18-007								
1	1-10	IV	42	48	56	6	14	8
2	1-10	IV	42	48	56	6	14	8
3	1-10	IV	42	48	56	6	14	8
4	1-10	IV	42	48	56	6	14	8
5	1-10	IV	42	48	56	6	14	8
6	1-10	IV	42	48	56	6	14	8
7	1-10	IV	42	48	56	6	14	8
8	1-10	IV	42	48	56	6	14	8
9	1-10	IV	42	48	56	6	14	8
10	1-10	IV	42	48	56	6	14	8
11	1-10	IV	42	48	56	6	14	8
Sum			462	528	616	14.28%	33.33%	16.66%
IH40/ FM291 Underpass, Gray County, Control #0275-11-061								
1	1-6	C	12	14	16	2	4	2
2	1-6	C	34	40	46	6	12	6
3	1-6	C	34	40	46	6	12	6
4	1-6	C	8	10	12	2	4	2
Sum			88	104	120	18.18%	36.36%	15.38%

PART IV. COST ANALYSIS AND RESULTS

TxDOT's Bridge Division provided the lowest bid tabulations, quantity estimates, and bid costs for all the selected bridges. The division also provided twelve-month-moving average unit bid costs ending December 31, 1992. These unit bid costs are used to re-estimate the total construction costs of each bridge, in order to minimize bias in bid estimates. These revised total construction cost estimates for all the selected bridges are shown in Table B4-1 for HS20 loading and are used throughout this study.

INCREMENTAL METHOD

The incremental methodology is based upon the principle that each vehicle class should share in all increments of costs in constructing a bridge for that vehicle class. For instance, the quantity of reinforcement material varies with different vehicle classes. When this quantity is multiplied by the unit cost of material, it results in the final total cost of the bridge element (FHWA, 82; Cavazos, 85). This methodology was adopted in the 1982 FHWA HCA Study for allocating bridge construction costs. Results of this study are used in computing incremental costs of constructing bridges for design vehicle classes H2.5, H5, H10, H15, H20, and HS15, taking the revised construction cost estimate of the existing bridge, which was designed for HS20 loading. The bridge cost estimates for HS25 and HS30 bridges require computation of associated incremental costs of all bridge elements that vary with the design load. The incremental design and analysis is restricted to bridge superstructure, which includes slabs and beams, as discussed in earlier sections. Incremental costs of slabs, beams, and substructure are computed. The following formula is used to compute the cost of constructing a bridge for a HS25 class loading:

> Total cost of bridge under HS25 loading = Total cost of the bridge under HS20 loading - Sum of the slab, beam, and substructure cost under HS20 loading + Sum of the slab, beam, and substructure cost under HS25 loading

A similar procedure is adopted in computing the total construction cost of the bridges under HS30 loading.

BEAM COST ESTIMATE

Beam costs are computed based on price estimates provided by independent precast concrete manufacturers.

The Precast Concrete Manufacturers Association (PCMA), San Antonio Region, was approached for an independent and realistic cost estimate of the precast concrete beams under all loadings. The PCMA took a keen interest in the study and forwarded the bridge information, including the results of the structural analysis and the reinforcement details, to several of its members. Based on this information, two precast concrete manufacturers (The Manufactured Concrete Products Company (MANCO), located in San Antonio, Texas, and the Texas Concrete Company (TCC), located in Victoria, Texas, provided unit price estimates for beams under different loading conditions for all bridges. Based on these price estimates, the total cost of beams in each bridge under different loadings is computed, and these costs are shown in Table B4-2 in columns [3] and [4] respectively. Average values of these two sets of results are shown in column [5]. Column [2] shows the twelve-month-moving average cost of beams in each bridge under HS20 loading. The values shown in parentheses in columns [3], [4], and [5] for HS25 and HS30 classes are the percent increment values of HS20 class loading.

SLAB COST ESTIMATE

It is a normal practice in highway construction to bid for slabs by square footage of the deck area. Therefore, the computation of an incremental cost of slab thickness and associated concrete and reinforcement is quite difficult. To account for these additional costs, an approximate method, based on proportional slab thicknesses, was devised in consultation with TxDOT's bridge engineers. Under this method, computed slab thickness for HS25 loading is divided by the thickness of one HS20 slab. The computed thickness ratio is multiplied by the twelve-month-moving average cost of the HS20 slab to obtain the slab cost of HS25 loading. A similar procedure is adopted to obtain the slab costs under HS30 loading, and the results are shown in column [7] in Table B4-2. Column [6] shows the slab thickness of each bridge deck in inches under different loadings. The costs of railing and surface treatment are assumed to remain constant.

