

Washington State Highway Cost Allocation Study

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This paper presents a discussion of the objectives, procedures, methodology and some of the findings of a three-year study of highway cost allocation conducted by the Washington State Council for Highway Research through the agency of the University of Washington and the State College of Washington for the Washington State Legislative Joint Fact-Finding Committee on Highways, Streets and Bridges for the biennia 1953-55 and 1955-57.

Answers to the following questions were the objectives of this study. Who should contribute toward paying the cost of public roads and streets in the State of Washington? What is an equitable division of road cost responsibility among the three principal direct beneficiaries: the highway users, the owners of affected property, and the general public? How can the users' share of these costs be divided equitably among the various types of automobiles, trucks, and buses?

Major reliance was placed on collateral research by the Washington State Highway Department and the United States Bureau of Public Roads. Where data were lacking original fact-finding was done.

The collection and analysis of these data are discussed as well as the manner in which responsibility for Washington's highway costs might be divided between users and others. This is done for each road system (county, city and state—a reasonably functional as well as administrative classification) and for the combined systems on the bases of relative use, earnings credit and relative benefit. The results are also compared with the actual 1953 needs and with the 1954 receipts from users and others for highways.

These comparisons show that the current rate of user contribution is sufficient to support the users' share of the cost of a modern-day system of public roads and city streets.

The users' share of the highway costs is then divided among classes of users on three different bases: the amount of highway use (ton-mile or weight mile), operating costs, and incremental costs.

Alternative procedures for converting user group responsibility into individual fees and the cost of borrowing for highway construction are also discussed.

● THE WASHINGTON State Legislature instructed its 1953-55 Joint Fact-Finding Committee on Highways, Streets and Bridges " . . . to ascertain, study, analyze, report on, and make recommendations as to: (a) Motor vehicle taxation, including the assignment of the total highway costs among property owners, general taxpayers and highway users . . . " (1). A study of who should pay for Washington highways, on what basis they should pay, and how much they should pay was inaugurated. People must pay if they want the service provided by adequate highway systems. The problem is the most equitable method of collecting the costs.

JOINT FACT-FINDING COMMITTEE ON HIGHWAYS, STREETS AND BRIDGES

A Joint Fact-Finding Committee on Highways, Streets and Bridges was first established by the Washington State Legislature in 1947 to review highway, road, and street requirements and to assemble the facts that were necessary for a consideration of that subject. The committee has been reactivated by every legislature since then to continue its study of highway problems specified by the legislature. Membership of this committee is comprised of six senators appointed by the president of the senate and six members

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of the house appointed by the house speaker. One of the senate members and one of the house members are appointed from the area included within each of the six state highway districts. This committee exists only during the interim between the biennial sessions of the legislature.

After each session the reactivated committee organizes into subcommittees corresponding to specific sorts of highway policy problems. Some of these problems may have been designated by act of the legislature. On many of these problems the committee will enlist the aid of a consultant or of a research agency. Each spring just prior to the next legislative session the committee holds fifteen to twenty public hearings throughout the state. The studies in progress are explained, and the people of the state present their views on highway problems to the committee. These hearings give the people a chance to find out what is being done to find better solutions to highway problems, and to present problems they feel need study in the next biennium.

WASHINGTON STATE COUNCIL FOR HIGHWAY RESEARCH

In 1951 the Washington State Council for Highway Research was created by the Governor. "The purpose of the State Council for Highway Research is to augment, correlate and classify all highway research resources in the State of Washington for the solution of the State's highway transportation problems. To this end, maximum use will be made of the research facilities of the University of Washington, State College of Washington, the counties, cities, state highway department and any other group which has facilities to bring to bear on the economical solution of the State's many problems involving highways, roads, and streets.

"The Council will consider for assignment to an appropriate agency any problem presented to it by the legislature, highway user group or any other representative body which has problems in the fields of highways, roads or streets." (2)

The nine members of this council were selected to provide a broadly representative group: the Director of Highways; the Chairman of the Highway Commission; the district engineer of the Bureau of Public Roads; the manager of the Automobile Club of Washington; officials of the Washington Highway Users' Conference, the Association of Washington Cities, and the Association of County Commissioners; and professors of Civil Engineering from the State College of Washington and the University of Washington. The Joint Fact-Finding Committee for Highways, Streets and Bridges has frequently used the services of this Council.

Financial Support for Research

The Council has no funds to distribute nor does it make any charge for its services. Since 1951, funds for specified highway research activities have been provided by a special fee authorized by the legislature. The 1953 law reads: ". . . In addition to all other fees prescribed by law, there shall be paid for each motor vehicle the following amounts at the time of the payment of the registration fee as provided by law:

For each truck under 12,000 lbs.	\$.25
For each truck over 12,000 lbs. and under 20,000 lbs.	.50
For each truck over 20,000 lbs.	1.00
For each trailer 4,000 lbs. to 12,000 lbs.	.25
For each trailer 12,000 lbs. to 20,000 lbs.	.50
For each trailer, semi-trailer or pole-trailer over 20,000 lbs.	1.00
For each diesel truck	2.00
For each auto stage	1.00
For each for-hire vehicle over 4,000 lbs.	.50
For each motor vehicle not otherwise taxed herein	.10

Such fees shall be collected for the calendar years 1953, 1954, and 1955, only and shall be deposited in the motor vehicle fund, and shall be used by the joint fact-finding committee on highways, streets and bridges, and the state highway commission to help defray the cost of special highway use and weight studies and tests upon highways as provided for in this act and for other necessary expenses of such committee." (1) A similar law was passed in 1955 for the calendar years 1956, 1957, and 1958 only.

PROCEDURE FOR THE HIGHWAY COST ALLOCATION STUDY

In 1953 the Fact-Finding Committee asked the Washington State Council for Highway Research to make recommendations conforming with the legislature's directive to study the allocation of highway costs. The Council developed a prospectus for the study, suggested it be done at the University of Washington with the assistance of the State College of Washington, and that a board of consultants (M. Earl Campbell, Harmer E. Davis, and Bertram H. Lindman) be asked to advise the Council on the scope and technical procedures of this study. Accepting these suggestions, the legislators also set up an advisory committee of highway-interested citizens to act as liaison between the study group and the public, so that the objectives and the conduct of the study might be more widely understood. The approved plan of procedure is outlined as follows:

1. Review of existing studies and outline of needed areas of investigation by research subgroups.
2. Initial meeting with board of consultants for review of research prospectus, including study plans of the various research subgroups.
3. Collection and organization of data by research subgroups:
 - a. Application of Malad and Maryland test road findings to Washington roads.
 - b. Compilation of data on effect of road improvement on property values.
 - c. Study of commercial value of roads as reflected in competitive transportation rates.
 - d. Compilation of material on history of road standards, costs and financing in Washington since 1900.
 - e. Limitations on credit financing in Washington.
 - f. Vehicle usage data.
4. Interim meeting with the Board of Consultants.
5. Meeting with Advisory Committee at Public Hearing.
6. Application of data of Item 3 above to:
 - a. Incremental cost study analysis.
 - b. Operating cost analysis.
 - c. Weight-distance analysis.
 - d. Earning credit analysis.
 - e. Relative use analysis.
 - f. Relative benefit analysis.
 - g. Formulation of a tax structure.
7. Meeting with the Board of Consultants.
8. Compilation of report and its submittal to the Research Council.
9. Transmittal to Interim Committee.
10. Public hearings on report, sponsored by the Joint Fact-Finding Committee.
11. Report of Interim Committee to the Legislature.

ORGANIZATION OF THE STUDY

The study was divided into three phases as shown in Figure 1. Work on all three phases progressed simultaneously except for the final step of the development of the several bases for tax structures. There were nine subgroups in the study headed by teaching and research staff members of the University of Washington and Washington State College. The University teaching and research staff members were from the following disciplines: Civil Engineering, Geography, Economics, Business Administration, and Mathematics. These faculty members supervised the graduate students and others who staffed the various subprojects, mostly on a part-time basis. About 40 graduate students, ten undergraduates, and two or three full-time assistants were em-

ployed during the academic year; with most of the staff working full-time during two summers. The junior author served full-time as the coordinator of these various efforts, while the senior author was responsible for the over-all direction of the study, in addition to other academic obligations. Considerable turnover in staff occurred as students graduated and others took their places. Four master's theses were written on various phases of this study.

