

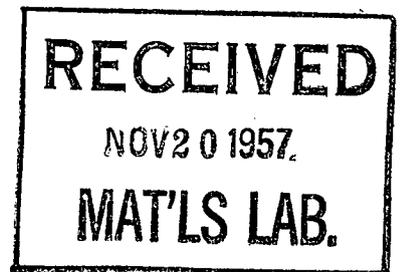
**HIGHWAY RESEARCH BOARD**

**Special Report 28**

***Economic Impact  
of  
Highway Improvement***

**Conference Proceedings**

MARCH 18-19, 1957



**National Academy of Sciences—**

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## *Preface*

One of the new and important fields for highway research is the economic impact of highway improvement. This encompasses commercial, industrial and residential developments in both urban and rural areas; indeed, virtually all segments of the activities of the nation.

Research findings in this field can be put to many uses. They can be helpful in connection with highway right-of-way acquisition, the conduct of public hearings, public relations activities in general, the determination of highway location and design, and other aspects of highway modernization.

In recognition of these circumstances, the American Association of State Highway Officials passed a resolution in November 1956, urging all state highway departments to undertake and foster economic impact research, and asked the Highway Research Board to sponsor a conference dealing with this matter. It is in pursuance of this request that the Board arranged this conference, which dealt with the nonvehicular aspects (land values, land use changes, bypass effects) of economic impact, rather than with the economic consequences of improving traffic operations. However, it is difficult, if not impossible, to separate the direct traffic benefits obtained by the users of motor vehicles from the benefits extended to the land and the community. It is the desire for equity in taxation that recommends the attempt.

Both short- and long-range objectives were explored at the conference. Both approaches are important from the standpoint of the highway official. The short-range studies will be of immediate assistance in connection with right-of-way acquisition and hearing activities. The long-range approach will yield more fundamental data upon which he can premise a long-range highway program of stable character, oriented to produce the best in highway transportation from many points of view.

The conference Proceedings contain a condensed version of reports made by participants, together with summaries of the discussions. A reorganization of material was made in order that the technical reports might be grouped together and the discussions be reported by subject matter.

Grateful acknowledgment is made to M. Earl Campbell, Engineer of Economics, Finance and Administration, Highway Research Board, and to Edmond L. Kanwit, Transportation Economist, Bureau of Public Roads, for their reporting and summarizing of the conference material.

## *Participants in Conference*

- Ackerman, Edward A., Director, Water Resources Program, Resources for the Future, Inc., Washington, D. C.
- Adkins, W. G., Associate Research Economist, Texas Transportation Institute, Texas A & M College System, College Station, Texas.
- Bone, A. J., Associate Professor of Highway & Airport Engineering, Department of Civil & Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts.
- Buckley, J. P., Chief Engineer, Highway Division, Automotive Safety Foundation, Washington, D. C.
- Carll, Richard, The Brookings Institution, Washington, D. C.
- Carroll, J. Douglas, Jr., Study Director, Chicago Area Transportation Study, Chicago, Illinois.
- Colean, Miles, Consulting Economist, Washington, D. C.
- Davidson, F. William, Acting Director, New York Thruway Authority, Albany, New York.
- Dieter, Frank L., Director, Office of Planning, Arlington County, Arlington, Virginia.
- Garrison, W. L., Professor of Geography, University of Washington, Seattle, Washington.
- Harrison, J. W., Highway Research Economist, Council of Highway Investigation and Research, University of Virginia, Charlottesville, Virginia.
- Hess, Rudolph, Acting Assistant Chief Right-of-Way Agent (Supervision), California Division of Highways, Sacramento, California.
- Holshouser, Eugene C., Research Associate, Bureau of Business Research, University of Kentucky, Lexington, Kentucky.
- Holmes, E. H., Assistant Commissioner for Research, Bureau of Public Roads, Washington, D. C.
- Intermaggio, Joseph, Project Director, Committee on Urban Research, Highway Research Board, Washington, D. C.
- Johnston, J. Edward, Highway Transportation Specialist, U. S. Chamber of Commerce, Washington, D. C.
- Kanwit, Edmond, Transportation Economist, Bureau of Public Roads, Washington, D. C.

Levin, David R., Chief, Land Studies Branch, Financial and Administrative Research Division, Bureau of Public Roads, Washington, D. C.

Lockyer, Charles R., Assistant Professor of Economics, Bureau of Business Research, University of Kentucky, Lexington, Kentucky.

McKain, Walter C., Jr., Head, Department of Rural Sociology, University of Connecticut, Storrs, Connecticut.

Messer, Roy T., Chief, Division of Highway Transport Research, Bureau of Public Roads, Washington, D. C.

Michael, Harold L., Assistant Director, Joint Highway Research Project, Purdue University, Lafayette, Indiana.

Mickle, D. Grant, Director, Traffic Engineering Division, Automotive Safety Foundation, Washington, D. C.

Morf, Theodore, Engineer of Research and Planning, Illinois Division of Highways, Springfield, Illinois.

Richards, Glenn, Commissioner, Department of Public Works, Detroit, Michigan.

Roy, Robert Hall, Dean, School of Engineering, The Johns Hopkins University, Baltimore, Maryland.

Scheick, William H., Executive Director, Building Research Advisory Board, National Research Council, Washington, D. C.

Scotfield, William H., Agricultural Economist, In Charge Land Values Unit, Land and Water Section, Farm Economics Research Division, Agriculture Research Service, U. S. Department of Agriculture, Washington, D. C.

Sharpe, Gordon, Highway Transport Research Engineer, Bureau of Public Roads, Washington, D. C.

St. Clair, G. P., Chief, Financial and Administrative Research Division, Bureau of Public Roads, Washington, D. C.

Steele, C. A., Chief, Taxation and Economic Studies Branch, Division of Financial and Administrative Research, Bureau of Public Roads, Washington, D. C.

Steiner, James F., Manager, Construction and Civic Development Department, U. S. Chamber of Commerce, Washington, D. C.

Stewart, Charles L., Professor of Agricultural Economics, University of Illinois, Urbana, Illinois.

Straub, Arthur L., Highway Research Engineer, Council of Highway Investigation and Research, University of Virginia, Charlottesville, Virginia.

Taylor, Maurice, Associate Professor of Agricultural Economics and Rural Sociology, Agricultural Experiment Station, Montana State College, Bozeman, Montana.

Thompson, J. Trueman, Professor of Civil Engineering, The Johns Hopkins University, Baltimore, Maryland.

Tomlinson, George F., City Planner, Detroit City Plan Commission, Detroit, Michigan.

Waters, Jerome J., Jr., Assistant Engineer, Oklahoma Department of Highways, Oklahoma City, Oklahoma.

Wehrly, Max S., Executive Director, The Urban Land Institute, Washington, D. C.

Wetmore, Louis B., Head, Department of City Planning and Landscape Architecture, University of Illinois, Urbana, Illinois.

Zettel, Richard, Research Economist, Institute of Transportation and Traffic Engineering, University of California, Berkeley, California.

DIVISION OF ENGINEERING AND INDUSTRIAL  
RESEARCH, NAS-NRC

Jordan, Louis, Executive Secretary

HIGHWAY RESEARCH BOARD STAFF

Burggraf, Fred, Director

Ward, Elmer M., Assistant Director

Campbell, M. Earl, Engineer of Economics,  
Finance and Administration

McWane, Kenneth G., Engineer of Traffic  
and Operations

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# *Introductory*

## **Introduction**

### **Chairman Levin**

It is pleasant, indeed, to call this conference on economic research to order.

Economic impact research has interested highway officials for quite a while. The Highway Research Board, sponsor of this conference, has been in the past, as it is today, exercising leadership in this field.

It is not often, gentlemen, that I get a chance to introduce Fred Burggraf, Director of the Highway Research Board. It is with a warm feeling that I present him to this group this morning.

## **Welcoming Remarks**

### **Fred Burggraf, Director, Highway Research Board**

It is a great privilege to welcome you to this conference. We have looked forward to this occasion as one of signal importance and promise.

Its importance issues from the relation of the conference topic to the developing economic impact of the expanded highway program. Its importance is acknowledged by the American Association of State Highway Officials in Resolution 4 passed in their annual business meeting in November 1956. This resolution (see Appendix A) encouraged the states to make economic impact studies, and it also requested the Highway Research Board to sponsor this conference. Its importance is also noted in the fact that the Congress of the United States included Section 210 of the 1956 Highway Revenue Act of 1956, providing for research into the economic impact of highway improvement.

We feel that this conference has considerable promise because there are represented here many disciplines that can be brought to bear on this complex problem. By exchanging ideas and pooling experiences derived from a variety of studies and environments, you can provide a valuable guide to all who will be engaging in these studies.