SUBSTRUCTURE COST

An accurate design of piers, abutments, piles, and other substructure elements in a true incremental context is complicated due to the effect of other loadings such as ice, thermal stream flow, wind, and so on, which affect the substructure design almost independently of vehicle characteristics. Furthermore, soil condition and loading capacity of the soil greatly influence the substructure design. Consequently, as in the 1982 FHWA cost allocation study and the 1985 Indiana highway cost allocation study, the soil mechanical properties of the sample bridge and hypothetical bridges designed for loadings greater than HS20 are assumed to be identical and the loading capacity of the soil is assumed to vary proportionally to the load placed upon it. The 1982 FHWA study designed piles based on the assumption that pile length is proportional to the applied load. Though only 25 percent of the total applied load on piles is due to live load, a pile cost slope proportional to live load slope was considered. Accordingly, a cost increment of 25 percent under HS25 loading and 50 percent under HS30 loading is adopted in computing the cost of piles/drill shafts/footings. The resulting cost estimates are shown in column [8] in Table B4-2 as substructure costs. Other substructure components, such as pile cap, the stem of the pier, and abutment, are assumed to have the same general configuration as the existing bridge, and hence are termed as non-attributable costs. Based on our initial assumption that the road width under incremental loadings remains constant, it is assumed that pile/drill shaft/footing cost slope will cover for the incremental costs of other substructure elements not included in the study.

TOTAL BRIDGE CONSTRUCTION COST

Bridge construction costs vary from state to state, depending upon the location, cost of labor, materials, equipment costs, etc.; for example, the average cost of bridge construction in Texas from 1981 to 1986 is $32 per square foot ($2.97 per square meter), vis-a-vis $102 per square foot ($9.50 per square meter) in New Jersey (Moses, 89). In the present study, total bridge construction costs are computed by adding the material costs of all bridge elements identified to vary with incremental loads, as discussed in the initial section of this chapter. Table B4-1 shows several sets of values involved in computing total construction costs. The average cost of beams shown in column [5] is added to the cost of slab shown in column [7] and to the cost of substructure shown in column [8] in Table B4-2.

The resulting values are shown in column [9] in Table B4-1. In the Table B4-1, column [10] shows the total bridge costs, column [11] shows the sum of slab, beam, and substructure under HS20 loading. These values are based on twelve-month-moving average costs. In order to compute the total construction costs under HS20 loading, the sum of beam, slab, and substructure costs for HS20 loading in column [9] is added to the total twelve-month-moving average total bridge construction cost under HS20 loading in column [10], less beam, slab, and substructure costs for HS20 loading shown in column [11]. The results are shown in column [12] for HS20 loading. In order to compute the bridge cost under HS25 loading, the sum of beam, slab, and substructure costs for HS25 loading in column [9] is added to the total twelve-month-moving average total bridge construction cost under HS20 loading in column [12], less beam, slab, and substructure costs for HS20 loading shown in column [11]. A similar procedure is adopted for the HS30 loading as well. Column [12] shows the total cost of each bridge under different loadings. Column [13] shows the incremental cost percentage of constructing a HS25 and a HS30 bridge from a HS20 bridge. A 10 percent cost increment is included in the HS20 bridge cost in column [10] to account for engineering and contingency costs.

TOTAL CONSTRUCTION COST ESTIMATION

The total construction costs of all the selected bridges for the selected design loading classes are shown in Table B4-3. The 1982 FHWA study's results are used in computing construction costs of bridges designed for H2.5, H5, H10, H15, and HS15 loadings, as explained in earlier sections. Taking the bridge construction cost for HS20 design loading as the basis, the construction costs for these design loadings are allocated using the cost percentages in Table B4-1. For instance, under a H2.5 loading, the IH37 bridge costs $830,293, whereas, under a HS20 loading, the same bridge costs $1,027,845. The computed total bridge construction costs under HS25 and HS30 loadings (column [12], Table B4-1) are shown in Table B4-1 for all the selected bridges. For the sake of comparison of the computed total construction costs with the approximate values, a cost slope of 1 percent increase in bridge cost per unit increase in HS level for design loads above HS20 is considered, based on the Moses study (Moses, 89). Accordingly, a cost increment of 5 percent for HS25 loading and of 10 percent for HS30 loading is adopted. The computed approximate total construction costs are shown in Table B4-3. The values shown in parentheses for HS25 and HS30 classes are the percent increment values over HS20 class for each bridge.

Table B4-1
Total Bridge Cost Computation Under Incremental Load

Class	[9] = [5] + [7] + [8]	12-month Moving Avg. Cost		Bridge Cost	
		[10] Total Bridge	[11] Beam + Slab + Substr.	[12] Total	[13] %
IH37 South, Bexar County, Control #0073-08-117					
HS20	459,634	1,018,965	450,754	1,027,845	
HS25	508,399			1,085,490	5.61%
HS30	566,134			1,143,225	11.23%
Loop 375, Zaragosa Road, El Paso County, Control #2552-03-013					
HS20	937,748	1,675,630	867,028	1,746,350	
HS25	1,042,862			1,922,184	10.07%
HS30	1,162,823			2,042,145	16.94%
MH539, Royal Lane Bridge, Dallas County, Control #879-18-007					
HS20	1,499,562	2,551,124	1,480,177	2,570,509	
HS25	1,595,757			2,686,089	4.50%
HS30	1,718,306			2,808,639	9.26%
IH40/FM291 Underpass, Gray County, Control #0275-11-061					
HS20	149,522	197,128	216,841	220,679	
HS25	154,303			225,460	2.17%
HS30	160,964			232,122	5.19%