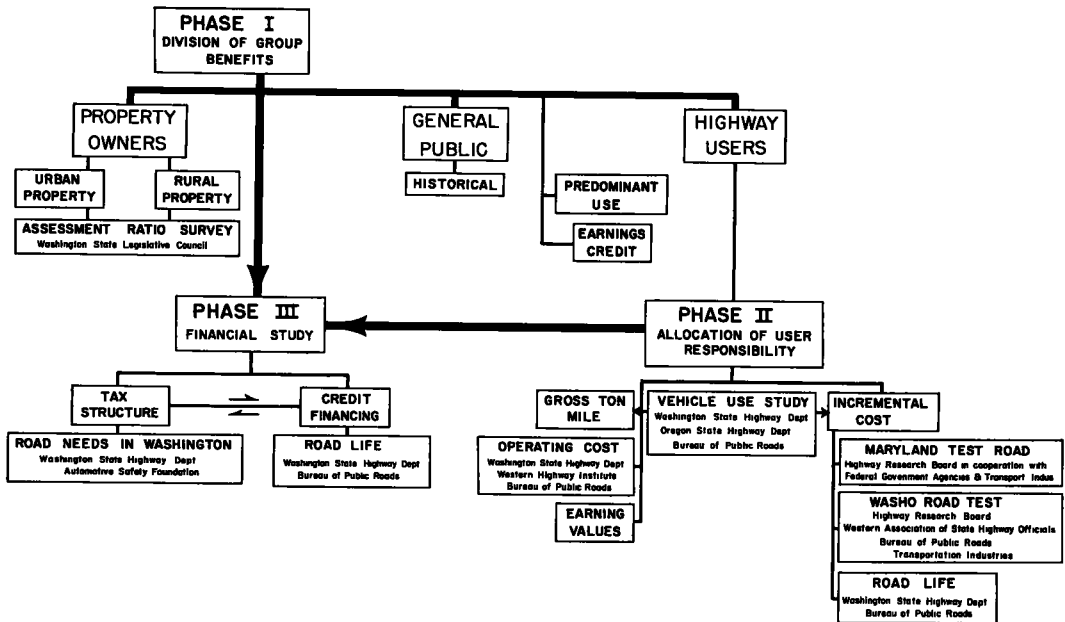


Figure 1. Highway Cost Allocation Study Program, 1955.

The various studies had the common objective of throwing light upon component parts of the two central problems:

1. What is an equitable division of road cost responsibility among the three principal direct beneficiaries: the highway users, the owners of affected property, and the general public?
2. How can the users' share of these costs be divided equitably among the various types of automobiles, trucks, and buses which operated on Washington's roads and streets?

Research Resources

In the conduct of this investigation major reliance was placed upon the results of collateral research by other agencies, such as the Washington State Highway Department and the United States Bureau of Public Roads. These other studies include the WASHO test road, the operating-cost study, the road-life study, the highway-needs study, the vehicle-use study, and "Needs of the Highway Systems 1955-84," House Document No. 120, 84th Congress. Where data were lacking it was necessary to do original fact-finding. The major expenditures of time and money on this project were used to obtain basic information in those areas where the facts were obscure. Thus, the principal subprojects of the research effort have dealt with the effect of road improvement on property value (6) (7), the value of road improvements to commercial users (8), the collection of data needed for weight-distance tax schedules (5), the limitations of credit financing (3), the historical trends in highway financing (3), and the incremental costs of road improvements (3).

RELEVANT COSTS

The study was not limited to state highways because county roads and city streets derive much of their revenues from the same sources that support state highways, and the three systems serve much the same traffic.

After the decision was made to include the costs of all roads and streets, it next became necessary to decide how these costs should be computed. Some investigators of highway finance have been concerned with assigning responsibility for the past expenditures which have provided our existing facilities; others have tackled the problem of who should pay for the future expenditures to be made in carrying out some contemplated program.

Probably the public is more concerned over finding money to buy new roads than over redressing possible inequities in the collection on monies already spent. On the other hand, if today's vehicles are to be taxed according to assumptions of relative use or benefit from facilities planned for construction in future years, most currently held tax theories lose some of their persuasive appeal. A third alternative, allocating costs which represent actual current expenditures, assumes that the present division of available funds among the state, county, and urban systems correctly reflects the relative needs of these systems.

It was decided that all these difficulties are best reconciled when "highway cost" is taken to mean the annual cost (depreciation plus maintenance) of a network of roads, streets, and highways adequate to meet current needs; not actual expenditures, present or past; and not the cost of providing for future traffic. This procedure relates to the cost of a road system designed to serve the same vehicles that are asked to share the expense involved.

The Annual Cost of Adequate County Roads

The annual cost per average mile of county roads in each county was estimated in the County Gas Tax Allocation Study of 1953-54 (10). The resulting values are shown on page 79 of the report on that project, and were accepted for use in the present investigation without modification. The classification of road mileage in each county as arterial or local, as made by the engineers responsible for that same study were used, since these results would give greater uniformity than would be obtained by relying upon the classification by local authorities in the individual counties. Traffic data for the several counties were adjusted from 1952 data published by the state highway department, and divided between arterial and access roads in each county in accordance with estimates obtained from the county engineer of that county (4).

The Annual Cost of Adequate City Streets

There is a notable lack of reliable information on the classification, traffic volume, and annual costs of county roads and city streets. A special effort was made to provide additional information on these basic ingredients of road planning and finance. A comprehensive study of county road needs had been completed for the Joint Fact-Finding Committee in 1954, for their guidance in passing legislation covering the allocation of the counties' share of the gas tax monies among the 39 counties of the state (10). These data were most useful in this study also. However, such data for city streets were not so readily available, if at all in some cases. A questionnaire was sent to each city requesting information on mileage, and annual construction and maintenance costs for arterial, residence and business streets. Information was also requested on average total daily traffic on these three types of streets. Of the 245 cities, 97 returned questionnaires. Many of the questionnaires returned were incomplete. However, the data received from the questionnaires plus information collected annually by the state highway department on city streets provided a basis for interpolating and estimating on the basis of population groupings, city street costs, traffic, and mileages. Data were also collected on vehicle miles traveled on the different classes of roads.

The collected data, as well as the estimates and analyses made of these data, were put into graphical and tabular form for the use of other substudies on the project.

In the summary below the estimate of annual vehicle mileage for city arterials ex-

TABLE 1
ESTIMATE OF ANNUAL ROAD COSTS FOR WASHINGTON COUNTIES^a

Type	Miles	Annual Traffic, (millions of veh mi)	Annual Cost ^b		
			Total (millions of dollars)	Per Road Mile (dollars)	Per Veh Mile (cents)
Land service	31,053	697	18.3	589	2.63
County trunk	8,397	1,047	20.2	2,406	1.93
All county roads	39,450	1,744	38.5	976	2.20

^aDeemed adequate for 1953 traffic.

^bEstimated.

cludes traffic on the urban extensions of state highways. The figures shown for the annual cost of city arterials exclude the cost of urban extensions of state highways. The need for some such arbitrary decision in this instance lies in the conflict between administrative classification and functional classification when state highways traverse urban areas.

The Annual Cost of Adequate State Highways

A basis for estimating the annual cost of an adequate system of state highways is to be found in the 1954 "Needs Report" by the Washington State Highway Commission (11). It was found that present and impending inadequacies should be relieved by a 10-year construction program totaling \$454 million, exclusive of a \$194 million Seattle freeway, a \$22 million Hart's Pass project, and a \$25 million Naches tunnel project. By this program 76 percent of the state highway system would be rebuilt to accommodate 1975 traffic at appropriate standards.

In order to make the highway figures fairly comparable with preceding estimates for local roads and streets, the Commission's estimate of future needs must be adjusted to represent the current situation. In this study of tax responsibility, the compelling reasons for working with the annual costs of roads adequate for present needs have already been examined. To compute such a figure for the state highways, it is first necessary to determine the cost of constructing such facilities, and then the annual charges for depreciation and maintenance to service and preserve the indicated investment. To accomplish this, three adjustments in the Commission's program estimate were made:

1. Reduction of the estimate to the level of current needs.

TABLE 2
ESTIMATE OF ANNUAL STREET COSTS FOR WASHINGTON CITIES^a

Type	Miles	Annual Traffic, (millions of veh mi)	Annual Cost ^b		
			Total (millions of dollars)	Per Mile (dollars)	Per Veh Mile (cents)
Residential	5,316	602	21.4	4,026	3.55
Arterial	1,031	489	8.4	8,147	1.72
All streets	6,347	1,091	29.8	4,695	2.73

^aDeemed adequate for 1953 traffic.

