Washington Highway Economic Impact Studies

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The improvement of roads and streets exerts an influence on the value of real property which merits consideration in any inquiry into the proper distribution of responsibility for road and street costs. During the past three years the Washington State Council for Highway Research has been investigating highway cost allocation for the Legislature's Joint Fact-Finding Committee on Highways, Streets and Bridges (1). A substantial part of this effort has been directed toward ascertaining the highway influence on land values.[1]

The project included two separate studies of land values, differing from each other not only with respect to the type of road under study, but also in the methodology employed. Rural road benefits were estimated for farmland and non-farm residential sites using both road utilization data obtained from interviews and value data obtained from sales records. In a separate study, the influence of freeway access upon suburban property values was measured in time, space and property characteristic in control areas and in the survey areas, before and after the betterment of survey area access.

THE IMPORTANCE OF ACCESS

●THERE is something anticlimatic in the pitch of many popular pleas for better roads. So often people seem to be saying, "Good roads make driving much more pleasant and, besides, they are indispensable to our social and economic well being; prerequisite to the full utilization of land, rural and urban; and vital to our national defense." Failure to base popular approval of a better roads program upon an elementary appreciation of the relative importance of various road benefits is not an inconsequential matter. Enthusiasm without understanding can lead to imprudent investment, inequitable taxation, and discriminatory policy decisions.

Almost invariably the local merchant is pleasantly startled to find his business improved after construction of the bypass which he had bitterly opposed. Only after the construction does the freighter discover that his time savings in operating trucks over the new toll road are more valuable than his share of the added cost of the seemingly extravagant facility. The advocate of a new freeway does not often clutter his arguments for a superior route location with details of any accompanying inflation in the value of his suburban acreage.

More roads would be built sooner and built better if there were better public understanding of highway functions and of their bearing on the justification of highway improvement expenditures.

Highway Cost Allocation

Expanding highway needs stimulate interest in the subject of highway taxation. Present tax support for roads and streets has developed over the years in response to generally held notions of what is an equitable and expedient method of paying for an evolving public transportation system. The propriety of these concepts should be re-examined whenever the character of the highway system has changed appreciably from what it was when the prevailing taxation practices were being formed. The appearance of

[1] In the cost allocation study the impact of highways is treated within a property value and taxation context. It is important to note, both to do justice to the breadth of the subject and the general applicability of the findings, that the subject is much wider in scope than is indicated in that discussion. The problem is within the general scheme of location theory, especially theory relating to the internal structure of the city, the size and spacing of cities and consequent arrangement of transportation routes, and agricultural location (2, 3).

entirely new road types, like the urban expressway, and the development of radically higher design standards for some old road types, such as those which follow the feeling that local rural roads regularly should be hard surfaced, provide strong arguments for a new look at the nature of the highway function, and at its bearing on tax policy.

Justification of New Construction

"A road user benefit analysis for highway improvements is a comparison of annual costs of alternatives. For each alternative the annual road user costs and the annual cost of improving, maintaining, and operating that portion of the highway are determined for a selected period of time. Then alternates are compared arithmetically to express a benefit ratio or quotient of the cost differences as follows:

$$\text{Benefit Ratio} = \frac{\text{Benefits}}{\text{Costs}} = \frac{\text{Difference in Road User Costs}}{\text{Difference in Highway Costs}}$$ " (4).

The report from which the foregoing excerpt is quoted was written to fill an "increasing need for analysis to indicate justification of the expenditure required and the comparative worth of proposed improvements, particularly when comparing likely alternatives." The same report also recognizes that attention should be given to land and community benefits, although the authors did not find it possible to treat these in detail at that time.

Emphasis on road user benefits to the neglect of land and community benefits should furnish adequate guidance either in evaluating the justification for proposed highway betterments, or in choosing between alternate proposals, so long as the pending decision relates to ordinary rural state highways. It should be apparent, however, that many local roads and streets are built primarily to provide access to agricultural land, to other natural resources, or to suburban residential areas. Here also decisions on whether the road should be built, which route it should follow, and what design standards should be required, properly should depend upon full exploration of the services which the new facility is intended to provide. Where the provision of access is the road function neither the economic justification of the new facility nor its engineering design can be performed without taking cognizance of associated benefits to real property. Moreover, those persons for whom the road is built should not be overlooked when revenues are sought to pay the bills.

Land Acquisition and Severence Value

Aside from its influence on highway policy, as discussed in the preceding paragraphs, the value of access demands attention as a factor to be considered in the appraisal of land to be acquired for highway right-of-way. The utility of a given parcel of land may be injured by the intrusion of a roadway in singular ways which are beyond the scope of this paper; but superimposed upon this individual effect is a general increase or decrease of value associated with the over-all influence of access upon location.

Variations in road service have the effect of varying the locations of places served by roads. In turn, the value of places may vary. Stating the problem in this manner recognizes that property value is, at least in part, the outcome of competitive bidding for locations and recognizes that roads function by connecting places. Following this line of thinking, a change in road quality occasions a concurrent change in the locations of places served by that road. Because location has value, a change in road quality would be accompanied by a change in the value of places served by that road. These value changes thus serve as a measure of the over-all influence of access on location mentioned in the paragraph above.

The road system may be viewed as a net focused on urban centers. Looking from the urban center outward and considering gross patterns of change, two main aspects of the measurement problem may be seen. First, modern expressways are linking suburban areas more closely with the center of the city. The land is changing in location and the main determinates of change are the expressway itself and the status of the urban real estate market. Looking further into the countryside, the land becomes more sparsely settled and takes on a rural character. Here the determinates of change

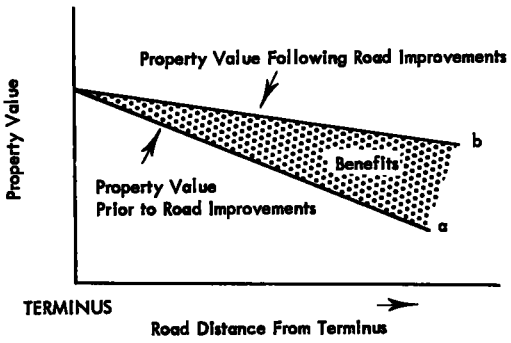

Figure 1. Positive benefits.

are somewhat different from the suburban case, the status of agriculture is pertinent, the road network is highly varied in quality, and locations are not in reference to the central city alone.[2]

This basic inter-relation between location, land value, and highway betterment may be elaborated graphically (Figure 1). For this analysis consider a terminus (perhaps a town) around which property values decrease due to the effect of location on property value. When the road system was primitive property values diminuted rapidly with distance from town as shown by the line marked a. Following a period of road improvements the property values diminute less rapidly with distance from town and this is shown by the line marked b. The shaded area shows the distribution of benefits.