I would like to express my deep appreciation to the Automotive Safety Foundation and to the Bureau of Public Roads for their financial assistance in making this conference possible. I would also like to express my appreciation to Messrs. St. Clair, Levin, and Campbell, who have made the preparations for this meeting. And I would like to express my sincere gratitude to each of you who have come to contribute your ideas and experiences.

On behalf of the Executive Committee of the Board, and as its Director, I welcome you to this meeting, and express my sincere wishes for its success.

Chairman Levin: G. P. St. Clair, Chairman of the Highway Research Board's Department of Economics, Finance and Administration, is also Director of the highway cost allocation studies being made by the Bureau of Public Roads under Section 210 of the 1956 Highway Revenue Act, which directs the Department of Commerce to undertake such studies in the next sev-

eral years. From several different points of view, therefore, Mr. St. Clair is vitally interested in this business of highway economic impact research.

### **The Benefits of Highway Improvements (Orientation)** **Guilford P. St. Clair**

I want to supplement the welcome given by Mr. Burggraf and Mr. Levin in my capacity as Chairman of the Department of Economics, Finance and Administration. I will try to make my remarks very brief, because we want to get to the business of the conference.

The subject of this conference is chiefly the benefits derived from highway improvement other than those that can be directly measured as benefits to the motor vehicle users.

There are two major facets of the problem; that is, we have to deal with the problem of economic impact at two levels of approach.

The upper level is that of the meaning and significance of the economic impact studies—the meaning and significance of the benefits from highway improvement. How do they impinge on the property owner, or on business? What are the gains and losses? What are the time relationships? There is an immediate benefit accruing to the motor vehicle. What is the time relationship of its benefit to property? To generation of business? Again, what are the pluses and minuses involved? Are there dis-economies or dis-benefits? Are they averaged out in the long run? In dealing with this subject is it necessary to survey the entire field and come out with a net rather than with a gross measurement of benefit?

The lower level is that down-to-earth business of how to conduct studies and develop techniques. It is going to be extremely important for those at this conference who have conducted these studies to discuss the techniques that have been applied with more or less success in the past few years. Some studies are very recent and have perhaps been more experimental than signally successful in their application. However, they may afford assistance.

As already mentioned, I am charged with responsibility for the highway costs allocation study in the Bureau of Public Roads. Under Section 210 of the Highway Revenue Act of 1956 the Secretary of Commerce—and we act as his deputy—is required "to make a study to provide Congress with information on the basis of which it may determine what taxes should be imposed by the United States and in what amounts, in order to insure, in so far as practicable, an equitable distribution of the tax burden among the various classes of persons using the Federal-aid highways, or otherwise deriving benefits from such highways."

The Bureau has been instructed to make a study and investigation of:

1. The effects on design, construction, and maintenance of Federal highways of (a) the use of vehicles of different weights, dimensions, and other specifications, and (b) the frequency of occurrence of such vehicles in the traffic stream.

2. The proportionate share of the design, construction, and maintenance costs of the Federal-aid highways attributable to each class of person (vehicle) using such highways, such proportionate share to be based on the effects referred to in item 1, and the benefits derived from the use of such highways.

3. Any direct and indirect benefits accruing to any class which derives benefits from Federal-aid highways in addition to benefits from actual use of such highways, which are attributable to public expenditures for such highways.

The last paragraph means that we are to inquire rather comprehensively into the subject of benefits derived by classes of persons or groups - beyond direct vehicular benefits. That is why we in Public Roads come with a plea to this conference for help. We need help in framing the general concept of such studies and in actually conducting them. The cooperation of university and research groups is essential to the accomplishment of this particular part of the study.

Section 210 mentions the benefits derived by vehicle users from direct use of the Federal-aid highways. We conceive of such benefits as falling into four general categories, as follows:

1. Reduction in vehicle operating costs, which vary with size and type of vehicle
2. Reductions in time costs, or time savings, which are very real, but not so easy to measure categorically as operating costs.
3. Savings due to the reduction in motor vehicle accidents, the cost of motor vehicle accidents.
4. That rather vague, but in a sense measurable, quantity, the reduction in the strains and annoyances of driving under congested conditions. People pay money at toll gates, for example, not only for the time saved, but also for the reduction in strain that results from being unable to drive under relatively uniform and uninterrupted conditions.

We shall try to improve the measurement and evaluation of such benefits, and a considerable part of the study will be the application, by what has come to be called differential-benefit analysis, of the measurement of comparative motor vehicle group benefits or savings to the problem of motor vehicle tax allocation.

We are, however, asked to include the non-vehicular benefits; that is, benefits derived by other than the motor vehicle user. We propose to utilize information gathered in that field in considering the extent, if any, to which the Federal-aid highway program should be supported by sources other than motor vehicle taxation. The Federal Government shifted, with the passage of the Highway Revenue Act of 1956, from a general revenue to a user tax basis for the support of the Federal-aid highway program. Section 210 in a sense reopens the question and asks us, through the comparative measurement of benefits derived from the existence or the improvement of the Federal-aid highways, to examine the question of whether and to what extent other-than-motor vehicle users should defray a part of the cost of the Federal-aid highway systems. That is the reason we of the Bureau of Public Roads are such interested participants in this conference.

Section 210 requires that we shall submit a final report on or before March 1, 1959. This means that any work of this character must be completed and in the Bureau's hands about July 1, 1958 to be ready in time for the final report. It can conceivably be extended two months perhaps to September 1, but further extension will be impossible because there will be the analysis to complete, the report to write, and the need for clearance of the report before it is presented to Congress.

I am going to ask you to think about two kinds of studies that are needed: one, a general appraisal of the meaning and economic significance of highway benefits; the other, measuring the actual effects on the economy of a local area or region, on the generation of business, and on other economic indexes. With respect to the latter type of study—everybody confronted with a research problem likes to "kick it around" for a while and really find out what it is about before getting really going on the job—"work out the bugs," as the saying is—but it looks as if to produce a study for the Section 210 investigation, it will be necessary to utilize tried and true methods of collecting and analyzing data. During this conference, we are going to try to find out what the tried and true methods are.

## Conference Objectives

### Chairman Levin

Mr. St. Clair has indicated a very important objective of this conference in connection with the highway cost allocation studies authorized by Congress.

Bureau and highway officials generally are very much interested in that particular use of highway economic impact studies. There are three or four other rather important uses, some of them longer-range uses. I might quickly mention these additional areas of potential use.

One concerns the hearing requirements of the 1956 Act, in connection with highway projects that bypass or penetrate any city, town, or village. In these hearings, the economic effects of the proposed improvement must be considered. Research of this kind, conducted on an objective basis, would greatly assist these hearings.

A second objective and potential use of this kind of research relates to right-of-way acquisition for the highway itself. Particularly in connection with interstate projects, we are approaching new kinds of situations and new groups. These groups are asking all kinds of questions, as those of you who have undertaken this research today know. In fact, your research has been addressed to documenting answers to those questions. If we had the information available, we would be able to buy right-of-way at a fair value both to the property owner and to the public.

Thirdly, with the findings of research of this kind, highway location and design itself can be "sharpened up" to do a much better job. If we understood and could evaluate the economic impact of highways on communities, urban and rural, on different patterns of land use, etc., these factors could be taken into consideration in highway design and location and highway planning in general.

Finally, community planning and the very pattern of our urban and rural communities themselves could be influenced significantly by this kind of research.

Mr. St. Clair indicated that we are interested in the facts. We have no preconceived notions. We are interested in the losses as well as the gains. We are interested in the dis-benefits as well as the benefits.

The earliest types of research of this kind, in the late 1920's and early 1930's, were undertaken in rural areas in connection with development of improved farm-access roads. We began to do a considerable amount of research in connection with urbanized areas when we accelerated urban

highway activity. There are some who believe that we may have been emphasizing urban economic impact research almost to the total exclusion of the rural. At any rate, we would like to concentrate now on both rural and urban aspects. If we have neglected one or the other, we should try to rectify that.

We would like a free and informal interchange of ideas and concepts here. We are interested in improving techniques; those used in connection with completed studies, those associated with current research, and those which will be undertaken in the future.

As you know, the Highway Research Board has circularized each of you in an attempt to ascertain what problem areas are of greatest interest among the participants in this conference.

Land use is at the top of the list with 23 of the 24 returns received in time for tabulation indicating interest. Next in order of interest were land values, 19; benefit-cost analysis, 13; general economic impact, 13; industrial impact, 12; retail sales, 11; and effect on traffic pattern, 10 (see summary tabulation).

We have mapped out a 4-session approach to the problem. We shall discuss the problem of land values in the first session; land use in the second session; then consider some special problem areas, such as the urban bypass, traffic interrelationships and general economic orientation in a third session; and, finally, the application to highway cost allocation studies in the fourth session.