^bEstimated.

TABLE 3
ANNUAL COSTS OF STATE HIGHWAYS

Mileage	Annual Costs		
	Total (millions of dollars)	Per Road Mile (dollars)	Per Vehicle Mile (cents)
6,207 ^a	30.7	4,946	0.50
6,672 ^b	50.6	7,584	0.70

^a Rural.

^b All state highways including their urban extensions.

2. Estimation of the first cost of a fully adequate system by expanding the estimate to cover 100 percent, rather than 76 percent of the present state highway mileage.

3. Conversion of the adjusted estimate to an annual cost basis.

Excluding the cost of providing for local urban traffic on the urban extensions of state highways an estimate of the annual cost of adequate state highways is presented in Table 3.

HISTORICAL BACKGROUND

Prudent policy decisions must take into account the way in which existing policy was developed over the years (3). In order to provide information on trends in highway standards and financing, and to find the cost of basic roads, rural, and urban in the pre-automobile period, the history of roads and streets (for the United States generally and for Washington specifically) was reviewed. While interest was concentrated chiefly on cost data and design standards circa 1905, the study also included research into financial and administrative practices prior to 1890 relating to both rural roads and city streets. Other historical statistics related to road mileage growth, road and street revenues 1905-1955, county and state road funds, population 1905-1955, motor vehicle registration 1906-1955, motor fuel consumption, and total vehicular travel 1921-1955.

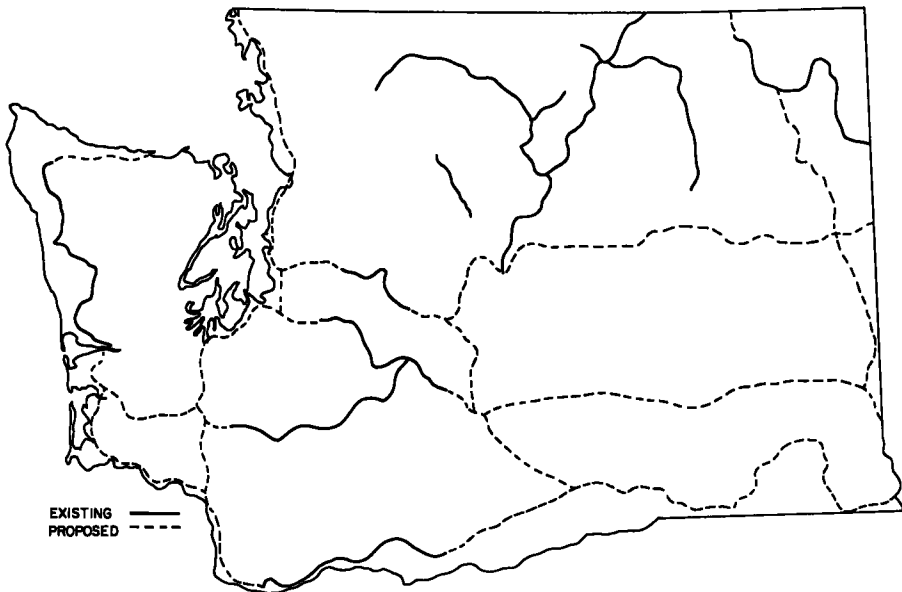


Figure 2. Washington State Highways in 1908.

THE NATURE OF HIGHWAY BENEFITS

The legislative directive for this investigation specifically named the general public the owners of real property, and the highway users as the three groups which are jointly to bear the costs of providing roads and streets. These three groups are, of course, the very groups which traditionally have shared the expense of providing public roads in the United States. That these particular groups have been recognized in this respect is a reflection of the three purposes for which roads have been laid out and improved, namely, to make possible the administration of government, to provide access to private property, and to facilitate personal and commercial transportation. Highway finance policy of the past suggests the prevalence of a popular feeling that any group's proper share of road expense is related to the benefits which that group derives from the road. Even those advocating that cost responsibility be made proportional to road use probably look upon the privilege of road use as a benefit for which payment should be made.

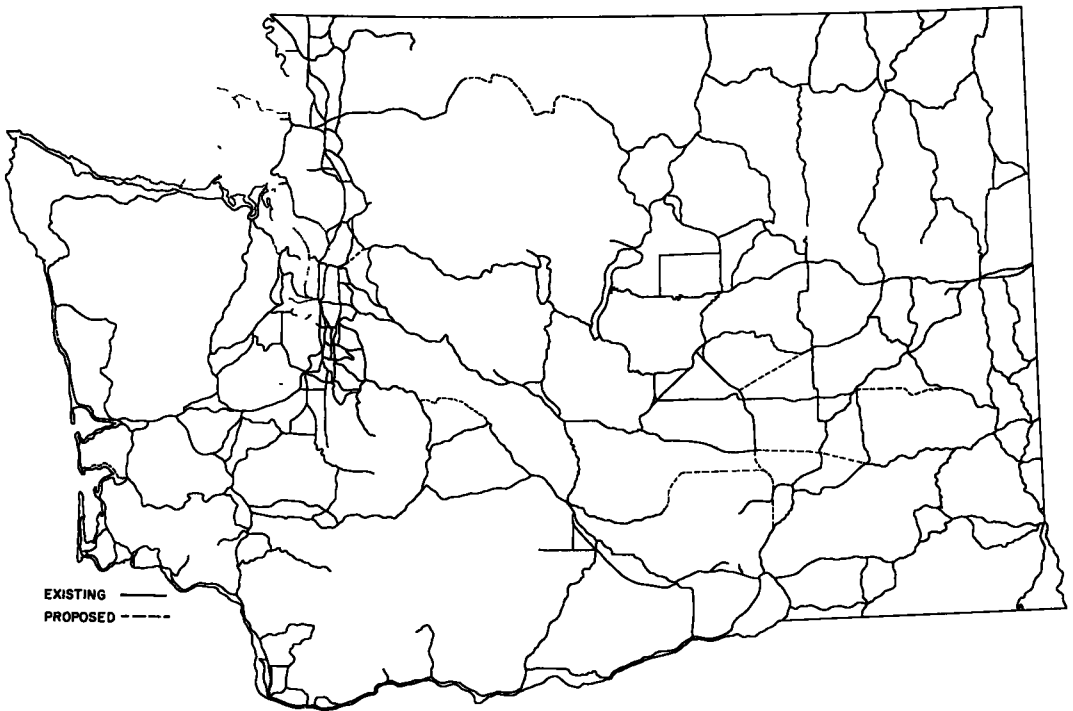


Figure 3. Washington State Highways in 1955.

Although the public preference for assigning total road and street costs to beneficiaries has resulted in a three-way split among the general public, property owners and highway users for many years, the relative responsibility of the individual groups has not stayed the same. As road functions change with our changing economy, the allocation of road costs must periodically be re-examined.

Everyone benefits from good roads; however, despite the fact that all highway benefits are broadly diffused throughout society, they are not uniformly distributed with respect to individual persons. People vary greatly in their ownership of land and in their use of highway transport. Complete reliance on property taxes would give some highway users a free ride; and a complete reliance on user fees for the support of highway improvement would confer on some landowners an unearned increment of value. It could still be true that the average citizen would not gain or lose by a choice between tax theories, but the average citizen exists only in imagination. More importantly, the pressure for specific highway expenditures is apt to be exerted most strongly by those

who expect to profit directly from the proposed work. Under such circumstances it is likely that the public interest will be served best by charging an appropriate share of the cost of the improvement against those who stand to benefit personally and directly from the proposed expenditures.

Benefits are hard to evaluate, qualitatively as well as quantitatively. Government benefits from roads in the very real sense that communication is essential to the exercise of authority and, hence, to that preservation of order which is essential to the survival of organized society. Nor is this benefit measured by the travel mileage of governmental vehicles with much greater validity than the value of our Strategic Air Command during the past decade could be measured by the number of atom bombs which it has dropped on enemy targets.