Not all property receives positive benefit from a general improvement of access. Stated in the language of Figure 1, line b need not lie wholly above line a (Figure 2). The demand for land near a terminus may decline when better roads make distant land more accessible. Possibilities as those illustrated by this concept provide additional incentive for the more rigorous analysis of the nature of highway impact on land values.

The Washington Studies

The investigation which is reported in subsequent sections of this paper was motivated by an interest in the financing of highway improvement. The preceding discussion, however, purports to show that these studies have reference beyond the financing problem. Specifically, the two investigations here reported are concerned with the economic impact of urban expressways and of improved rural roads on property values. In both cases the influence of the expenditures is not confined to highway user benefits and costs. In both cases, also, the highway administrator faces problems of route location and the justification of expenditures in which prudent decisions require consideration of land and community benefits.

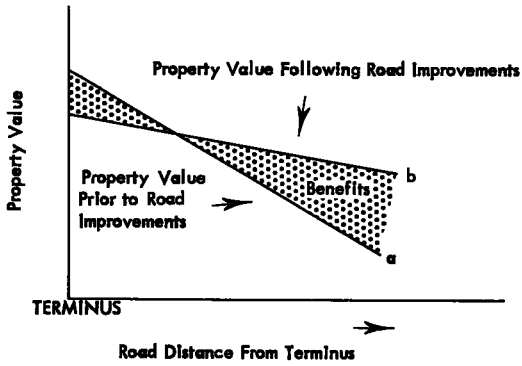

Figure 2. Positive and negative benefits.

IMPACT OF EXPRESSWAYS ON SUBURBAN AREAS

The urban expressway duplicates the function of existing city streets; the expressway provides access from residential areas to the central business district and access between other termini of urban traffic.[3] But the expressway differs from present routes, investment requirements per mile of route are extremely high and, being new, no generally acceptable pattern for financing expressways has evolved. Needs for expressway construction are great, thus, implications for construction and financing policies from studies of the impact of expressways are urgently needed.

[2] Looking far enough away from the city the road net is seen to form interurban connections and these connections would change when roads are changed. By and large this aspect of the problem was not considered in the research reported here.

[3] Too, the expressway may link cities, each to the other. The present study, however, is limited to intra-urban area impact of the expressway (1) Part V.

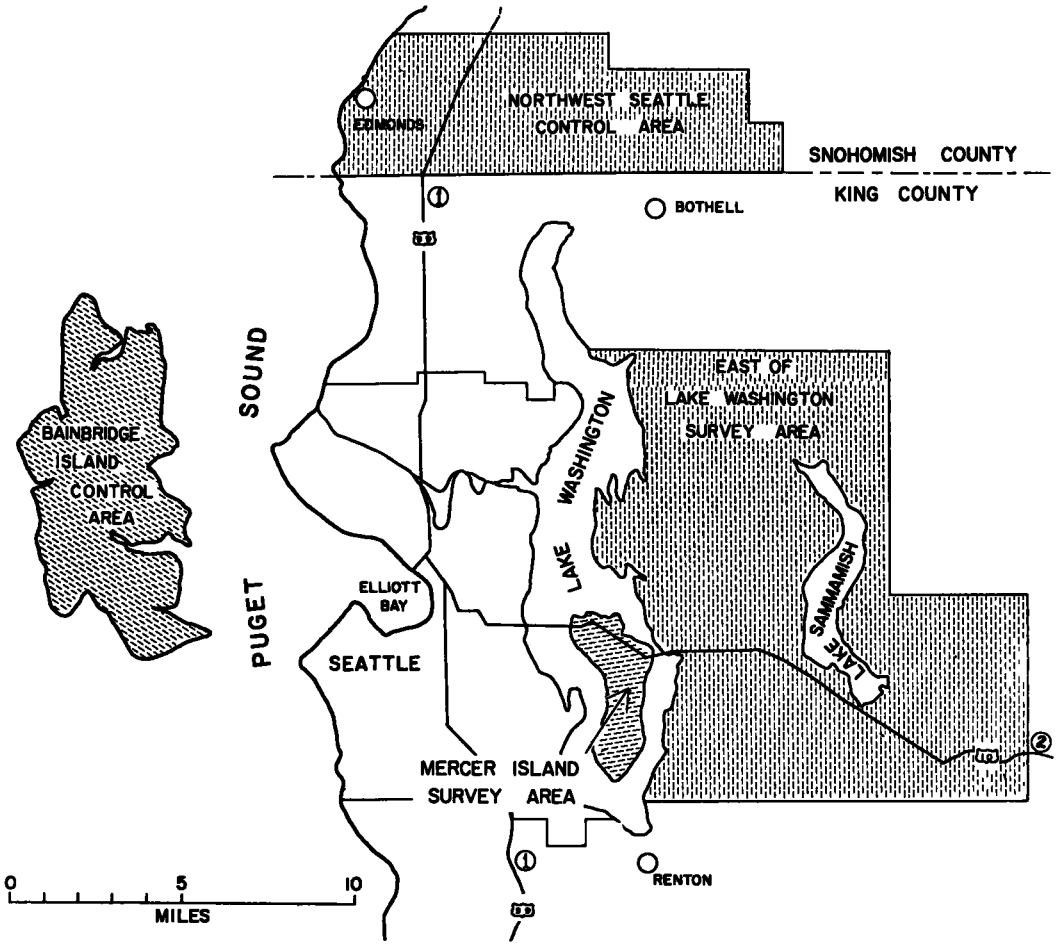

Figure 3. Survey and control areas.