SUMMARY OF INTEREST IN PROBLEM AREAS  
INDICATED BY PARTICIPANTS

<u>Listed in Original Letter</u>	<u>Total Times Checked<sup>1/</sup></u>
1. Land use . . . . .	23
2. Land values . . . . .	19
3. Retail sales . . . . .	11
4. Industrial impact . . . . .	12
5. Impact on government services . . . . .	5
6. Effect on traffic pattern . . . . .	10
7. Effect on tax ratables . . . . .	6
8. Benefit-cost analyses . . . . .	13
9. Priority determination . . . . .	2
10. General economic impact . . . . .	13
<u>Additional Problem Areas Submitted</u>	
11. Relation to natural resource exploitation.	
12. Effect of traffic on economic impact on areas served.	
13. Migration of workers to new plants.	
14. Influence of highway on plant location.	
15. Use of mass transit.	
16. Effect of limited access on fire districts and related problems.	
17. Effect of limited access on school districts, etc.	
18. Effect of limited access highways on community development.	
19. Population shifts.	
20. Effect on farm real estate market.	

<sup>1/</sup>There were 24 returns. Nearly all contained multiple checks.

21. Public hearings.
22. Land use change interrelations.
23. Area development.
24. Transportation.
25. Effect of substandard design on benefit cost.
26. Freeway impact in residential areas.

# *Session I*

## *The Impact of Highway Improvement on Land Values*

### California Land Value Studies—Research Through Operations Rudolph Hess, California Division of Highways

Before saying anything on techniques, I would like to clarify my position a little. I am with the Right-Of-Way Department of the California Division of Highways. The use of studies of economic impact of highway improvement in California is a very practical one.

I have been sent here in a certain degree of desperation, but in accord with the resolution passed by the American Association of State Highway Officials at their Annual Meeting in Atlantic City in November 1956, to tell what California has done in the way of practical studies and to ask that we get aid and that every other state highway department consider the initiation of such economic impact studies to the extent feasible in each state.

We are involved in a great many hearings. The studies that we made have, in every case, assisted us in carrying on these hearings and disseminating information to the communities before the hearing and during the stages before the final decision hearings.

The underlying reason for these studies relates to right-of-way acquisition. If a right-of-way department is to maintain a sound appraisal procedure to determine the fair market value of property required for various types of highway improvement, it has to have immediate knowledge of the probable effect on any type or piece of property. This research is one of immediate expediency to determine what is to be paid the property owner not a year from now but today.

The techniques have been relatively simple. They have been published in magazine articles, and they have also been presented before the American Association of State Highway Officials. 1/

One of the first problems that needed immediate analysis was that of access-controlled bypasses.

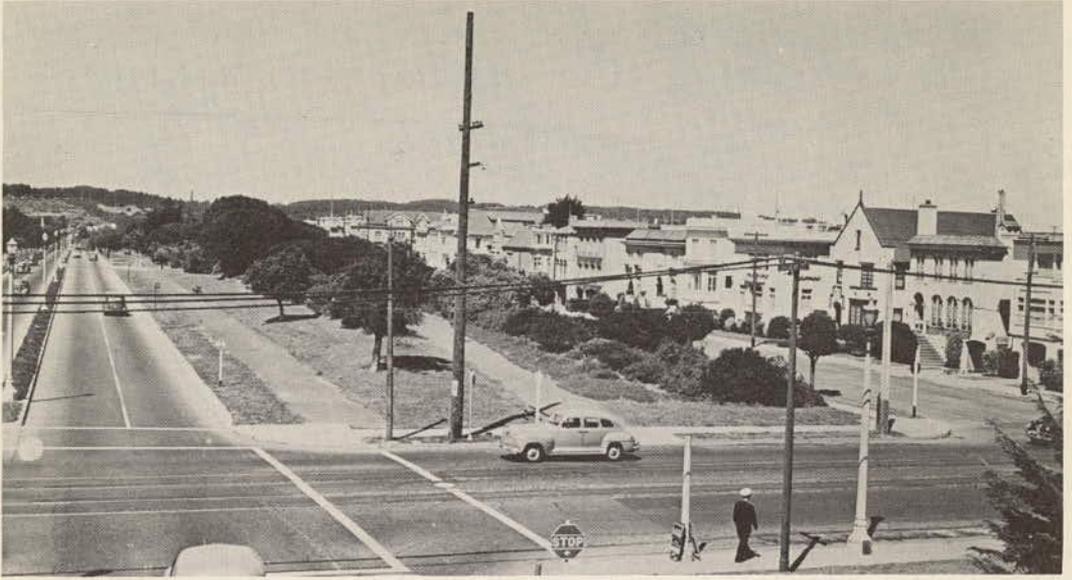
No attempts were made to determine in general the distribution of wealth by reason of location or improvement of conventional or random-access highways.

The basic source of economic data is the sales tax return. This has proven an infallible source of information. Special authority was received from the governor to use all sales tax information, as long as the studies were presented on a percentage basis and did not reveal to the general public the fluctuations of any specific enterprise.

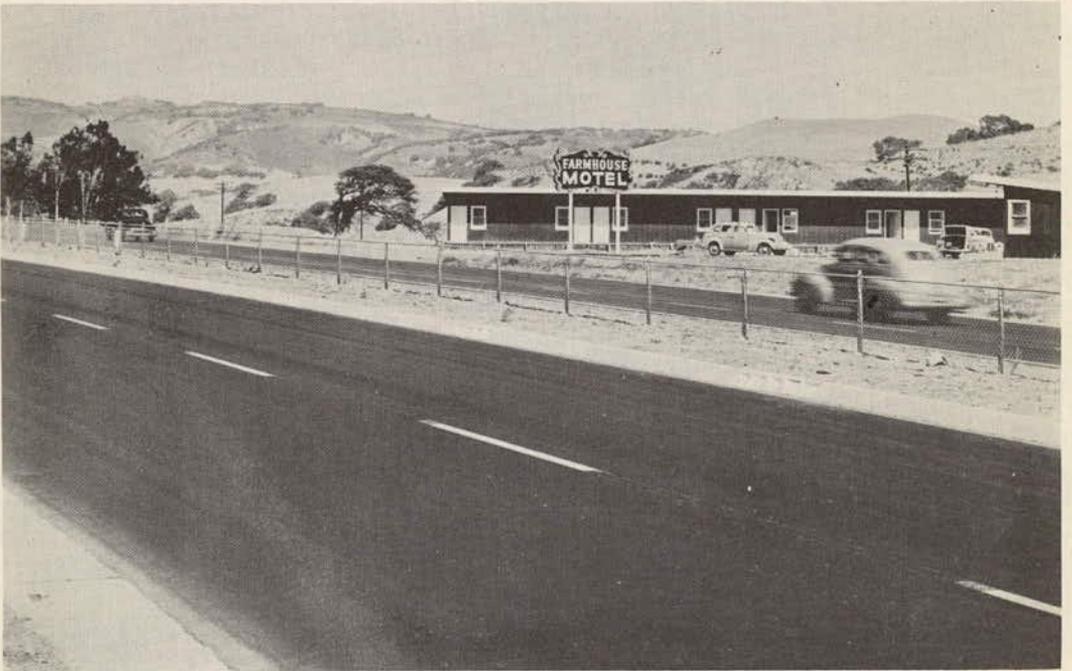
With this source of material, studies have been made of some twelve

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1/"Techniques of Making Highway Economic Impact Studies." A paper presented before the Annual Convention, American Association of State Highway Officials, Seattle, Wash. (November 1954).



A section of Park-Presidio Boulevard in San Francisco, Calif. This residential area, fronting on a boulevard with park-like characteristics, has been the subject of special economic study in California.



Expressway at Buellton, Calif. A segment of economic impact research in this state has involved motel operations such as this.

cities. The usefulness of personal interviews for this type of research has also been explored and it has been proved that the personal interview as such has not contributed much to a sound study in California. The sales tax returns or some such source of information, rather than personal opinion, is much more effective.

The second type of studies has been on land values adjacent to free-ways. Available sales data both before and after the highway improvement have been used, with an attempt in every instance to get resales of identical property. This is a continuing study, one that is simple in technique but effective in use.

Some of the data on these properties are particularly useful to the appraisal sections in the everyday work in right-of-way acquisition. In fact, the data are the basis for all appraisals as they pertain to compensation for land and improvements taken and any damage to the remainder. Every highway department probably has insufficient information on the damage factor on properties. In fact, we have begun to feel from the data gathered to date that the damage concept, as such, is erroneous as approached from the appraisal process. The appraisers are continually looking for damages rather than benefits. The California studies have indicated very little in the way of damages and a great deal in the way of benefits.

For research on a long-range program, we are well aware that this may extend over an entire area. For immediate application however, the use of sales data provides a simple technique that is invaluable to present at these hearings.