Real estate is benefited by the considerable increase in property value that is added when land becomes accessible. At least equally conspicuous is the advantage conferred upon the vehicle operator by better roads. These benefits overlap, of course. It would be visionary to conceive that a rigorous definitions of benefits accruing to either the land or the vehicle can be made, or even that an absolute distinction does in fact exist in any real sense. Road improvement raises the value of real property because highway users can then reach the affected property with greater convenience and at less expense. Conversely, most road usage is merely a means to the end of reaching some destination, some specific parcel of land. Convenience, rather than equity, may partly determine in the future as in the past, whether the vehicle owner or the land owner will be charged with the direct cost of highway construction.

Even though the placement of highway cost responsibility is guided to some extent by considerations of expediency as well as of equity, the decision is nonetheless critical. From the practical standpoint the basis for placing cost responsibility is highly important to winning public acceptance of the tax burden, to facilitating wise decisions on program expenditures, to the avoidance of drastic disturbance of our economic structure, and to the most efficient utilization of all means of transportation.

In review, the question of who should pay for roads must depend, in part, upon one's individual conception of the nature of the highway function. What is a highway system? Is it wholly a public utility which happens to be operated by government? If so, it should be run like a business, and the user should be charged in direct proportion to his use of the road. It remains to be determined what is the appropriate measure of use. If, on the other hand, highway operation is wholly a normal function of government the costs should be paid out of general tax revenues; and if, for convenience, a separate highway fund is to be established, such a fund should be supported by taxes levied in accord with general tax theory. Among the possibilities, under this concept, are taxes levied in proportion to the benefit received or in proportion to the ability to pay. Finally, it is possible to view highway improvement as a unique extension of the governmental function, in which the added expense incurred by the government to improve the basic highway facility for the benefit of the public is to be charged against the beneficiaries in proportion to their individual responsibility for added increments of expenditure.

TABLE 4
HIGHWAY USER SHARE OF TOTAL
ROAD AND STREET COSTS

Theory	System	Share (percent)
Earnings credit	County	22
	City	64
	State	94
	All	62
Relative Benefit	County	56
	City	15
	State	75 ^a -88 ^b
	All	54 ^a -60 ^b
Predominant use	County	52
	City	28
	State	100
	All	67
Actual sources in 1953	County	68
	City	31
	State	100
	All	76

^aIncludes contributions to freeway costs from benefited property.

^bAssumes no charge against property for urban extension of state highways.

These various theoretical considerations have suggested various methods of assigning responsibility for road costs.

Sharing the Cost

The highway users' share of total road costs was estimated by three theories: earnings credit, predominant use, and relative benefit. In applying the relative benefit theory the highway user and the property owner were assigned appropriate portions of the added expenditure required to improve the road above the standard of a basic road essential to the operation of governmental functions. Table 4 presents the results of this analysis.

The foregoing estimates of user responsibility agree on the point that the current rate of user contribution is sufficient to support a modern-day system of public roads and streets provided that some practical means can be found to increase the contributions from the general public and from owners of benefited property.

DISTRIBUTION OF USER RESPONSIBILITY

Even after highway users, as a class, have been allocated a definite responsibility for meeting the total costs of roads and streets, there remains the major problem of determining how they shall share this responsibility, as individuals. This would be a considerable problem even if all highway users operated identically similar vehicles, because a responsible official might wonder whether to tax them all equally, or to tax them in proportion to the amount of driving they did in a year, or to tax them according to the profit they derived from their use of the road, or according to their ability to pay additional taxes. These alternatives were discussed briefly (3), and it is relatively easy to limit the choice of methods to the two possibilities.

1. Should motor vehicle taxes be imposed in proportion to the use made of the road?
2. Should motor vehicle taxes on any individual represent the cost of providing the additional facilities which his use of the road entails?

In the first case the highway department acts as a landlord, renting the use of his road. In the second case the highway department acts as an agent, collecting from his principal only the repayment of sums spent on behalf of the principal. If road use is thought to be a proper criterion of cost responsibility it is important to decide upon the proper unit for measuring use. The most popular unit is the product of weight and distance, but also there are those who advocate a unit which expresses the value of the use. It is in this field that divergence of opinion becomes most extreme, because there is involved a fundamental concept of the role of government in operating a road system, and because the impact of highway taxation on affected industries will vary notably with the application of one or another theory of taxation.

Weight-Distance Taxation

Mileage taxes find expression in two remarkably contrasting forms. In some cases the road-use principle is used as a basis for assigning tax responsibility, but the assignment is collected from each vehicle in a lump sum based upon average mileages for the vehicle type. In other cases the mileage tax is used only as a means of collecting from each vehicle its share of road costs which are assigned to vehicle types or classes in proportion to the influence that the weight of the typical vehicle has exerted on the cost of road construction and maintenance.

Bases for Weight-Distance Taxation—Automobiles and Taxicabs, Trucks and Buses

Data were acquired through the use of questionnaires sent to Washington registered vehicle owners with the 1955 license applications. (5) These questionnaires were sent to the owners of over 200,000 vehicles in the state and covered 10 percent of registered automobiles, 50 percent of the registered trucks and trailers, and 100 percent of registered buses and taxicabs. Returns were received from 40 percent of the sample. Information was also collected from the files of the State Liquid Fuel Tax Division on fuel consumption and miles traveled by diesel vehicles. The Motor Vehicle License Department provided information on the number and types of vehicles registered over

a period of years. The Highway Planning Survey provided data on actual operating weights for over 75,000 trucks and trailers. Private agencies and firms also provided information.

The data from the questionnaires were punched on cards and processed by machines. Information from all the sources was analyzed statistically and cross-checked. This information was summarized and tabulated for automobiles by make; taxicabs by make; buses by licensed gross weight groups, type of fuel, and type of service; and trucks by licensed gross weight groups, type of fuel and type of truck.

Operating Cost Theory

Motor freight revenues are roughly determined by freight rates, and these rates tend to be proportional to truck operating costs in a competitive situation. Thus, in a very

TABLE 5

AVERAGE GROSS TON-MILE CONTRIBUTIONS OF WASHINGTON^a

Make	Average Contribution per Gross Ton-Mile for Passenger Cars (Mills)	Average Contribution per Gross Ton-Mile for Taxicabs (Mills)
Buick	2.79	2.39
Cadillac	2.15	2.36
Chevrolet	2.63	2.64
Chrysler	2.50	2.70
DeSoto	2.54	2.45
Dodge	2.65	2.59
Ford	2.62	2.56
Frazier	2.36	2.76
Henry J.	2.52	--
Hudson	2.52	2.42
Kaiser	2.49	2.28
Lincoln	2.34	2.07
Mercury	2.62	2.45
Nash	2.29	2.18
Oldsmobile	2.57	2.22
Packard	2.41	2.75
Plymouth	2.61	3.39
Pontiac	2.61	2.62
Studebaker	2.63	2.48
Willys	2.87	3.05
Miscellaneous	2.22	2.41
Average	2.57	2.97

^aRegistered passenger automobiles and taxicabs, by makes, 1954.

general way, vehicle operating costs are related to the profit or benefit that the industry derives from its use of the highway.

The advocates of this proposal suggest that after the users' share of the total annual highway bill has been determined by other methods each vehicle should be charged in proportion to the product of its annual mileage and its operating cost per mile. The operating costs for different vehicle types were determined in an extensive investigation conducted by the Washington Highway Department, the U.S. Bureau of Public Roads, and the Western Highway Institute.