Measuring the Impact of Expressways

Since expressways connect places, it is logical to look to these places to find the impact of expressways. Many ways come to mind that a place may change because of the development of expressway service (or the lack of the development of expressway service when that service is provided elsewhere), the type of land use may change, the intensity of land use may change, the value may change, and the like. Whatever the change may be it is a result of the expressway. The expressway provides improved access; the change is in response to the change in opportunities at affected places due to change in the relative position of the places. The value that places command on the market is a function of the opportunities for use they offer and when the opportunities change the value changes. This sequence—a change in access followed by a change in land use opportunities followed by a change in property value—provides a measure of the impact of expressway construction.

The value measure is a logical, widely accepted measure in its own right. It is especially useful as a measure of impact for the users of such information. As mentioned previously, information is urgently needed for the development of construction and taxation policies. Information in value terms gives direct evidence of advantages of the expressway and consequent improved access for the property owner.

Scope of the Expressway Impact Study

The type of route with which this study deals is the limited access urban expressway

serving suburban lands, in this case the Lake Washington Floating Bridge connecting the City of Seattle with suburban Mercer Island and the mainland to the east (Figure 3). For many years Mercer Island has been connected with the mainland to the east by a bridge, but until 1940 ferries provided the only direct connection between the island and Seattle to the west. To reach Mercer Island by land from Seattle it was necessary to drive around either the north or the south end of Lake Washington, a trip taking ap-

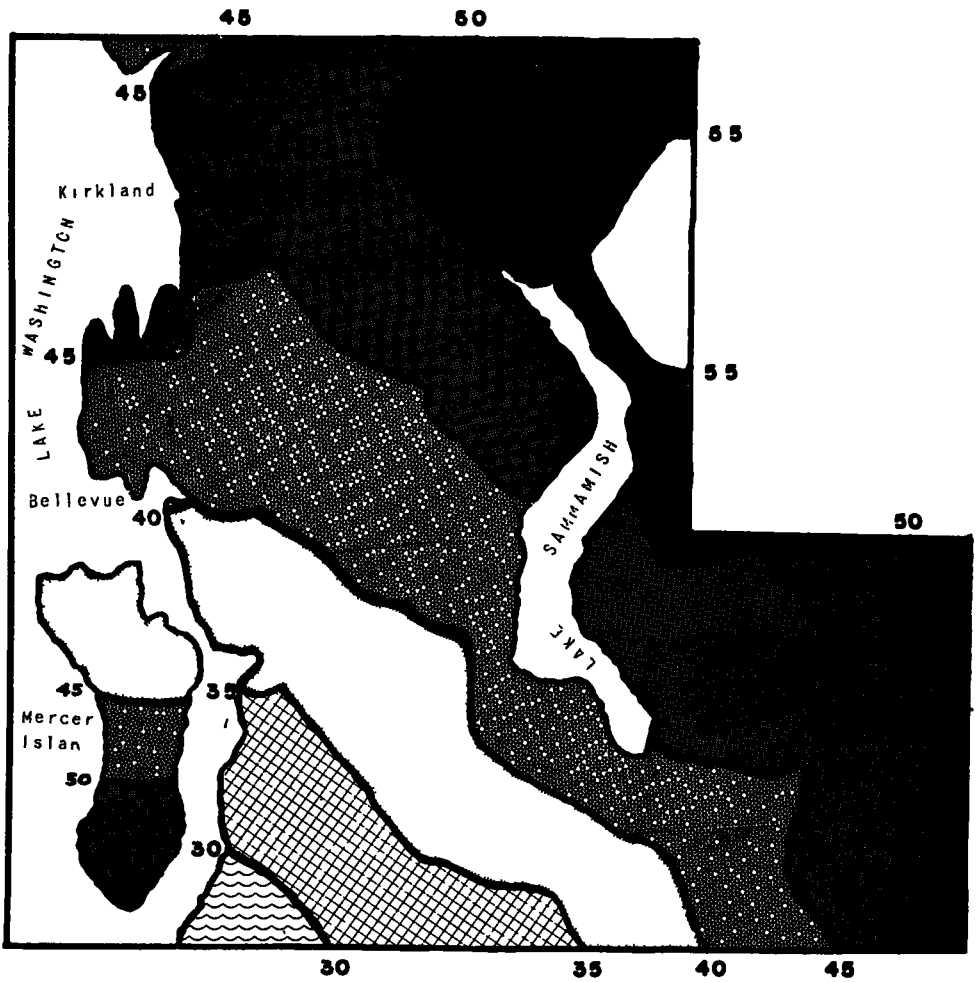

Figure 4. Pre-bridge travel time zones in minutes from 4th and Madison, Seattle.

proximately three-quarters of an hour (Figure 4).

The construction of the Floating Bridge in 1940 reduced the travel time from downtown Seattle by two-thirds; from approximately forty-five minutes to twenty minutes (Figure 5). With such a drastic improvement in access it could be expected that Mercer Island's development and settlement would be accelerated, and that values of Mercer Island real estate would advance; probably more than in most other sections of the Seattle metropolitan area. Relatively similar benefits also could be anticipated for the mainland area immediately east of Mercer Island through which the freeway extension of the Floating Bridge passes.

The selection of Mercer Island and the larger area to the east (East of Lake) for study was dictated not only by the convenience of their location, but also by the singular fact that these are the only suburban areas in the State of Washington which have experienced improved access through freeway construction over a relatively long period