An indication of the necessity for this type of immediate research by the highway departments is contained in a recent conversation with a highway commissioner in Los Angeles. He asked for some information that could be presented almost immediately at a hearing on the effect of controlled-access highways on adjacent residential properties. Fortunately, we had just completed a rather extensive study of residential properties throughout California, including catalogued interviews for more than 1,000 properties, but only those adjacent to the freeways on which there have been resales were used for this particular purpose.

As a basis for the analysis, 540 adjacent residences were found. They were identical with non-adjacent properties within the same sub-divisions, and were sold in like manner and at the same time. The same typical pattern was found throughout the state in each of the studies. This type of material provides a practical application to a current problem.

## **Washington State Studies**

**William L. Garrison, Department of Geography,  
University of Washington**

Three studies sponsored by the Washington State Council for Highway Research and the Interim Committee on Highways, Streets, and Bridges of the state legislature were undertaken over a three-year period. The studies as a whole were in response to a variety of problems posed by highway improvements and the tax situation in the state. These studies were summarized at the 1957 Annual Meeting of the Highway Research Board by R. G.

Hennes 2/ and are reported here in Appendix E.

One of the studies was undertaken by Professor Bayard O. Wheeler, Department of General Business, University of Washington. He was concerned with the impact of urban expressways on urban land values. Another study, undertaken by the speaker, was concerned with the impact of improvements in rural areas.

Land values were studied in order to determine what happens when one changes the road situation in an area. Land value measures are attractive for highway impact studies because there are in land valuations actual measures of how persons have placed value on land as a result of the road situation. As the road situation is changed, land values may change; thus, there is a measure of the value or "benefit" of the change in the road situation.

The urban study was concerned with the effect of expressways on urban land values. 3/ It is common knowledge that land receives dramatic benefits when expressways are built. Perhaps these gains could be a source of finance for the building of these very expensive facilities. At any rate, knowledge of benefits gives information on the benefit situation within which road improvements are made.

The study proceeded by analyzing the general structure of land values in the Seattle urban area prior to the building of the Lake Washington floating bridge, then making a study after the bridge was constructed to see how the pattern of land values had changed. The bridge served as an approximation of "the expressway." The pattern of values in the city has, of course, changed. There is no question but that improved access to the Seattle area through the building of the bridge to the east and the opening up of new lands tributary to the city center have had vast effects on these changed land values. The study served to trace these out.

The study relating to rural road improvements had somewhat different dimensions. 4/ In Washington there are a variety of rural landscapes. One case is the typical metropolitan area-rural landscape, where the city is sprawling outward over the countryside. Here the rural landscape is changing, farms are changing into suburban property. The improvement of roads quite obviously can accelerate or decelerate these changes. One study dealt with rural areas subject to such urbanization.

Another rural study was concerned with an area of extensive wheat farming because these farms form another important kind of rural landscape in the state. The third kind of rural area that was studied was one of oasis farming; specifically, an area of apple farming near Wenatchee.

Each study proceeded by observing a series of land values and then

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2/Robert G. Hennes and W. W. Mylroie, "Allocation of Road and Street Costs, State of Washington," and R. G. Hennes, B. O. Wheeler, and W. L. Garrison, "Washington Highway Economic Studies." Proceedings, Highway Research Board, (1957).

3/Bayard O. Wheeler, "The Effect of Freeway Access Upon Suburban Real Property Values." Washington State Council for Highway Research, University of Washington, Seattle, Wash. (1956).

4/William L. Garrison, "The Benefits of Rural Roads to Rural Property." Washington State Council for Highway Research, University of Washington, Seattle, Wash. (1956).

interviewing persons who resided on the subject land. Interviews were made to obtain data on road use.

The next step was to apply statistical techniques to associate the position that the studied parcels of land had on the road system (this position defined in terms of road use) with the land value structure of the area. In each of the three study areas the road system was divided into three types (hard surfaced roads, gravel roads, and dirt roads) and property values were associated with each of these road types.

The chief techniques used in the Washington studies were the travel interview, which has been highly standardized and is known to be reliable; data from public sources, for land values; and standard statistical procedures, used to determine associations between roads and their uses and property values.

The paper "Obtaining Data for a Highway Impact Study" (See Appendix E) elaborates the remarks just made on the way data were obtained from public documents and interviews. "Statistical Analysis of a Road Improvement Impact Problem" (See Appendix E) deals with the rural studies and explains the kind of statistical model that was employed for the estimation of associations. There were several difficult estimation problems. Originally we had only primitive and intuitive notions about road uses in rural areas and how road improvements might change road uses, and thus the values of places served by roads. Because of this lack of a priori knowledge we needed a statistical model that could be used in a "fishing expedition". In other words, what was wanted was a model that could be applied in different circumstances in different ways to try to find best approximations. The model developed fitted that requirement. Different functions were tried to describe the way land values change with road changes until functions that would fit the data were found.

Another subject in the paper on the statistical model that is of particular interest is the discussion of methods used to verify the model. The fact of changing the road system may very well change the system of behavior (that is, how roads are used) that generates land values. This is a complicated problem.

The third paper, "A Source of Theory for Highway Impact Studies" (See Appendix E) discusses the problem which was the chief handicap during the studies. There were no "sharpened" statements (theory, intelligence, or a priori knowledge) directly related to the kind of problem under investigation. There was no guide to tell what the situation ought to be; nor how to relate experience of previous researches. This short paper is a statement of the highway impact problem as one of relationships among locations. A bibliography attached to that paper brings together materials from location theory to serve as a systematic source of information to guide highway impact studies.

### **The Dallas Expressway**

**William G. Adkins, Texas Transportation Institute,  
Texas A and M College System**

A study of the North Central Expressway of Dallas, Texas, is now being carried out. When this work was begun it was hoped that someone else had done such a study so that there would be available a worthwhile base to improve upon. It was found, however, that apparently no one had done such

a study as well as had been hoped for.

The first objective of the study was to determine changes in market value both of properties in areas presumably affected by the Dallas expressway and in non-affected areas. Those familiar with the Houston-Gulf Freeway study recognize here a common objective.

The second objective was to determine changes in tax valuations in affected and non-affected areas. The term "valuations" is used because these are true values or appraisals, rather than just assessments which might be a changing proportion of the appraised value.

The third objective was to determine changes in land use in affected and non-affected areas. It was felt that this should be limited to general land use as it might be reflected in value of improvements added, etc.

The fourth objective was to determine incentives for business and residential location along the facility. Persons who were located on properties abutting the expressway were interviewed. Information was obtained on number of employees of businesses and the general attitudes as well as incentives. The interviews did not extend beyond the abutting band of properties.

One factor that has pervaded our thinking is that insulation between properties and expressway influences builds up rather quickly, especially in high-density residential areas. In an established residential area there is perhaps some immediate influence from an expressway, but after the first few tiers of lots a measurable influence may disappear altogether.

A problem that requires further attention in the study of economic impacts of roads is that of delimiting the areas of influence of such a facility. In the Dallas investigation a 5.4-mile stretch of the expressway was chosen for detailed study. This section was chosen because of the desire to limit the research to an urban area, and this was the only urban stretch that had been completed for a long enough period to have brought about appreciable land use change.

An attempt was then made to determine affected areas along the 5.4-mile section. First we sought to find out what effect the expressway may have had on certain types of travel. Roughly, this was done by calculating time savings in travel to downtown Dallas from a large number of locations, all major thoroughfare intersections, as far out as expressway use resulted in time savings over the quickest non-expressway route. Time savings data were then converted to "route preference" lines by the use of an empirical curve of the relationship. 5/

One route preference line was drawn along which 50 percent of drivers to downtown Dallas would chose to use the expressway. Other lines showing 60, 70, 80 and 90 percent preferences to use the expressway were interpolated. Each particular line, however, outlined an area to broad for detailed study. Other methods using travel times were attempted without an improvement of results. The 50 percent line later was used in that control areas are located outside of this line.

The subsequent decision was to study abutting properties as one distinct type. Then, to broaden the base for comparison, behind this initial

5/The curve used was from "Effect of Travel Time and Distance on Freeway Usage," by Darel L. Trueblood. Highway Research Board, Bulletin 61, p. 18.



A portion of the Gulf Freeway as it approaches the four-street system at Houston, Texas. Note the extensive and substantial private development along the expressway. A fifteen-year study of land values and land uses along the urban portions of the Gulf Freeway has just been completed under the sponsorship of the Texas State Highway Department.

band about a two-block strip on either side of and parallel to the facility was studied. After further consideration it was decided that a third band was needed to extend the base for comparison.

Next in order was the selection of "control areas." These comparable areas ideally should be so far removed from the expressway that it can be assumed that its economic impact would not be measurably felt in them. Thus they would afford a standard for measurement of the impact of the expressway on affected areas.