Incremental Cost Study

In the incremental cost method (3) of assignment of tax responsibility the extra cost of building roads to higher design standards to serve heavier and more frequent loads is charged against heavier vehicles which occasion these increments of cost. The following steps were used in this substudy to determine and assign the costs:

TABLE 6
AVERAGE GROSS TON-MILE CONTRIBUTIONS OF DIFFERENT CLASSES OF VEHICLES BY LICENSED GROSS WEIGHT GROUPS, 1954 (MILLS)

Licensed Gross Weight Groups (in lb)	Diesel Trucks and Truck-Tractors (to 36,000 lb)	Diesel Trucks Truck-Tractors and Combinations (to 72,000 lb)	Farm Truck Gasoline	Inter-City Buses-Diesel	Inter-City Buses-Gasoline	Inter-City Truck and Truck-Tractors (to 36,000 lb)	Inter-City Trucks, Truck-Tractors and Combinations (to 72,000 lb)	Intra-City Buses-Diesel	Intra-City Buses Gasoline	Intra-City Trucks and Truck-Tractors	Logging Trucks, Truck-Tractors and Combinations (to 72,000 lb)	Trailers and Semi-Trailers
Under 2,000										6 306		
2,000 - 3,999			4 445 ^a			3 014 ^a	3 013 ^a			6 084	3 034 ^a	
4,000 - 5,999	4 620 ^b	4 465 ^b	4 006		2.29 ^b	3 091	3 090		3.50 ^b	5 048	2 734	4 916
6,000 - 7,999	4 703	3 935	4 106		2 20	3 112	3 112		2.88	4 127	3 425	1 335
8,000 - 9,999	4 285	3 369	4 294		3 09	2 516	2 455		-	4 520	2 769	2 470
10,000 - 11,999	4 903	3 758	4 022		1 89	2 527	2 474		2 11	3 385	2 409	5 661
12,000 - 13,999	4 350	2 149	3 913		1 98	2 402	2 355		1 88	3 261	3 445	1 951
14,000 - 15,999	2 678	2 088	3 593		1 88	2 233	2 187		1 90	3 059	3 183	0 772
16,000 - 17,999	2 823	2 289	3 715	1 28	1 83	2 440	2 409	1 61	1 73	3 226	3 338	0 966
18,000 - 19,999	3 512	2 664	3 429	1 46	2 19	2 585	2 556	1 28	1 87	3 532	2 723	1 319
20,000 - 21,999	2 612	2 344	3 746	1 32	2 20	2 562	2 432	1 68	2 94	3 482	3 328	2 228
22,000 - 23,999	3 386	2 985	3 841	1 16	1 93	2 464	2 292		1 30	3 247	1 781	0 758
24,000 - 25,999	2 188	1 861	5 356	1 08	1 91	2 492	2 411		1 44	2 769	2 887	1 743
26,000 - 27,999	2 073	1 749	6 723	-	-	2 181	1 967		1 51	3 486	3 071	2 296
28,000 - 29,999	2 295	2 019	2 524	-	-	2 565	2 323		-	3 253	3 195	1 575
30,000 - 31,999	2 469	1 802	3 664	-	-	2 696	2 451		-	4 879	3 548	1 234
32,000 - 33,999	3 381	3 024	4 952	1.22	1 86	2 624	2 386		-	4 560	2 109	7 372
34,000 - 35,999	1 946	1 633	4 097			2 553	2 511		-	5 004	2 166	0 709
Combinations												
32,000 - 33,999							1 371					
34,000 - 35,999							1 460					
36,000 - 37,999		1 311					1 549				1 753	
38,000 - 39,999		1 354					1 653				1 835	
40,000 - 41,999		1 339					1 703				1 906	
42,000 - 43,999		1 362					1 798				1 970	
44,000 - 45,999		1 367					1 683				2 039	
46,000 - 47,999		1 388					1 739				2 076	
48,000 - 49,999		1 394					1 813				2 138	
50,000 - 51,999		1 425					1 606				2 150	
52,000 - 53,999		1 406					1 606				2 165	
54,000 - 55,999		1 405					1 618				2 111	
56,000 - 57,999		1 404					1 640				2 115	
58,000 - 59,999		1 414					1 665				2 081	
60,000 - 61,999		1 415					1 777				2 064	
62,000 - 63,999		1 446					1 813				2 089	
64,000 - 65,999		1 427					1 813				1 986	
66,000 - 67,999		1 413					1 823				2 001	
68,000 - 69,999		1 363					1 822				2 010	
70,000 - 71,999		1 364					1 832				2 021	
(Average contribution per gross ton-mile up to 20,000 lb)			3 847									
Up to 36,000 lb	2 094		3 974	1.24	1 99	2 592		1.61	1.95	4 068	2 466	2 658
Up to 72,000 lb		1 974					2 060				2 476	

^aUnder 4,000 lb

^bUnder 6,000 lb

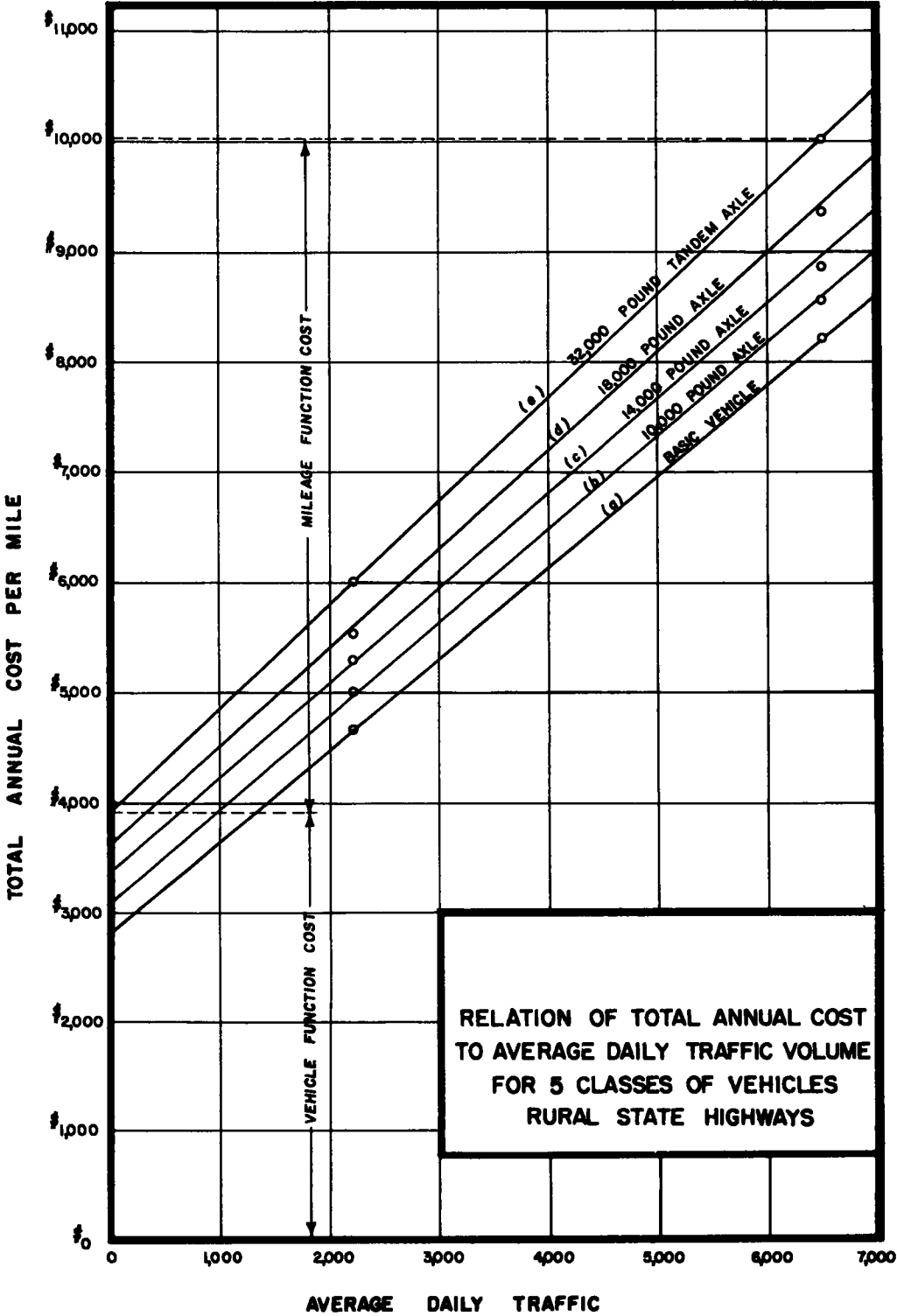


Figure 4.