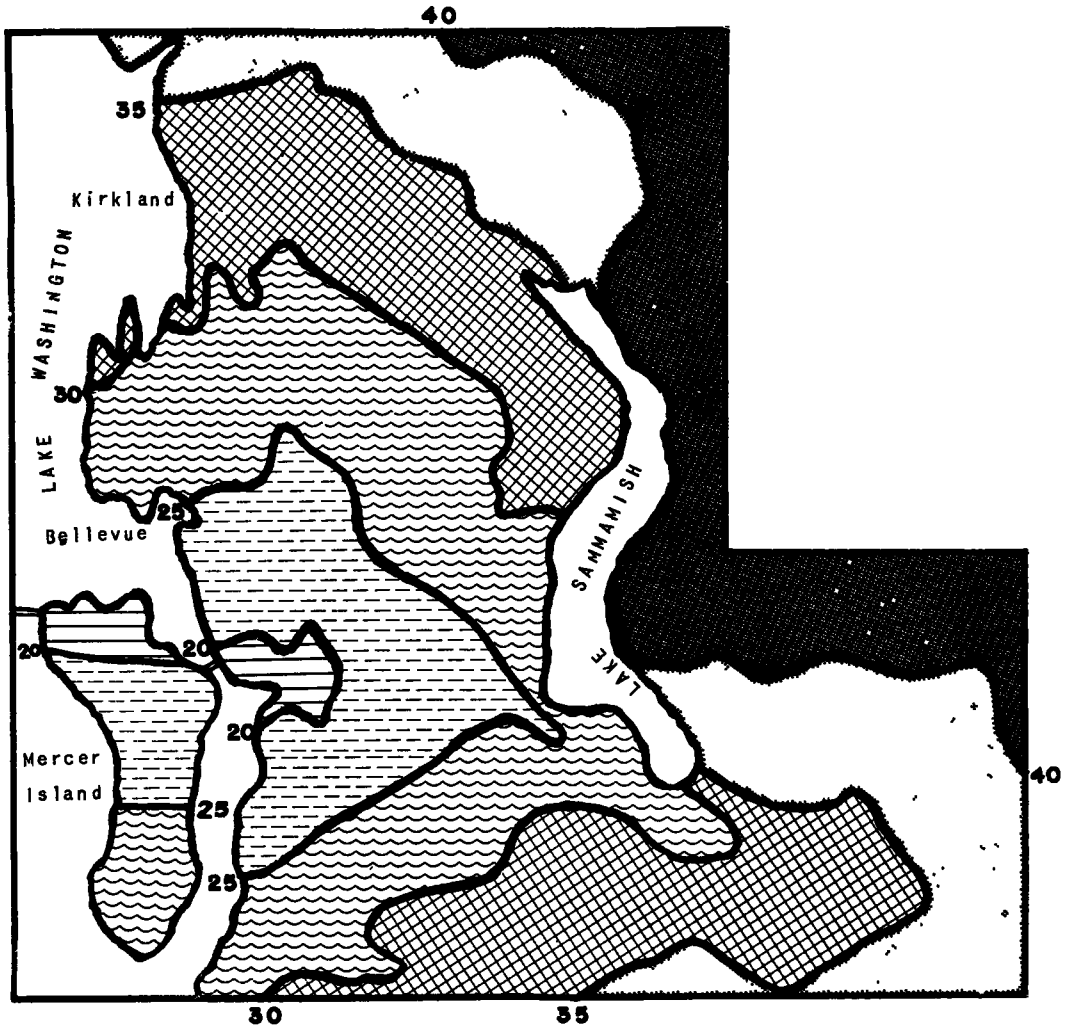

Figure 5. Post-bridge travel time zones in minutes from 4th and Madison, Seattle.

of time. The span of 15 years since the construction of the Floating Bridge covers sufficient time to yield a useful model of the effect of improved access upon property values.

Measurements

The study recognizes three significant time periods. The pre-bridge period extends from 1935 to 1940, the interim or toll charge period extending from 1940-1949, and the toll free interval since 1949. In the Mercer Island study, value data were collected for these three periods, but the findings for the toll charge period did not contribute sufficiently to the objectives of the study to warrant their use, and similar information was not collected for the subsequent study of the suburban area lying east of Lake Washington and Mercer Island.

To measure the change in property values, records of actual sales were compiled for both the "before bridge" and "after bridge" time periods. The type of real property covered in the study is improved residential and unimproved land suitable for residential development, whether platted or unplatted. Agricultural, commercial, and other types of land use are excluded. The relatively long period of time covered required the selection of a type of property that predominated throughout the entire time period.

The strictly suburban, even semi-rural, character of the survey areas prior to 1940 precludes consideration of commercial and industrial properties as reliable sources of information on changes in land value representative of the survey areas.

The unique objective of the study required a depth of coverage and analysis not common to other studies. The isolation and measurement of access influence alone, among the many variables affecting property values, dictated the careful identification and evaluation of other influences so far as possible. Topography, community facilities, changing local road patterns, inflationary effects and other factors were recognized as contributing to property values. The Mercer Island pilot study revealed that some of these factors were measurable within a range of acceptable reliability only at great cost. In the survey area East of Lake, as well as Mercer Island, those variables were considered which appeared to be dominant in affecting property values: location on waterfront or inland, degree of capital investment shown by improvement or non-improvement, and the level of economic activity in the Seattle urban area.

Some of the new or unusual problems encountered at the outset were the insular nature of Mercer Island and its topographical affinity for waterfront development; the multiple access approaches to the survey areas from Seattle both north and south of Lake Washington, before and after construction of the bridge; and, most difficult of all, the collection of reliable value data for a twenty year period spanning deep depression with limited real estate activity and high level prosperity with unprecedented growth in the area.

Of the several available sources of property value data, the best was found to be the record of sales transactions in the office of the county auditor, as recorded by title insurance companies. Only those sales were listed which buyers chose to have recorded, but unrecorded sales are estimated to constitute only a relatively small fraction of the total. Since title insurance companies classify these public records by location of property, this source was used with favorable results in coverage, time and expense.

The sales data were sampled by a predetermined sample pattern designed to yield property value information for selected categories of property at different periods of time. Resales of the same property in both time periods were infrequent.

Economic and other conditions were dissimilar in the two time periods (pre-bridge and post-bridge). Market activity in real estate and suburban development was slow in the pre-bridge period, while activity in the post-bridge years assumed boom proportions. Moreover, land availability, building methods, and consumer preferences have all undergone change in the interim. Accounting for all such divergencies would be difficult, if not impossible. Expressing values in constant dollars at least corrects the data for one of the most important differences between the two periods.

Few previous studies have attempted to isolate the influence of access from the other factors affecting property value. When undertaken, it has been through the use of comparative control areas. While this method commends itself, and was used in this study, a more precise measure is desirable in seeking results which may be useful in the allocation of highway cost responsibility. Multiple regression analysis offers the possibility of achieving greater precision in isolating the value of access. Both of these methods were used in this study, and their use is discussed in the following paragraphs.

Survey and Control Areas

For all metropolitan areas reported by the United States Census in 1950, population increases since 1940 amounted to 13.9 percent inside the central city and 35.5 percent outside the central city. Comparable figures for Seattle are 27.0 percent and 46.5 percent, respectively. It is necessary, however, that the suburban study areas be compared not only with the city as a whole, but, more pertinently, with other suburban areas of similar characteristics not experiencing access betterment since 1940. With this in mind, the Mercer Island survey area was compared with Bainbridge Island as a control area; and the East of Lake survey area was compared with the southwest Snohomish County control area.