The control areas were selected by consulting with tax people and realtors, plus other persons that were thought to know Dallas well. They were asked to look back to 1941, which was the first year of the base period for this study, and try to pick areas over the northwest and northeast quadrants of Dallas that, in many attributes, would have been comparable to what had existed along the expressway route before it was built.

Other factors besides general location were checked. The persons who were suggesting the comparable control areas were asked to keep in mind their distance from downtown, the presence of a railroad, racial islands, approximate time of development of these areas, and of improvement for the properties, the types of properties, zoning regulations, and other related factors. Old maps were also checked, but were found to be of limited value.

A number of independent opinions were obtained as to what areas would compare with the study areas along the expressway, and from the consensus, fifteen different areas were picked.

In the choice of these control areas the findings can be materially influenced, but care was exercised that the biases were removed or resolved insofar as they were recognized.

It was decided to use tax records, not only because one of the objectives was to see what advantage was taken of increased land values for tax purposes, but also to serve as a second index of values and to furnish gross measures of land use changes.

Confidence was lacking in real estate sales as an index of value, especially for small areas. For example, in dealing with a very small area and a very small number of sales, sizable errors can creep in purely by chance.

Some of the sales information came from Dallas County plat books; the prices paid were verified in warranty deed records. On those deeds not giving sales prices, the upper limits of prices, as calculated from internal revenue stamps, were used.

The tax appraisal data, or true tax values, as they are called, were obtained from city tax records. Since they are tax appraisals, not assessed values, no manipulation was required.

The permissive uses were obtained from the city zoning map. Land area was taken from the county plat books and verified in the city tax records. Information of incentives and location for attitudes toward the facility were obtained for abutting properties by interview. Sales prices for inflation were adjusted by using a dollar value index of consumer prices for Dallas.

Attempts are being made to adjust sales for variations in improvements by the technique used by Elder in the Gulf Freeway study. The technique

was to take the improvements evaluation for tax purposes, apply a construction cost index factor to it, and subtract this product from the sales price. The remainder was then considered to represent the price paid for land only. This technique, although it adjusts for variations in types of property that are sold, probably does not give a remainder that represents the price of land alone.

The amount of statistical work involved was insurmountable by hand; therefore, the magnetic drum calculator was used and a method worked out whereby all the methods that were applied to sales information were used in one quick operation of the machine.

## **Farmland Values of the U. S. Department of Agriculture** **William H. Scofield, Agriculture Research Service,** **U. S. Department of Agriculture**

The rural studies carried on by the Department of Agriculture have been primarily in cooperation with the state agricultural colleges, usually employing people with training in land economics. Currently being planned is a series of studies in the Great Plains area, on a sample of about 35 counties, in which graduate students will be used for field supervision of enumeration. This will be an interview survey in which sellers and buyers of farm property will be contacted. Apart from this survey the Department has a continuing research project, in which estimates of farm real estate values submitted three times a year are compiled and analyzed. These are subjective estimates made by farmers as to market values in their localities. In some areas these estimates reflect such market factors as location and non-farm use, in addition to agricultural value. They are useful for measuring general movements in market values by states and regions, and may have some utility for rights-of-way valuation problems.

In the regular research work no specific studies have been made of the impact of highways upon the values reported, but we have been increasingly aware of such influences through reports obtained from the local reporters. These reporters incidentally, are dealers, local brokers and abstractors who report regularly. For instance, when the Ohio and Indiana turnpikes were being built, reports were obtained on the impact of those highways upon rural property values extending north and south from the highway as farmers attempted to relocate themselves on other farms. In fact, the last survey (November 1956) contained a specific question along this line. About a third of the reporters said they had observed some non-farm influences operating in their local areas. Such influences are largely concentrated, of course, in the Southeast, the East and the West Coast, with low incidence in the Central Plains and Central Corn Belt areas.

A report, "Current Developments in the Farm Real Estate Market," is prepared three times a year on these general trends.

The question arises as to what extent we are limited in our thinking by measuring only the changes in values that have occurred up to the date of a study. There is a flow of benefits being created by highway programs which should be recognized. Many of these benefits are yet to be realized and will occur over an unknown number of years in the future. People are generally slow to readjust their concepts of value, certainly of farm property. Among farm people it may take a number of years before the full economic significance of a highway is appreciated and is translated into rural property values.

It also takes the actions of a good many other people, with respect to plant locations and uses of lands along highways, to create a new level of values in a farm community.

Local people use essentially the comparative method of evaluation. They observe what the other properties have sold for. They compare theirs with them, and they arrive at some judgment as to what they will ask or pay for property. We are trying to determine the actual valuation procedures followed by sellers and buyers in the Great Plains study, through analysis of about 1,000 transfers that occurred in 1956.

There is another potential for research in this general area in the census of government projects that is now getting under way. In this census a sample of possibly 200,000 transfers of all kinds of property will be obtained. They are concerned primarily with investigating price and type of transfer and whether or not it is a bona fide transfer. It is hoped that the farm sales that fall in that sample can be separated and followed up with another questionnaire in which could be included such factors as location with respect to type of highway.

### **Montana Farm Property Study**

**Maurice Taylor, Associate Professor, Agricultural Experiment Station, Montana State College, Bozeman, Mont.**

A brief study of rural land values was made in Montana in connection with the improvement of a particular secondary road. The method was rather crude, and the degree of validity of the conclusions is unknown. In most of the rural areas of the state which had significant highway improvements, a scarcity of sales data was found. In the particular area not a single farm had been sold since the development of the highway about three years prior to the study. Therefore, use of another method was required—a method that might be called an opinion survey.

We contacted every farmer in this particular area in which a road had been improved from rather primitive standards to a surfaced road. The estimates these people gave indicated a land value increase in the development of the highway of about 12 or 13 percent. This amounted to something like \$12,000 or \$13,000 per farm.

These people also were asked to give estimates of cost savings in transportation and operation of their motor vehicles.

Approached in this way an capitalized, cost savings amounted to something like \$3,000 per farm. Therefore, from the standpoint of cost savings alone, one cannot justify the highest increase of \$12,000 per farm as reported.

### **Discussion on Land Values**

In reporting on the studies made in Washington State, Mr. Garrison had said that perhaps we had erred in confining ourselves merely to studies of "the indicators of the effects," such as land values, whereas changes in land values result from changes in the behavior of people affected by highway improvement. Chairman Levin asked Mr. Garrison how this basic problem—the effect of highway improvement on people's behavior—could be studied. Mr. Garrison recommended studying how property values were

determined on the market, the factors that enter into competitive bidding for locations.

#### NEED FOR THEORY

Mr. Garrison suggested that best utilization be made of information available, but emphasized that "... the crying need is for sharpening of theory." This would enable us to approach the problem more effectively. This point of view was supported by Mr. Carroll. As he phrased it "... when you are talking about research, ... you are thinking about something that accumulates and falls into a framework ... the cumulative effects of these several parts really get nowhere unless the theory is perfectly constructed." He thought development of theory to be the only efficient approach, even though it takes time. He pointed out the danger, for example, of attributing increases of land values solely to highway improvement, which may not be warranted by the facts because many other influencing factors might have been present.

Mr. Garrison's opinion was that we have a rich storehouse of techniques. The problem is lack of knowledge as to what to do, therefore we don't know which technique is appropriate.

#### PRACTICAL PROBLEMS AND THEORETICAL APPROACHES

Discussion prompted by the paper on the influence of the Dallas freeway revolved around the practical uses of these short-run studies, and the need for more theoretical economic and social investigation. Mr. Morf, said we are actually dealing with two kinds of problems. "In the first place we were required to establish (and in urban areas within very narrow limits) the location of an interstate system as of the first of January. That is primarily a location problem, which we hope can be rationalized in terms of these values." Thereafter comes the burden of acquiring rights-of-way, which tests the validity of the empirical values used in location.

The other problem, according to Mr. Morf, was the "more long-range rationalization of the philosophy behind these changes." He did not view the two objectives as mutually exclusive, but pointed out that the practical operating problems had to be solved today, whereas the rationalization will require a longer period of time.

#### INFLUENCE OF ACCESS POINTS

Mr. St. Clair brought up the questions of the relationship of access points along an expressway to land values. He expressed the opinion that the distance from an access point is more important than the mere condition of abutting the expressway. Mr. Adkins agreed that this was a logical assumption for rural areas subject to immediate urban development, but had not been apparent in Dallas where the character of original settlement seemed to be more important. In Dallas, however, along the Central Expressway, frontage roads exist along almost the entire distance. Adkins said that no special effort had been made to study areas for a greater distance at the interchanges than was done generally along the expressway.