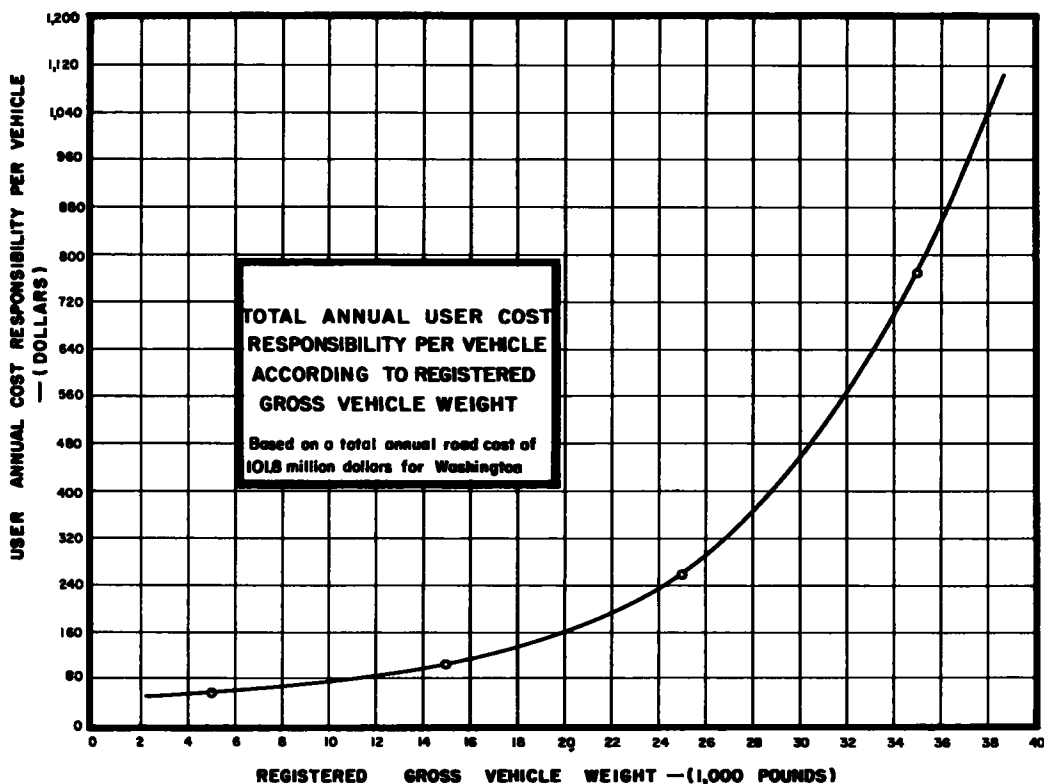


Figure 5.

1. Roads were classified according to usage (usage measured by estimated average daily traffic volume).
2. The increments of the annual cost for each road class were determined on the basis of design standards for that class road.
3. Vehicles were classified into principal types according to gross weight; then the relative use of each class of road by each vehicle type was determined.
4. The finding of the Malad and Maryland test roads were related to the Washington roads as a guide in determining road life and design requirements as affected by vehicle weight classes on each class of roads.
5. Incremental costs were assigned to vehicle weight groups according to the proportionate use that each weight group made of each class of road.

Rural roads and city streets were handled separately in this study.

TABLE 7

Licensed Gross Vehicle Wt. (Ton)	Average Annual Mileage	Annual Impost (Fees plus fuel tax)		
		by operating cost theory (dollars)	by ton-mile theory (dollars)	by incremental cost theory (dollars)
Auto	8,900	61	58	58
6-ton	5,620	79	75	85
10-ton	9,450	154	197	160
14-ton	20,700	283	598	365
18-ton	30,100	634	1,132	860

In the determination of which items of highway expenditures were primarily vehicle function or readiness to serve costs, and which were primarily mileage or traffic function costs, graphs were plotted for each vehicle type using total annual cost per mile as ordinates and overage daily traffic as abscissa. The resulting curves were straight lines. The point of intercept of the curve of the heaviest vehicle with the "O" ordinate was used as the dividing line between vehicle function cost and mileage function costs. Such a graph for rural state highways is shown as Figure 4.

Dividing the User Share of Highway Costs Among Different Vehicle Types

Table 7 shows the amount to be charged the average vehicle in each weight class as its share of a total annual user responsibility of \$74 million. The assigned annual mileage is the average value for all vehicles of the specified gross weight.

PROPERTY VALUE STUDIES

The allocation of cost responsibility between highway users and others according to relative benefits required the collection of information on how road improvement does affect land values. Consequently, two important sections of the project were concerned with the economic impact of improved access on rural and suburban property values.

Benefits of Rural Roads to Rural Property

The approach to this study was through the study of rural farm and nonfarm property values and the association of property values with variations in roads (6). The property values used in this study were taken from actual sales records and were restricted to sales believed to represent actual market conditions. The data were taken from records of property sales where a warranty deed was transferred.

Measurements of road location for this study were made to include considerations of (a) the measurement of the location of the property from several reference places, (b) each type of road that would have an effect on property values that was not necessarily equal to the effect due to other road types, and (c) the length of road to affect property values. These measurements along with measurements of land values and other qualities of rural locations were achieved in eight steps.

These eight steps were applied in three geographical areas on two types of rural land use, farm land and residence sites of rural nonfarmers. The three areas chosen are a cross-section of the rural and urban economic structure of the state.

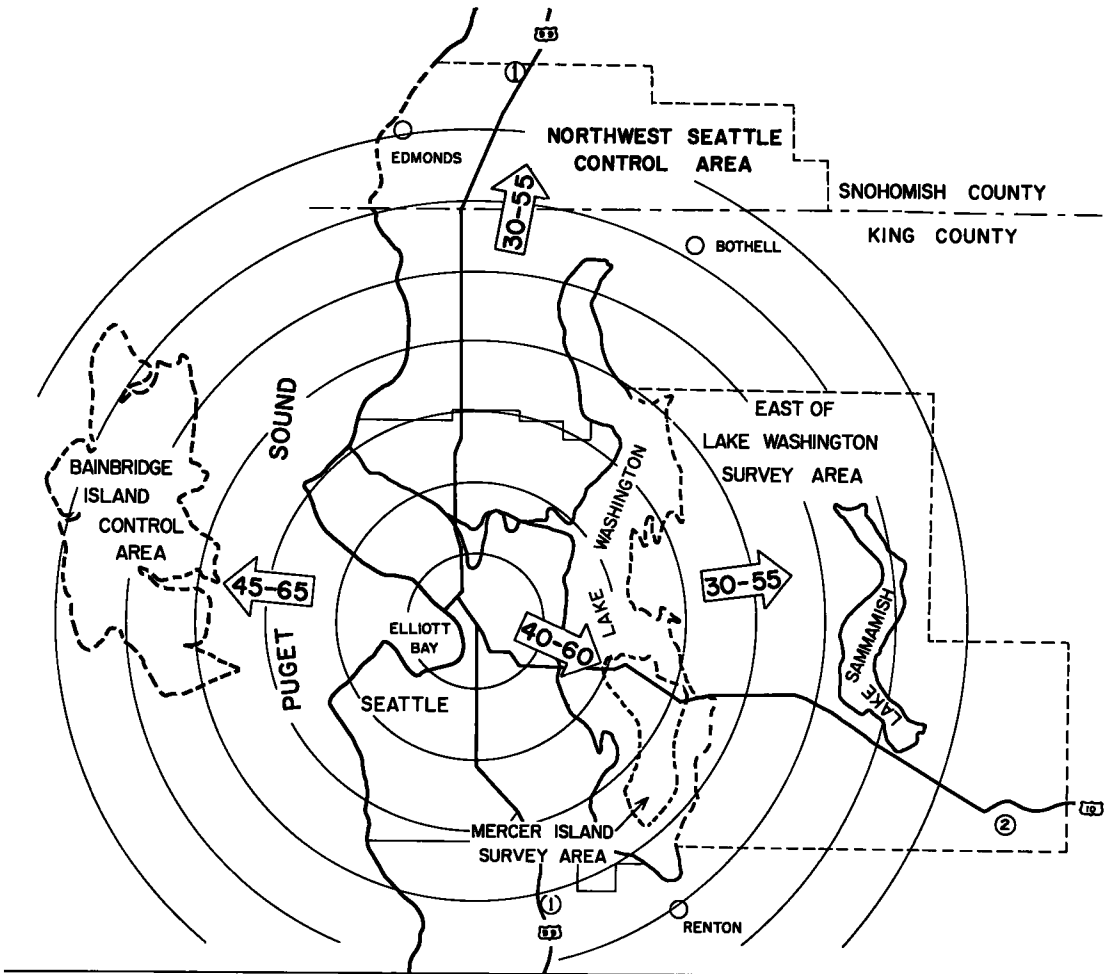
Much of the data for this study was obtained by the personal interview method based on previously designed questionnaires covering the information needed. They were not opinion polls, but factual data polls of residents of sampled properties. Title insurance company records were also used.