TABLE 1

LAND VALUES IN CONSTANT (DEFLATED) DOLLARS

	Pre-Bridge Values		Post-Bridge Values		% Increase	
	Mercer	Bainbridge	Mercer	Bainbridge	Mercer	Bainbridge
Waterfront ($/front ft)	$50.11	$24 12	$137.82	$48 39	175	101
Inland ($/sq ft)	0.103	0.064	0.319	0.092	210	44
	East of Lake	Snohomish	East of Lake	Snohomish	East of Lake	Snohomish
Waterfront ($/front ft)	$44.12	$51.37	$139.37	$110.13	216	114
Inland ($/sq ft)	0.049	0 063	0 241	0.225	392	257

Mercer Island is an area of some 4,000 acres located in southerly Lake Washington, approximately one mile east of Seattle. The island divides itself naturally into three main areas: a gently rolling plateau with occasional steep hillsides in the north; a rugged narrow central portion; and a larger flat area to the south. The development of the area has been impeded to some extent by an inadequate water supply, and by the handicap which the impervious clay soils place on septic tank operation. The rugged shoreline provides beautiful estate settings; but difficult road building terrain. State Highway 2, an extension of the Floating Bridge freeway, crosses the northern end of the island.

Bainbridge Island lies west of Seattle in Puget Sound. It is topographically similar to Mercer Island, but is 3.5 times larger. Like Mercer Island, the water supply is limited. Like pre-bridge Mercer, it is reached from Seattle by ferryboat. About three-fourths of the area is suitable for agricultural use and residential development. In 1940 Bainbridge had a population density of 124 persons per gross square mile, compared with 187 for Mercer Island. Between 1940 and 1950 the growth in population amounted to 34.5 percent for Bainbridge, 232.6 percent for Mercer Island. Both islands were 50-60 minutes travel time from downtown Seattle in the pre-bridge era.

The East of Lake survey area includes 128 square miles in a tract extending twelve miles eastward from Lake Washington. State Highway 2 provides expressway service to the west over Mercer Island and the Floating Bridge to Seattle. The entire area was accessible from Seattle in the pre-bridge period by roads around the lake, but the bridge has made possible a time savings of from 5 to 20 minutes in the trip from Seattle.

The southwest Snohomish County control area comprises 43 square miles lying north of Seattle, and is similar to the East of Lake survey area. In 1940 this control area had a population density of 140 persons per gross square mile, which had increased 124 percent by 1950. The entire East of Lake survey area experienced a 109 percent population increase in the same decade, from its 1940 population density of 283 persons per gross square mile; but the more comparable 15-20 minute time saving zone, East of Lake, had a more significant population increase of 141 percent. Both the survey area and the control area were 30-55 minutes from downtown Seattle in the pre-bridge era.

The Impact

The preceeding paragraphs give the bases for comparative studies of expressway impact and comparative studies were made for both the Mercer Island and East of Lake area (Table 1). In addition to these comparative studies, a regression study was made in the East of Lake area.

In the regression study the value of property was related to the expressway as well as qualities of land (e. g. , steep or not steep) which relate to value. The multiple correlation was found to be 0.34; significantly different from zero, and showing a positive correlation, although notably less than a perfect correlation of 1.0.

TABLE 2

PERCENTAGE INCREASE IN ADJUSTED LAND VALUES ATTRIBUTED TO ACCESS

Method	East of Lake	Mercer Island
Regression	70%	-
Comparative [a]	78%	154%
Comparative [b]	118%	120%

[a] Comparison of survey and control area dollar increases, expressed as percentages of pre-bridge values.

[b] Excess of survey area value increase over control area increase, in percent

Holding the other variables constant, it was found that the construction of the bridge was responsible for a 69.8 percent increase in the average value of land, with a computed standard error of 29.1 percent.

Finally, it is now possible to tabulate the study findings according to the analytical procedures employed (Table 2).

It is clear from this table that the value impact of the expressway is great, the expressway approximately doubles the value of tributary residential lands. The general implications of this finding are not previously defined. The implications require thoughtful evaluations of road improvement problems and additional evidence of the nature of change.

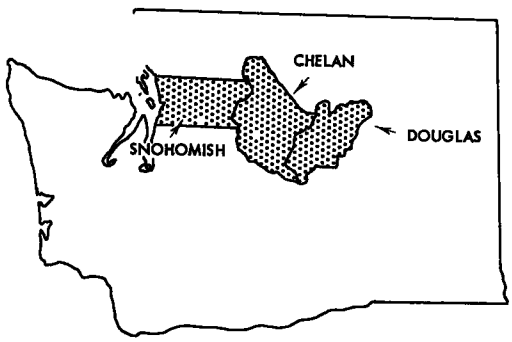

Figure 6. Study areas.

IMPACT OF HIGHWAY IMPROVEMENTS IN RURAL AREAS

The impact of highway improvements in rural areas differs in several ways from the problem of the expressway and suburban areas just discussed. In the problem before us now the farm business is the predominate kind of land use to be considered.[4] But residential uses continue to be important; in the typical rural area there are many non-farm rural residences and, of course, the farm itself generally serves as a residential site. Too, types and lengths of service roads vary over a wide range. In some directions, say toward a large city, a residential site may be served by a modern expressway. Towards other trip termini, say the place where day to day grocery shopping is done, the rural site may be served by a route of only poor quality.

The distinctive features of the rural problem are, then, (1) the likelihood of highway improvements of many kinds (referring here both to changes in route quality, e.g., paving a dirt road, and to the selective orientation of changes, e.g., the route serving a rural site may be improved to place A but not to place B) and (2) the predominance of agricultural land uses.

DATA USED IN THE RURAL IMPACT STUDY

How do highway improvements affect rural areas? It has already been noted that the impact of improvements may be measured by the value placed on property (or locations), thus a series of observations of property values were needed to answer the question. Another requirement was the association of highway improvements with these values, but this presented real operational difficulties. In the first place, the countryside is unlike a laboratory; it is not practicable to vary road improvements and observe following variations in values. In the second place, it is not always clear what road improvements relate to what places and in what degree. The ruralist usually uses several routes in day to day travel. If one of these routes is improved, say the route one travels to church, how does this relate to improving another of the routes, say the route used for convenience goods shopping? At any rate, a travel survey is needed to find the places tributary to a road improvement.