#### PRACTICAL USES OF LAND VALUE STUDIES

Mr. Taylor raised a question as to the practical uses of land value studies. If we possessed a formula which would measure the effects of

certain kinds of highways on land values, what use could be made of it? Could land value studies, for example, help Montana find ways to finance highway construction?

In reply, Mr. Adkins pointed up the operating applications of the studies—aid in highway location and design public hearings on bypasses, right-of-way acquisition, and community planning. In relation to financing, he referred to the Chairman's statement that roughly \$6 to \$7 billion for rights-of-way would be spent for the federal-aid system over the next 13 years. In this area, he thought that the "... research might really pay off."

Potential savings through economic surveys were emphasized by Mr. Waters, who stressed the need for conducting economic surveys in the selection of highway locations where potential traffic would justify the expenditure, and where such locations might make a maximum contribution to the economy of the state. He pointed out that railroads were now abandoning some right-of-way in places where the traffic no longer provides revenue sufficient to justify operation. He presented a brief paper on techniques to be used in a series of economic surveys to be made in Oklahoma, including a proposal for a new controlled access route from Oklahoma City north to the Kansas line. <sup>6/</sup> Included in the paper was a proposal from the director of the Oklahoma Bureau of Business Research; recommending the use of multiple and partial regression analyses to evaluate the role of highways in general economic development. This is essentially the method used in Washington State as reported by Mr. Garrison.

Mr. Waters emphasized the public relations aspects involved in the selection of highway locations, especially of bypasses. Among the points suggested in the conduct of public hearings were:

1. Sending out form letters inviting important local officials and important personages to the hearings.
2. Using the excellent opportunity provided by the hearings to inform the public of technical problems confronting the highway department.
3. Discussing the economic development of the state and the relation of highway improvement to it.
4. Informing the public of the research and work that goes into the building of a modern highway.
5. Holding the hearings in a public place, such as the county court house.
6. Using material from other states on benefits from new highway construction.

#### RESEARCH PERSONNEL

At this and other sessions of the conference considerable concern was shown by participants with respect to obtaining adequate personnel to complete the contemplated studies. Manpower and money were regarded as the two fundamentals needed to assure that the required work would be done.

Mr. Scheick asked what kinds of talents were used in making land value and other economic impact studies. The most frequently mentioned skill (Adkins, Scofield and Garrison) was that of the land economist. Mr. Hess

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<sup>6/</sup>A paper prepared by Jerome J. Waters, Jr., Assistant Engineer, Economic Survey Section, Oklahoma Highway Department.

stated that California used appraisers, and junior right-of-way agents with college background in economics or business administration.

Other sessions brought suggestions of such professional groups as the American Economics Association, the Farm Economics Association (Stewart), possible foundation aid (Ackerman), state highway department right-of-way personnel (Hess), operations research teams (Roy), advisory committee on a national basis (Stewart and Wehrly), and regional conferences among interested parties (Wetmore, Steele, et al.).

#### PRIORITY DETERMINATION AND ECONOMIC IMPACT

Mr. Wetmore pointed out that many decisions of far-reaching consequence must be made in a highway improvement program. Among these are questions of priority in improving particular highways or sections, final determination of the nature and location of interchanges, and construction of frontage roads. These decisions could affect the development of areas and encourage redevelopment where it might or might not be economically justified. He implied that economic impact research would yield better decisions.

#### USE OF OPERATING DATA FOR RESEARCH PURPOSES

Mr. Hess pointed out that under the present federal-aid program pre-negotiation appraisals are required, which will provide background material for research on land values. For years California has gathered materials on sales to justify land acquisition. He recommended that each state review its appraisal section, assemble materials, and go on to make economic studies.

He thought that the need for additional money would be slight. Describing the California expenses, he stated:

"With this source of material, in the ten years that we have been keeping track and making economic studies as best we can, the funds expended on all of the things that we have published to date have been under \$100,000."

Directing his attention to the matter of personnel, Mr. Hess said that California used its junior right-of-way staff to collect field data. This use of operating personnel trains them in the appraisal field, and the expenditure involved is not for research purposes alone.

#### HIGHWAY IMPROVEMENT AND FARM LAND

Mr. Stewart made several observations on the relationship of highway improvement to farm land values. The early sharp increase in value subsides as highway facilities multiply. The same comment applied to land values in general was later made by Mr. Zettel. Mr. Stewart also said that highway impact will vary with the type of farming. Dairy farming, for example, which requires frequent deliveries, will be more affected than cash grain farming.

#### RESEARCH SUGGESTIONS

In Mr. Stewart's opinion, existing shortages of qualified research personnel would be a more serious obstacle than developing research techniques. He suggested that the importance of the economic research projects

might cause some existing research projects to be set aside in their favor in colleges of agriculture. He also suggested attendance of highway representatives at regional meetings of farm economics groups to interest them in the cause.

Mr. Wetmore recommended that a broad statement of the problem would attract more participation, particularly among persons concerned with the major problems of land use.

Mr. Kanwit emphasized the need for careful interpretation of cause and effect. He pointed out that the discussion thus far had been concerned largely with statistical techniques rather than with analysis, and that the value of the studies would hinge largely on the validity of interpretation. As an example, he pointed out that the movement of residential values in the postwar period had been narrowed by FHA and VA appraisals so that ease of sale as well as dollar value must be considered in the interpretation of the effects of highway improvement on property values.

Mr. Steele, speaking in his position as coordinator of the benefit studies being conducted by the Bureau of Public Roads, said:

"The Congress of the United States has looked at our entire highway program from the standpoint of nationwide values; that is, not only the values that the program is supposed to bring to motor vehicle users, but to other beneficiaries as well. You might say, then, that our interest is at the broadest possible level, and, except for the time limitation that has been imposed upon us, it would be at the longest range level.

"On the other hand, at the state level...there is an immediate problem of acquiring right-of-way in connection with a program that is already under way, and attempting to do the best job we can in planning and designing this highway network.

"It does seem to me that we can bring all of these objectives together...we ought to be thinking not just of the specific studies that are outlined here...but also of those that the members of the American Association of Highway Officials had in mind when they proposed this meeting.

"I don't believe that the objectives are at all in conflict...we can come up with some studies that can be completed to a large degree in the time that we can have available and that would help us in the studies directed by the Congress under the Highway Revenue Act of 1956, and also help the state people, particularly in connection with the planning of the interstate program, and more widely in connection with their planning of tax programs."

The session on land values concluded with comments by Mr. Holmes, who expressed satisfaction that the meeting had brought out so many aspects of the problem. He pointed out that although land acquisition, location, and public hearings problems are before us today, the requirement for the broader analyses of benefits written into the Highway Revenue Act by the Ways and Means Committee is also before us now. The preparation of the report and the presentation of it to Congress "...will very likely have some far-reaching effects, and they may be felt very soon...We don't have very much time."

## *Session II*

### *Impact of Highway Improvement on Land Use*

#### Measuring Land Use Change Along Route 128, the Boston Circumferential Highway

A. J. Bone, Massachusetts Institute of Technology

Route 128 in Massachusetts is a facility whose impact has been widely discussed. This route provides a limited access loop around the congested Boston area. There have been several articles concerning that facility: "Industry" published an article in June 1955; and "Engineering News-Record" of October 13, 1955, and "Business Week" of May 14, 1955, both carried short stories relative to the spectacular industrial growth that is taking place there.

However, the Massachusetts Department of Public Works wanted to make a research study of the impact of Route 128 and obtained the assistance of the Massachusetts Institute of Technology.

This work is being financed by a grant from the Massachusetts Department of Public Works, matched by federal-aid funds, and is being done within the framework of the Joint Highway Research Project established between the Massachusetts Department of Public Works and the Massachusetts Institute of Technology.

Route 128 describes an arc around Boston at a radius of about 8 miles, with an extension to Gloucester. Such a route existed for a long time, but it went through nearly every congested center in the suburbs and therefore was not of much value as a bypass around Boston.