The results of this study indicate that the paving of existing roads serves to increase average farm values by 15 percent, neglecting any secondary effects upon the market for farm products or on the demand for farm land.

Freeways and the Suburbs

Conspicuous increases in suburban property values accompany freeway development. (7) The increasing investment in this type of facility cannot keep pace with the increasing demand without the development of a tax structure appropriate to the needs and nature of this new type of road. Primarily these freeways serve the suburban fringes of urban centers, and the future dimensions of the problem are forecast by the fact that almost all of the increase in the population of the United States during the past five years has been suburban in character. This dispersal of urban working population is a development of utmost importance from the standpoint of civil defense, as well as in many other ways; and even today highway administration has no more important job than to reduce the travel time of the daily migrations of the suburbanites.

The effect of freeway access upon suburban property values was examined through the study of a limited access freeway, the Lake Washington floating bridge and its highway approaches connecting downtown Seattle with residential Mercer Island and the mainland to the east.



SURVEY AND CONTROL AREAS

PRE-BRIDGE TRAVEL TIME IN MINUTES AND DISTANCE IN AIRMILES FROM
4th AND MADISON, SEATTLE

CIRCLES AT INTERVALS OF TWO MILES FROM 4th AND MADISON

PRE-BRIDGE TRAVEL TIME IN MINUTES FROM 4th AND MADISON
SHOWN THUS: 

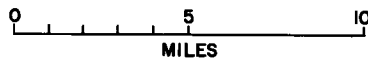


Figure 6.

Mercer Island was studied first to test survey methods and sources of information; and to provide a pilot study useful for the subsequent survey of the larger area east of the Lake and of selected control areas. The opening of the floating bridge from Seattle to Mercer Island in 1940 reduced the travel time between the two places from 45 minutes to 20 minutes. The resultant cost saving accelerated the development and settlement

of Mercer Island and the area east of it. The span of 15 years since the completion of the bridge covered sufficient time to yield a useful model of the effect of improved access upon suburban property values. The values studied cover two periods of time: pre-bridge years and late post-bridge years. To measure the change in property values, sales prices were obtained from records of actual sales values for "before" and "after" time periods. Control areas were also used for comparative purposes.

The types of real property used in this study were improved and unimproved residential land suitable for residential development whether platted or unplatted.

It was found that, after adjustment for other factors, the construction of the freeway added 70 percent to the value of the suburban areas which it served. This percentage is the property value increase attributable to the construction of the freeway only and does not represent the total property value increase of the given time period.¹

COMMERCIAL MOTOR CARRIERS AND HIGHWAY USERS

This study covers competitive and structural analysis of the commercial highway user industry, the volume and character of freight traffic movements by commercial motor carriers and factors relating to earning value of commercial motor carriers.

(8) The basic objective of this study was to measure the benefits commercial users receive from the highways and to arrive at basic measures of the ability of these users to pay for the roads over which they operate.

Competition, both among the various truckers and between motor freight carriers and other forms of transportation, was considered in evaluating the ability of carriers to pay additional taxes. This study gave consideration to both qualitative and quantitative aspects of carrier competition in Washington.

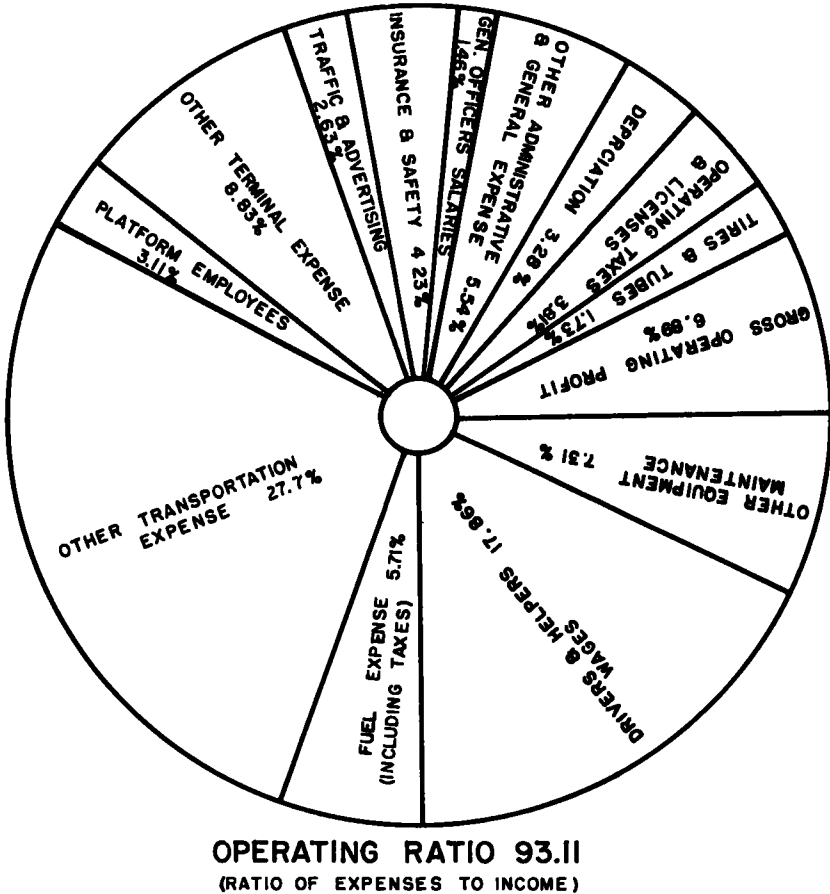
"The study of earning values of commercial motor vehicles using the highways of the state of Washington was a study of many things that affect carriers. Briefly stated, these factors included: (1) Competition among the highway users and with other forms of transportation, (2) the pricing structure of highway carriers, (3) economic regulation of motor carriers by the Washington Public Service Commission in so far as it affects pricing policies and ability to adjust rates charged, (4) the basic franchise or permit to carry products as both a limiting factor in earning values and a basic license to do business, (5) cost data and information, both to determine total per mile and per ton costs, and as a means of analyses of various items of expense to arrive at norms and comparative standards of efficiency and cost determinations and (6) analyses of consists or character of traffic moved to determine to what extent the mixture hauled, seasonal patterns, differences in traffic make-up from varying economic activities, average weights and other factors relating to commodities transported affect earning values." (8a)

To carry out these studies an analysis was made of operating authorities and competition with other transportation modes. A study was also made to determine the type and amounts of commodities carried by the commercial highway users. In order to measure the monetary return to the carriers for transporting commodities, it was necessary to determine the mixture of commodities which move in various regions of the state. Freight bills covering one year's shipments were obtained from selected carriers. Pilot studies were utilized to determine methodology and procedures and in the final study, statistical samples were taken from a total universe of about 2 million freight bills. These data were coded, punched and tabulated by machines, then analyzed to show (a) yearly consist for selected general freight routes or carriers, (b) commodity consist summaries of 15 predominate commodities, (c) monthly traffic pattern for four selected freight routes and carriers, (d) yearly consist of six

¹The study of highway benefits to rural and suburban property is discussed in greater detail in another paper ("Washington Highway Economic Impact Studies," by R. G. Hennes, Bayard O. Wheeler and William Garrison, Bulletin 169, Highway Research Board, 1957).

selected carriers of special commodities, (e) point to point commodity flow for three major distribution centers to be selected destinations and (f) outbound commodity flows from eight selected cities without regard to destination.