The idea in the paragraph above specified the data used in the research. Data collection began by observing a series of values of parcels of land. The resident or user of each parcel was then interviewed to determine travel patterns. This interview step allowed each parcel to be located on the highway system in terms of the routes used

[4] Other kinds of activities are also typically rural in location, for example, forestry. In the present study chief interest was in the farms and non-farm residences of agricultural areas and the study was limited to such areas. It might be pointed out, however, that agriculture generally appears first in the succession of land uses outside of built-up urban areas.

and the frequency of travel. Studies were made of farmland in three areas—Snohomish, Chelan, and Doublas Counties, Washington—and in two of the counties studies were also made of non-farm residential sites (Figure 6). Thus, the basic information consisted of five sets of data. Each data set contained observations of property value matched with routes used by the users of the land.

The routes were grouped into six classes:

(a) the route to the place of usual household shopping or "convenience goods" shopping, for example, the place where food is usually purchased.

(b) the route to the place of usual seasonal or "shopping goods," for example, the place most frequently visited for the purchase of clothing.

(c) the route to the place most frequently visited for purposes of amenities. Trips to church and grange activities are examples of trips used to define this type of termini. Amenity travel when the travel was the amenity (pleasure driving) did not enter into analysis.

(d) if the study parcel of land was a farm, the route to place of usual or most frequent purchase of supplies used in the operation of the farm business.

(e) if the study parcel was a farm, the route to place of usual sale of products of the farm business.

(f) if the study parcel was the site of a non-farm residence, the route followed to work and return.

For each place each one of these routes varied in length, quality of highway used, and in the frequency of travel or use. Thus the travel information for each place was by type of trip, with each type of trip divided into use of routes of different quality. There was a problem here in that interview respondents could make only crude identifications of differences in route quality. The best that could be done was recognize paved versus gravel versus dirt surfaced routes and these were the quality classes. In addition, we knew the length of each route and the frequency of use.

To make this travel or location information clear, consider a hypothetical example (Table 3). A value observation was made from sales records. Matched with this observation was information on the length and quality of the route to each of several trip termini. In addition, the frequency of travel or use of each route was known. It is easy to see that two measures of location were available, the simple distance to termini measurements and each of these distances multiplied by frequency of travel (hereafter termed travel measurements).

For each parcel observations were also made of such variables as land capability and this information was also matched with the value data. These variables varied from study to study. Although inclusion of these variables were important in the measurement problem, they will not be discussed here because they are beyond the scope of the present analysis topic.

STATISTICAL ANALYSIS OF THE RURAL IMPACT PROBLEM

The Estimates

Estimates of the value impact of highway improvements were made by multiple regression methods using inverted matrices. This method is not new, but the large amount of computational labor involved has discouraged its use on as extensive a scale as that in these studies. However, the use of electronic highspeed computers made the inverted matrix solutions practicable here. The use of inverted matrices simplified the calculation of errors of the regression coefficients, the tests for significant

TABLE 3

HYPOTHETICAL EXAMPLE OF TRAVEL AND VALUE INFORMATION FOR A NON-FARM RESIDENCE

	Travel to Place of—															
	Convenience Goods Shopping				Shopping Goods Shopping				Most Usual Amenity				Employment			
Value ($)	P[a]	G[b]	D[c]	F[d]	P[a]	G[b]	D[c]	F[d]	P[a]	G[b]	D[c]	F[d]	P[a]	G[b]	D[c]	F[d]
3,000	3 2	0.8	0.1	3.1	8 3	0 9	0 0	1 0	7.2	3.1	0 2	0 8	8.3	1 1	0.0	5 0

[a] Miles of paved road. [b] Miles of gravel surface road. [c] Miles of dirt surface road [d] Frequency, trips per week

differences among the coefficients, and the deletion of independent variables from the regressions in order to simplify the presentation and use of the findings of the study.

In general, the postulated relationships took the form:

$$Y = \alpha + \sum_{i=1}^{n} \beta_1 x_1$$

Y is property value, α is a constant, and the x_i's are the variables of travel via different routes.

For each data set, the data were arrayed on punch cards and matrix transposition, multiplication, and inversion steps yielded the net regression coefficients (the b_1's as estimates of the β_i's), the variance-covariance matrix, and the error variance.

Decision Criteria

These materials were then used to resolve each regression into its principal components. Terms were deleted using t criteria for the hypotheses $\beta_1 = 0$ and $\beta_1 = \beta_j$ and on the basis of the contribution of each deleted term to the error variance. This deletion process decreased the quality of each estimating equation. On the other hand, each full regression equation contained eleven or twelve terms and in many of the studies a number of the terms had little effect on the error variance. In addition, the large number of terms in each study limited the potential uses of the measurements in practical applications.

Criterion of the size of the error variance was also used to select among the estimating equations utilized in the studies. As mentioned before, measurements of routes were made in two ways—simple distance measurements and travel measurements. In each study the regression using the travel measurements gave a lower error variance than the regression using simple distance measurements and the distance measurements were discarded.

In addition, criterion of the size of the error variance was used in two studies to select the "best" functional relationship between travel measurements and property values. Theoretical considerations suggested that property values would vary with the inverse of distance.[5] Regressions using this function were compared with linear functions and "best" function was taken to be that with the least error variance. Of course, this procedure did not yield a known "best" function. The procedure allowed the selection of the "best" function of the functions considered.

In general, the regression coefficients were of two types. Some of the coefficients related to dichotomized observations of land utilization and the like. In these cases the hypothesis tested took the form $\beta_1 = 0$. As would be expected from the nature of observations and the problem, these hypotheses were rejected in almost every instance.

The remainder of the coefficients related to the travel measurements. In these cases we were interested first in the hypothesis $\beta_i = 0$. For one of the trip types (amenity travel) this hypothesis was rejected in almost every case. For the remaining trip types the hypothesis was not rejected for the paved routes terms in about half the cases. Next, for the trip types where the hypothesis $\beta_1 = 0$ was rejected for poorer than paved routes, the hypothesis $\beta_i = \beta_j$ was tested to compare the paved route coefficients with the nonpaved route coefficients. This hypothesis was rejected for the paired coefficients in at least one of the trip types in every study area. Hypotheses were tested at the five percent level of significance.