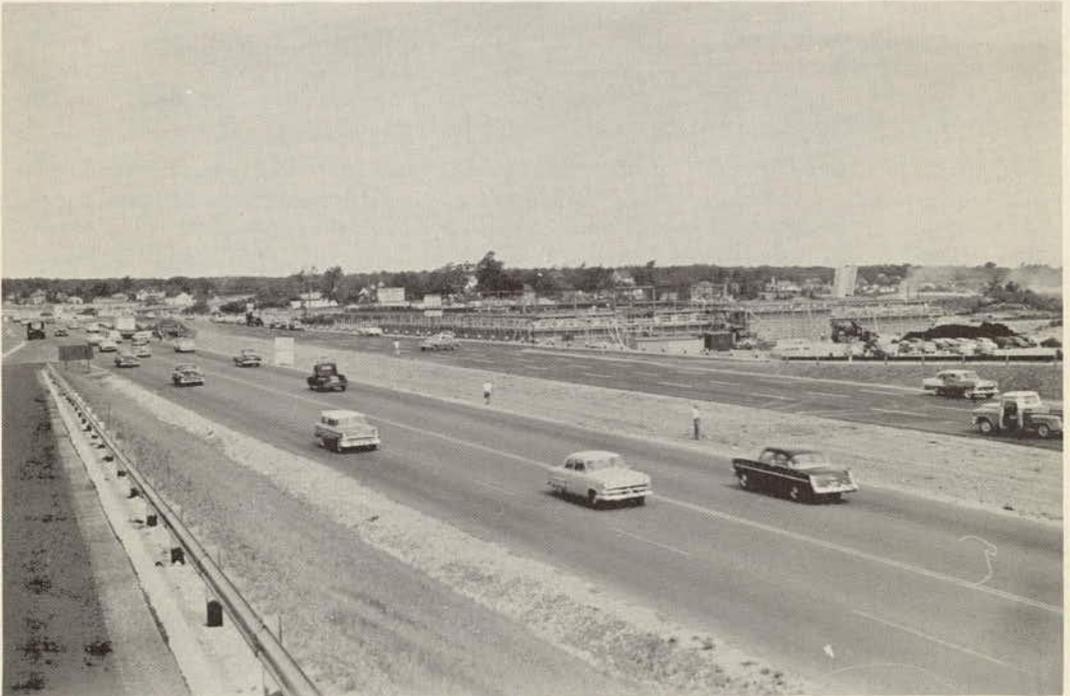
Starting in 1936 and still continuing, this road is being rebuilt as a limited-access 4- and 6-lane highway on a new location. The new location was placed in the nearest fringe of undeveloped land adjacent to the suburbs. That fringe of undeveloped land was the potential area of urban decentralization, but probably no one was quite aware of that at the time Route 128 was being planned. Two unforeseen things happened when the road was opened. First, about three times as much traffic appeared as was forecast; second, there was a rapid growth of industrial plants along the highway. An actual count shows that 65 new industries located there within the past few years. And this is only the beginning, because many tracts are being acquired with the idea of developing them into industrial or shopping centers.

Access to the road is only by the interchanges. Being a "free" road, the interchanges are quite close together at places, averaging perhaps two or three miles apart. In one instance—only one so far—the pressure of new industries has brought about a new interchange. Additional interchanges, of course, might adversely influence the efficiency of the road.

These developments along Route 128 are obvious to anyone who drives along this highway. One of the problems will be to determine to what extent the highway was responsible for these developments, or to what extent



A typical view of industrial development adjacent to Route 128, in the vicinity of Newton, a circumferential expressway in the Boston Metropolitan Area. The economics of this highway facility have been investigated in piecemeal fashion but a comprehensive study is now being sponsored by the Massachusetts Department of Public Works at the Massachusetts Institute of Technology.



Another view of Massachusetts Route 128, showing adjacent commercial development under construction at Dedham, Massachusetts.

the developments might have taken place in this area anyway. Much of the area was rocky and swampy, and it seems unlikely that the development would have taken place had the highway not been built there.

The efforts of certain promoters have been an important factor. They came in early, bought up the land, and offered package deals to individuals --making it quite attractive for them to locate there. Other promoters are still beginning to enter this activity.

The method of attack so far has paralleled that described by Mr. Adkins for the Dallas study. We are working with the cities and towns, because their governments in Massachusetts possess most of the useful information. Afterwards, we will have to assemble the data and try to see to what extent the highway has influenced growth.

In the town of Needham, for example, a new industrial center was opened and has now nearly reached saturation so far as available industrial sites are concerned. The net values created, minus cost of the improvement, have amounted to a savings of about \$5 per \$1,000 of evaluation on all taxable property in Needham in 1956.

### **The Chicago Transportation Study** **J. Douglas Carroll, Director** **Chicago Area Transportation Study**

In the Chicago Area Transportation Study an attempt is being made to simulate, in model form, an entire metropolitan area, so that it can all be "remembered" on a computer in a very crude way. The operation consists of two parts: all of the land use of the metropolitan area is recorded and its transportation network also is recorded.

The economy of the area and the population are going to grow. But the shape of the growth is affected by the location of the transportation utilities. It is hoped, by manipulating this on a computer, first by revising locations and capacities of the network, to see what the consequences are in terms of land use readjustments. On the other hand, it is planned to examine land use growth potential to see what effect it has on the location of the highway network. We hope that these studies will yield some measures of the related effects of road improvements on land uses and, thus, land values.

In terms of total benefits, the problem is an interesting one. The benefits are calculated by simulating traffic flows through the road network and calculating the direct costs for building and the user's costs after each improvement has been added. If only one highway or one rapid transit route is built, the benefits accruing to the users from that particular facility would be very high, because of the low quality of competing facilities, that is, the benefits per unit of cost would be high.

As another piece of the network is added, the incremental savings due to the second facility would be slightly less per mile than the first one was; and so on, until the network is completed.

Now, the problem is how large a network to construct. Should one build to the point at which the gross benefits are exactly equal to the gross costs? At this point, we have perhaps substituted highways and transportation for health and welfare and other similar things. Obviously, we don't go all the way; we stop at some intermediate point.

This is really a question of criteria for the allocation of limited resources in order to arrive at a transportation system which has benefits of a particular magnitude in proportion to the outlays involved.

We don't know the answer to this. We have only come to this position by starting with benefit-cost studies and discovering how inadequate they are to give the complete answer. In these analyses the service of the facility is compared with its investment cost, thus you can see what you are dealing with in a limited framework.

The early studies done in California compared the actual cost of driving over a mile of expressway as compared with driving over a mile of city streets. They showed that expressways were something like two and a half times as efficient in terms of direct user costs. We all recognize, however, that those who use an expressway must also use additional portions of city streets to get on and off it; moreover, persons using expressways travel farther to reach the same destination, so that the appropriate consideration must be the whole journey—not just one mile on expressway as opposed to one mile on city streets. Therefore, we began to measure the entire cost of the trip over the alternate routes.

This really did not give an immediate answer to location problems because when the entire benefit-cost picture was assembled it was found that it did not measure the effect of relative location. A shift in the location of one route might, in effect, reduce the vehicle miles of travel, but what the shift in location would do to the balance of the network could not be determined without a tremendous amount of new calculation.

Moreover, one link in a highway system might make all the others more productive because it provided greater route choice and longer stretches of freeway to drive on. The ultimate answer could really only be achieved by the crudest kind of calculation in which an entire design was tested against the growth of the community at a mid-point in its development. It became a self-defeating problem to consider doing this by conventional methods.

We are attempting a unique experiment; namely, to relate the entire land use pattern envisioned to the entire highway network through use of the memory device of the electronic computer, and then to measure the actual costs to the driver of using various alternate routes of travel.

As far as the indirect benefits go, we have not been able to measure them. We do have a means of calculating the mean accessibility of every point in the metropolitan area in terms of time and distance to every other point in the metropolis both with and without this network. It is our assumption that as this accessibility enlarges, or as time-distances shrink, we thereby increase the benefits to each site in the metropolitan area. This represents a social benefit, but we don't know yet how to measure it.

### **Method of Analyzing Agricultural Land Impact**

**Charles L. Stewart, Department of Agricultural Economics  
University of Illinois**

Let us begin with a concrete situation of the economic impact on agricultural land. I am thinking now of high-priced cash grain land in the middle of the cash grain area. Here are broad 200- to 300-ft highway rights-of-way located through the center of the land sections and avoiding

the section lines rather consistently. There is a great deal of concern as to what effect this may have. In one community, for example, there is quite a struggle as to whether the highway should go east or west of town because of its potential impact on agricultural values.

People who feel themselves more or less displaced, because their places are cut into segments by highways, are tending to take their indemnities and try to acquire property elsewhere. Since they have been doing that on a narrow market—and we probably have never seen such small offerings as there are at the present time—we have seen an increase of something like \$75 and acre in the price of land.

In Champaign County, Illinois, during 1956 we didn't see the shrinkage in the net returns from farming that we have seen in previous years, partly because of almost perfect weather and partly as a result of the use of present and prospective funds to buy land at some distance on the part of the persons practically displaced from certain tracts of land by highway development. I do not think that it is going to modify the land-use pattern greatly, but it is going to have an upward influence in the price of land, largely because of the scarcity of land offered for sale. Farms are being enlarged, and it is only as people are willing to bid up a segment of a farm, to add to what they have, that they can get some relief from the high cost per unit of product experienced in small acreages. Because of this trend toward larger farms, land values have become very sensitive.