Table B4-2
Bridge Element Cost Computation Under Incremental Load

Class [1]	12 Month Moving Avg. [2]	A [3]	B [4]	Beam Cost [5]=[3]+[4]/2	Slab Cost Thk (in/cm) [6]	Slab Cost Cost [7]	Substructure Cost [8]
IH37 South, Bexar County, Control #0073-08-117							
HS20	167,450	160,696	191,964	176,330	7.5/19	106,511	176,793
HS25		165,196 (2.8)	196,595 (2.4)	180,896 (2.6)	7.5/19	106,511	220,992
HS30		171,592 (6.8)	203,071 (5.8)	187,332 (6.2)	8/20	113,612	265,190
Loop 375, Zaragosa Road, El Paso County, Control #2552-03-013							
HS20	245,527	283,945	348,549	316,247	8/20	260,493	361,008
HS25		293,740 (3,4)	352,196 (1.0)	322,968 (2.1)	8.25/21	268,633	451,261
HS30		299,367 (5.4)	357,146 (2.5)	328,256 (3.8)	9/23	293,054	541,513
MH 539, Royal Lane Bridge, Dallas County, Control #879-18-007							
HS20	581,131	541,588	659,444	600,516	8/20	669,676	229,370
HS25		558,472 (3.1)	678,410 (2.9)	618,441 (3.0)	8.25/21	690,603	286,713
HS30		579,740 (7.0)	703,845 (6.7)	641,793 (6.9)	8.75/22	732,458	344,055
IH40/FM291 Underpass, Gray County, Control #0275-11-061							
HS20	73,155	70,333	83,654	76,994	7.5/19	62,697	9,831
HS25		72,606 (3.2)	86,027 (2.9)	79,317 (3.0)	7.5/19	62,697	12,289
HS30		74,712 (6.2)	88,150 (5.4)	81,431 (5.8)	7.75/20	64,786	14,747

Table B4-3
Variation of Bridge Construction Cost With Live Loading

GVW (kips)	Class	Cost %	Total Bridge Construction Costs IH37	Loop 375	MH539	IH40
5	H2.5	80.78	830,293	1,410,702	2,076,457	178,264
10	H5	82.61	849,103	1,442,660	2,123,497	182,303
20	H10	86.52	889,291	1,510,942	2,224,004	190,931
30	H15	90.43	929,480	1,579,224	2,324,511	199,560
40	H20	95.8	984,676	1,673,003	2,462,548	211,410
54	HS15	94.59	972,239	1,651,872	2,431,444	208,740
72	HS20	100	1,027,845	1,746,350	2,570,509	220,679
90	HS25		1,085,490 (5.61)	1,922,184 (10.07)	2,686,089 (4.5)	225,460 (2.17)
	HS25	105*		1,833,668	2,699,034	231,713
108	HS30			2,042,145 (16.94)	2,808,638 (9.26)	232,122 (5.19)
108	HS30	110*		1,920,985	2,827,560	242,747

*Moses study based approximate costs

PART V. DISCUSSION OF RESULTS

Increasing bridge design loadings from HS20 design class to HS25 and HS30 design classes increases the total bridge construction costs. An increase in HS level from HS20 to HS25 increased the beam costs by about 2 to 3 percent, while the increment varied from 3.8 to 6.9 percent under HS30 level (see Table B4-2). The increment in total bridge costs varied from 2.17 to 10 percent under HS25 loading, and from 5.19 to 16.94 percent under HS30 loading (see Table B4-3). These cost increments seem to fall within the approximate cost increment range predicted by the "TRB Special Report 225; Truck Weight Limits — Issues and Options." It is also to be noted that the HS25 level represents a 25 percent increase in design loading, and the HS30 level represents a 50 percent increase in design loading, over the HS20 level. The bridges built in urban locations (San Antonio, El Paso, Dallas) seem to have a higher increase in costs than bridges built in rural locations (Gray County). The bridge in El Paso County has shown the maximum increment, underlining the impact of geographic location. The state of Texas, in a recent year, has allocated about 25 percent of $2 billion annual highway contract work to bridges (TxDOT Bridge Design Guide, 90). For instance, new bridge costs in 1987, 1988, and 1989 were over $265 million, $165 million, and $181 million, respectively. Based on the results of this study, the incremental costs of raising bridge design loadings to HS25 and HS30 classes will not be significantly high. Though incremental costs of increasing bridge design loadings are minimal, any decision-making process pertaining to increased truck weight limits should also include other costs such as pavement life-cycle, fatigue life reduction of existing bridges, increased inspection and maintenance costs, and weight enforcement costs associated with heavy vehicles.

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