FINDINGS OF THE RURAL STUDIES

The regression analysis applied to each set of observations yielded what may be

[5] Based on the observation that costs of transfer are concave downward over distance (5). In one cast it was found that a non-linear regression was "better" than a linear one. The difference between the two was not great, however, and for convenience the present paper presents only linear findings.

thought of as the average contribution of travel to property value. The term travel is used because in every case it was found that simple distance measurements did not yield usable findings, usable findings were based on the travel per unit of time measurements. In general, it was found that travel via paved routes had little or no effect on value placed on property. But travel via roads of poorer quality depreciated value, the greater the travel the less the value of the property.

What is the impact of highway improvements? In general, the impact varies depending on the uses of the route. In terms of the data and findings of the present study, the impact is the same as removing the depreciation of value associated with poor quality routes. As a case in point, consider a mile of gravel road which depreciates value at five cents per tributary acre per mile traveled per year. Say that 100 miles are traveled over the road each year. Paved roads in the same area have no effect on property values. If the road is paved, depreciation of value in the amount of (0.05)(100) or $5.00 is removed. The value of the paving of the gravel road is, thus, $5.00 per acre. The total impact in the area is of course much greater, because likely the route serves many acres of property. [6]

Five studies were made and findings varied among areas and among kinds of land uses. The study areas represent (1) three agricultural areas of the state and (2) two cases where rural non-farm residences occur.

The Non-Farm Residences

Non-farm residential sites were studied in Snohomish County and in Chelan County. Although belonging to the same class of land use, the properties studied in the two counties were quite different. The Snohomish County observations were representative of a farming area where alternate employment opportunities have occasioned the retirement of lands and structures from agricultural uses, the parcels studied were previously marginal farms (Figure 7). [7] In Chelan County the parcels were typical of the encroachment of urban-type residences on agricultural lands. The typical residence was a post World War II home on a small lot.

In both Snohomish and Chelan Counties it was found that the routes used in the journey to work exerted the strongest influence on property values and in both cases the percentage effects were about the same. The average parcel not now served by a paved road would increase in value about 7 percent if the road were paved. The monetary units in which the value impact was measured varied from area to area.

In Snohomish County, where properties were formerly farms, per acre value measurements were made (Figure 8). Travel via routes with a poorer than paved surface decreased values at three cents per acre for each mile traveled per year more than did travel via paved routes. It is this difference of three cents that is shown on Figure 8. The figure indicates that if routes were improved by paving, tributary lands would increase in value (the diminishing of value by gravel routes would no longer be present), but the amount of increase would vary depending on the amount of travel over the improved routes.

The Chelan monetary rate of increase was much greater than the Snohomish County rate (Figure 9). In this case, the non-farm residence was typically a new home on a small lot. The rate of increase refers to a relatively valuable parcel of property and, as mentioned before, the percentage change here was about the same as in Snohomish County.

Farmland

Studies of the value impact of route improvements on farmland gave results that

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[6] Using measurements in this way requires that the structure generating the present values will not change when the routes are improved. Here this general requirement refers both to the supply and demand equilibrium setting the price of land and to the patterns of travel (1) Part IV, especially pp. 77-82, and (6).

[7] Figure 7 illustrates the arrangement of land uses, roads, and study parcels in one of the three study areas.

varied from area to area. The monetary rates of change and percentage aggregate changes for average parcels varied as did the type of trip of greatest importance in determining change. It is interesting, however, that in each case trips related to the farm as a residential site were more strongly related to property value than were trips relating to the farm business. [8]