A ranking study was made to determine whether there was correlation between gross revenues earned, total tonnage carried, and total miles traveled by commercial motor carriers. Among carriers having single commodity rights, noticeable correlation was found between these criteria within each grouping of carriers. Very little correlation



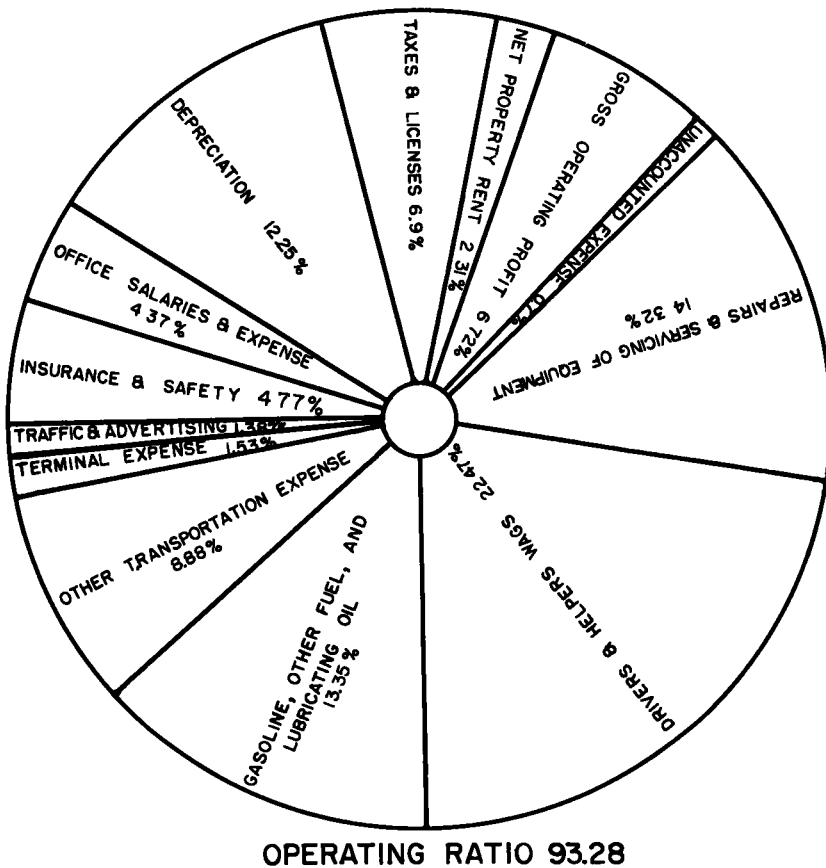
TOTAL REVENUE ALL CARRIERS REPORTING—\$ 538,752,400
 TOTAL REVENUE OF CARRIERS REPORTING TONS — 524,329,200
 TOTAL REVENUE OF CARRIERS REPORTING MILES — 524,278,800
 TOTAL TONS REPORTED—13,353,860
 AVERAGE COST PER TON—\$ 24.29
 TOTAL MILES REPORTED—593,601,800
 AVERAGE COST PER MILE—\$ 00.55

Figure 7. Aggregated averages of expense data, 325 Class I and II motor carriers, 1954. was found among tons carried, miles traveled or revenue earned among heterogeneous trucking firms.

Since most highway user tax plans take into account distance traveled and weight carried, revenue and expenses of commercial motor carriers were correlated with weight and mileage. A complete analysis was made of revenue, expenses, tonnage and mileage figures for all common carriers reporting these figures annually to the Washington Public Service Commission.

CREDIT FINANCING

It was required that the investigation be broadened to include a discussion of credit financing as it applies to the State of Washington. (3) This substudy discusses the character of the highway finance problems, public ability and willingness to pay for highways, state highway needs in relation to available funds in 1955-56, the alternates for financing highway needs, some pros and cons of credit financing of highway construction, and illustrative examples of highway finance in 1955-56 (including pay-as-you-go, borrowing of \$20 million, and borrowing of \$40 million considering cumulative construction investment, survival value, depreciation value, and bonds outstanding any given year of the ten), revenue bonds as general obligation bonds, and practical debt limits. Highway department historical data and road life data provided by the Bureau of Public Roads were the bases for this substudy. This information on credit financing will provide the legislature with guidance as to the effect of several possible bonding programs on the net worth of the highway system at the end of the program.



TOTAL REVENUE ALL CARRIERS REPORTING	— \$ 36,833,900
TOTAL REVENUE OF CARRIERS REPORTING TONS	— 23,440,000
TOTAL REVENUE OF CARRIERS REPORTING MILES	— 25,958,100
TOTAL TONS REPORTED	— 13,602,647
TOTAL MILES REPORTED	— 56,211,800
AVERAGE COST PER TON	— \$172
AVERAGE COST PER MILE	— \$00.46

Figure 8. Aggregated averages of expense data, 1,373 Class III motor carriers, 1954.

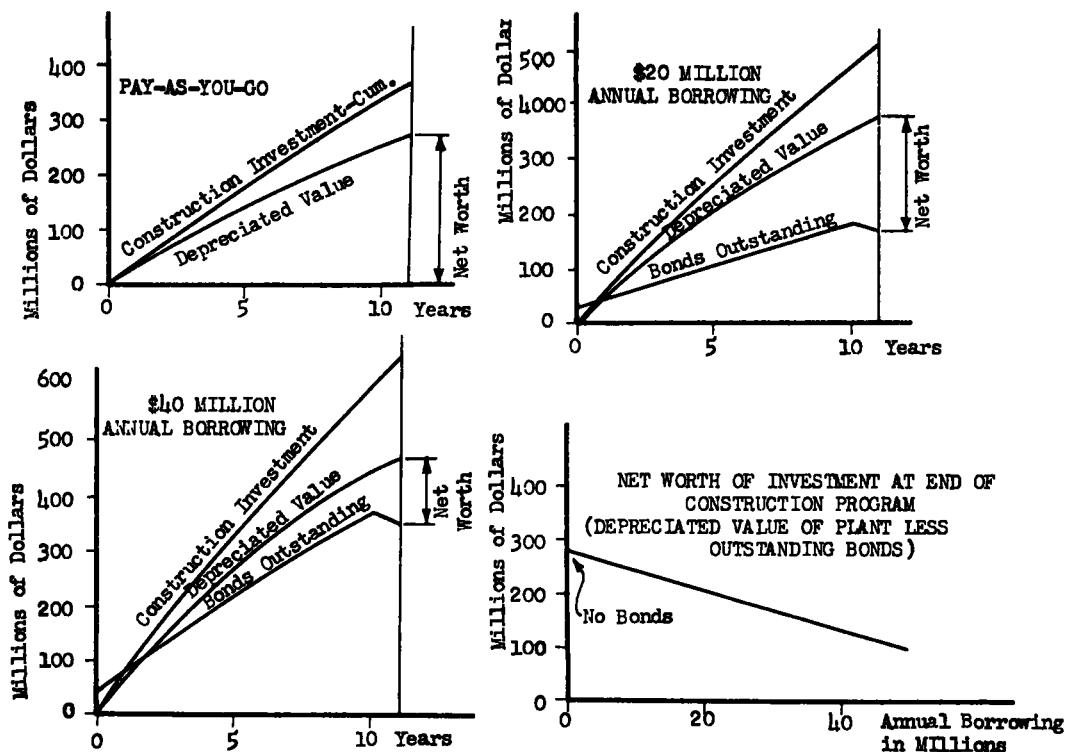


Figure 9. Results of a ten-year construction program, based on anticipated revenues, with and without bond issue.

CONCLUSIONS

The full report of these findings amounts to more than 1,500 pages in nine volumes, in addition to a pamphlet which reports a summary of the findings. Much basic information on road usage, life, costs, as well as property value changes and commercial user benefits and costs as related to roads, has been found and applied to the problem of how much who should pay for roads and streets in Washington State. Percentages of highway cost responsibility chargeable to the user and to others (on the basis of several different taxing theories) were determined. Information on the variation of user responsibility among users as shown by weight-mile, operating or incremental costs was also found. The legislature now has much more data than ever before to help them in establishing equitable tax support for highways and streets (whenever a decision shall have been reached regarding the rate of expenditure which will have public approval). This does not mean that all of the answers are obtained. There will always be a need for more research and study on highway cost allocation.

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 - Vol. 1 Automobiles and Taxicabs
 - Vol. 2 Trucks and Buses
6. _____, Part IV, "The Benefits of Rural Roads to Rural Property," Ex-

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8. _____, Part VI, "Commercial Motor Carriers as Highway Users in Washington."

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b. Vol. 2 The volume and character of freight traffic movements by commercial motor carriers in Washington.

c. Vol. 3 Factors relating to earning values of commercial motor carriers in Washington.

9. "Sharing the Costs of Roads and Streets in Washington," A summary report of the findings made to the Joint Fact-Finding Committee on Highways, Streets and Bridges, Washington State Legislature, through the Washington State Council for Highway Research.

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