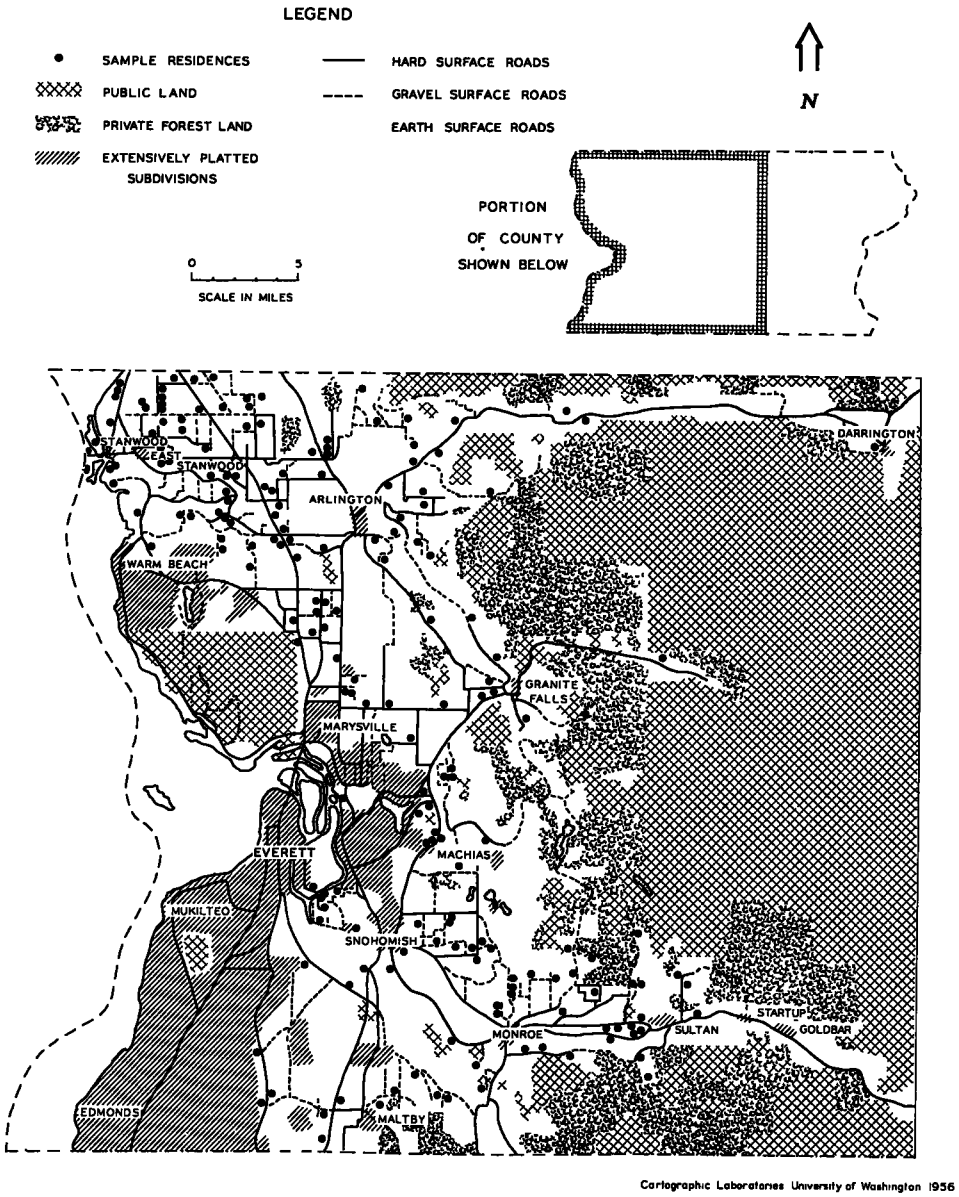

Figure 7. Snohomish County.

In both Snohomish and Chelan counties routes used for the journey for shopping goods, shopping exerted the strongest influence on property values. In the Snohomish County case where dairying is the predominate land use the expected increment to

[8]Current farm location theory postulates that locations are bid for on the basis of the location of the farm relative to markets for farm products (7, 8). In connection with implications for theory from the present study see (9).

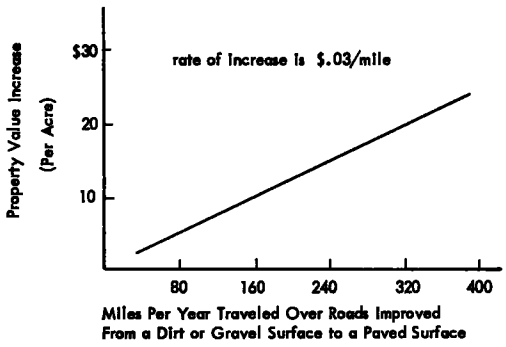

Figure 8. The value of non-farm residential sites in Snohomish County and the journey to work.

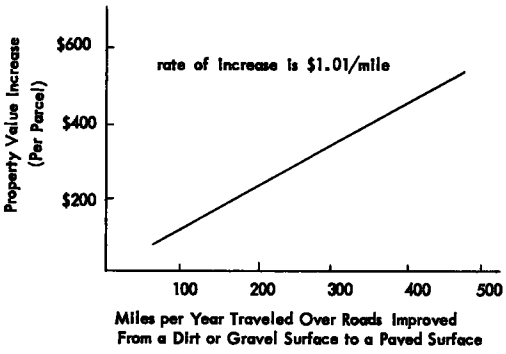

Figure 9. The value of non-farm residential sites in Chelan County and the journey to work.

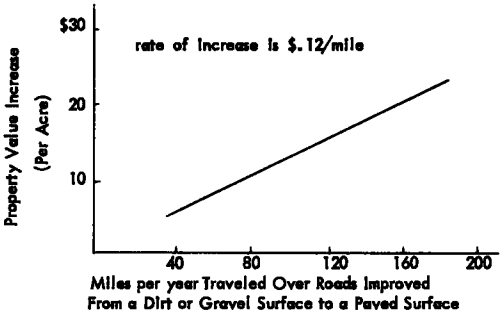

Figure 10. The value of farmland in Snohomish County and travel for shopping goods shopping.

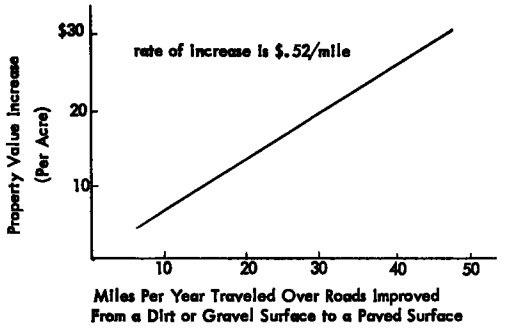

Figure 11. The value of farmland in Chelan County and travel for shopping goods shopping.

value was 12 cents per mile (Figure 10). This figure means that each acre tributary to the improved road would increase in value at a rate of 12 cents per mile traveled over the improved road per year.

Chelan farms are largely irrigated orchards. Under this intensive use the value of the land is high as is the contribution of road improvements to value (Figure 11). The rate of expected change here was 52 cents per mile traveled over the improved road. On the average, properties not served by paved roads would increase in value by 3 percent of present value if roads were improved. This is in contrast to Snohomish County where the average increase would be 7 percent. The apparent contradiction between monetary rates and percentage changes largely reflects differences in the levels of land values in the two areas. [9]

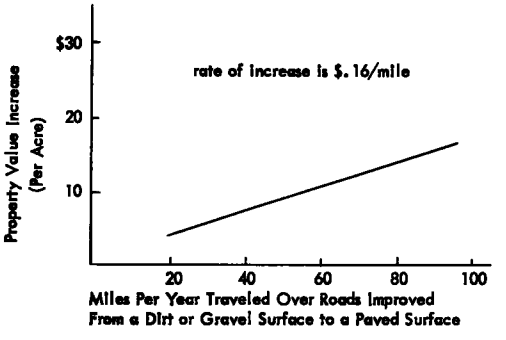

Figure 12. The value of farmland in Douglas County and travel for usual household shopping.

Farmland in Douglas County was the subject of the fifth study. This county is characterized by extensive land uses, largely grazing and wheat farming, and a dispersed pattern of settlement. Here the journey for usual household shopping exerted the

[9] The differences also reflect differences in the current road systems as well as differences in travel.

greatest influence on values (Figure 12). The expected change in value was 16 cents per mile and the average place not now served by paved roads would increase in value by 23 percent if roads were improved to a paved surface.

In Douglas County it was practicable to compare the diminution of value due to travel via dirt routes with that due to travel via gravel routes. It is interesting that in this case the effects were exactly the same. Travel via dirt routes decreased value at the same rate as travel via gravel routes. This is not what would be expected from common knowledge, but the writer can offer no good explanation for the finding.

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