With respect to measuring the impact of highway improvements on land use in agricultural areas, there are two major approaches, both quite standard. One would be to make a study in terms of the characteristics of the farms that are sold, reducing them by indexes so as to apply correlation analysis. Another method is to work with comparable areas. The comparable-area approach has been found to be as fruitful as the correlation analysis approach.

### **Alternatives Confronting the Highway Planner** **Louis B. Wetmore, Department of City Planning and** **Landscape Architecture** **University of Illinois**

There are some significant alternatives in the kinds of road systems which might be built. As we look at the rate at which this nation has been growing for the last 10 or 15 years and which gives promise of continuing, consideration of what might be called minor adjustments in this total system is not realistic. If we are talking about doubling the total economic activities of the many sizable metropolitan areas (introducing new units into the metropolitan constellations as smaller areas grow to this size) we get into real questions of choice among the alternatives to be faced as to the kind of highway or street systems that would give the best service.

In many areas land is a key resource and there is a serious question as to its capacity to meet out total needs. We already know that land for industrial purposes is very scarce in a great many areas. In many cases, use of land for highways or for urban uses is in competition with agricultural use. Increments of 10 percent can be handled but increments of 100 percent cause serious problems and pressures.

Many metropolitan areas are tending toward very low densities in new residential development. There is a question as to how long this trend toward lower density patterns in housing may continue despite what people may want. Other limitations may produce a different density or distribution pattern 20 years from now and give us quite different considerations as to the kinds and spacing of street systems that would be required. Even as we look at present trends in distribution, we have significant alternatives in the way in which we might direct the rapid development in our metropolitan areas. Yet only cursory attention is being given to these alternatives and to the ways in which the highway systems might be shaped to support a selected pattern of metropolitan area growth.

**The New York Thruway Beckons Researchers**  
**F. William Davidson**  
**New York Thruway Authority**

Basically, I am here as an observer. My field is public relations and public information. I do know, however, of something like \$400 million in capital investment along the New York Thruway route. Granted that this may not be a net gain for our state-wide economy and that much of it might have come to New York if the Thruway never had been built; but tremendous projects and developments have been created only because the Thruway was built. For example there is a \$30 million county-wide shopping center in Yonkers. The promoter of this development told me that if it had not been for the Thruway they never would have gone ahead with this project.

It is not claimed that all of the industrial developments along the Thruway have been created solely because of the Thruway. In fact, I should like to discuss the difficulty that people in my field have in claiming such things. We greatly desire to claim that because of the Thruway there have been new jobs and new money, and the higher we can go into the millions of dollars the better we like it. We use that approach, of course, but I must admit that there are times when I have my doubts as to the firmness of the ground that I am treading upon. Perhaps a brief review of the research done on the Thruway will explain.

I am the acting director of a department in the Thruway Authority—the Department of Public Information and Business Promotion. It is strictly a public relations outfit. That is our whole effort—news releases, promotion, speeches. The business promotion comes in chiefly thought out activities in persuading more commercial accounts, more trucking companies, and more bus companies to use the Thruway, which is one of the longest toll highways in the county.

The sources of information are basically these: Every two weeks we get literally hundreds of news clippings about the Thruway from papers all over New York, and that material is catalogued. By analyzing these newspaper clippings over a long period and watching the developments, we see the story unfolding. These news clippings also have valuable information as to capital investment and the reasons people locate where they do.

Some people are reluctant to admit that the Thruway influenced their move. In any case where there is some question as to the role the Thruway played in any substantial industrial or residential development, we usually try to contact the promoter or some local Chamber of Commerce official personally, to clear the matter up.



A view of the new and huge General Electric Electronics Park adjacent to the New York Thruway, just north of Syracuse in Central New York. The thruway is having a profound economic impact on business and industry in the State of New York.



Before the New York State Thruway was built, this area east of Buffalo had developed only scattered residential tracts. The opening of the Expressway has opened up the entire area. It is reported that \$50,000,000 in new building has been inspired by the thruway and that another \$50,000,000 will be spent on capital outlay in this area when the the Thruway's Erie and Niagara sections are completed.

The Chambers of Commerce are a very important source of information. We have utilized in the past direct personal letters, and even form letters, to contact their officials and various other groups, such as truckers and local business men, that we hear about moving into the Thruway area. In this way we try to get the facts relating to the effect of the Thruway on land use.

**If We Can Measure the Benefits, Could We Devise the Taxation?**  
**R. M. Zettel, Institute of Transportation and Traffic Engineering**  
**University of California**

There are a few things we should think about, particularly in relationship to the reasons we are here; that is, the problems of finding some answers rather quickly for the Congress, for the state legislators, and for the highway engineers who must make immediate locations.

I think all of us accept the point made some time ago <sup>1/</sup> that new increments of value are likely to decrease as the highway system improves and expands. The spectacular effects that have been observed may have come about because we have dealt with a very local area or an area within a community.

We have talked about the area of influence of the Dallas Freeway. Another freeway and another direction would change the pattern and would not have, as several people recognized, such dramatic effects on land values and land use as the first freeway development.

From the point of view of the Bureau of Public Roads there is also a larger problem—the net social gain. We may have a benefit to Boston or a benefit to Massachusetts and a benefit to Los Angeles, all of which tend to offset each other. When Congress is dealing with a highway system for the whole nation, presumably it would have to evaluate its impact in terms of the total effect.

One of the things that I am frequently asked and don't have the answer to is: "When we talk about impacts on land values, to what extent are we talking about benefits to highway users, the so-called idea of the transmitted benefit?" More specifically, there have been frequent references to savings in time and operating economies. These are regarded as benefits to highway users. Then an effort is made to find out the effect on land values, calling these benefits to land owners. To what extent are the same things being counted both ways?

With reference to financing the highway program, if we are talking primarily about the same benefit but measuring it in two different ways, then our conclusions with respect to the appropriate distribution of the fiscal burden will be quite different than if we assume that they are separable things.

If land values and the other possible impacts are net rather than transmitted benefits, is there any practical way of applying the known facts to the financing of highways? If we found increases in land values, we have assumed that we should impose property taxes in order to finance the highways, to make the property owner pay part of the costs. We have

<sup>1/</sup>Zettel, R. M., Proc., Institute of Traffic Engineers (1953).



A section of freeway at the south city limits of San Rafael, California. Note the character of the land use developments along this expressway and the physical and functional insulation of such uses from the highway facility itself.

to think about the actualities of the tax structure. Is there any practical way in which that can be done?

In the Dallas study, Mr. Adkins talked about affected and non-affected areas. If you found that there was an impact on land values and were to impose property taxes, wouldn't you be taxing the non-affected areas in order to pay for the initial benefits in the affected areas? The practicalities of the tax structure would probably require that course.

With respect to public hearings, we have a very practical problem. Congress has required consideration of the economic effects of freeways and of any of the highway relocations. The California Legislature last session added to its highway statutes a requirement that the Highway Commission consider the impact on the community values before locating a particular highway.

We have, to my knowledge, no definition of these community values that we are supposed to be considering. We have no techniques of measuring them. The Highway Division has to say in public hearings that it has considered, but it can't show just how the matter has been considered. They have no method, no formula for community values. They have their user benefit-cost analysis, and to this they add their good judgment or personal estimates in considering community values. If these values ought to be considered, we need a technique for measuring them.

The question was raised as to whether or not economic impact studies were helping the highway divisions in selling their programs. I would say: "Yes, they do to a certain extent." A point is reached (or at least I think such a point has been reached in California) where a highway program is accepted. But there will continue to be the difficult problem of locating these highways. You can't talk about the savings of one-half cent a day to a million motorists, or say to the man who is going to have his house taken by a freeway: "There is a net social gain." He has built a rose garden that you are not going to pay for when you condemn his property.

This does not mean, however, that the values of these studies have been lost. With respect to the individual hearings, their usefulness is clear. But even when you have sold key leaders in the state on the desirability of a highway program, those key leaders will sometimes have to do a little soul-searching when the highway location affects them adversely.

One of the difficulties now confronting us is that we have been adopting freeway locations by bits and pieces. We build a mile out in this direction, and then we have enough money to go to Los Angeles and build another couple of miles there. Possibly this is one of the basic deficiencies in the current program. The Legislature has requested the Department of Public Works, on recommendation of the citizens advisory committee, to set up a freeway system for the entire state, without regard to present jurisdiction over the highways. The citizens committee hopes that if we could set before the State of California the ultimate freeway system, as nearly as we can now foresee it, we will engender a great deal more interest.

We don't have to search for areas in which to build the highways. In our locational problems, we have two kinds of situations. We build a freeway, and it produces changes in land use. Conversely, the changes in land use come, and we have to build a freeway to take care of the people already there. It has worked both ways.

## Studying the Connecticut Turnpike—A Before-and-After Analysis

Walter C. McKain, Head, Department of Rural Sociology,  
University of Connecticut

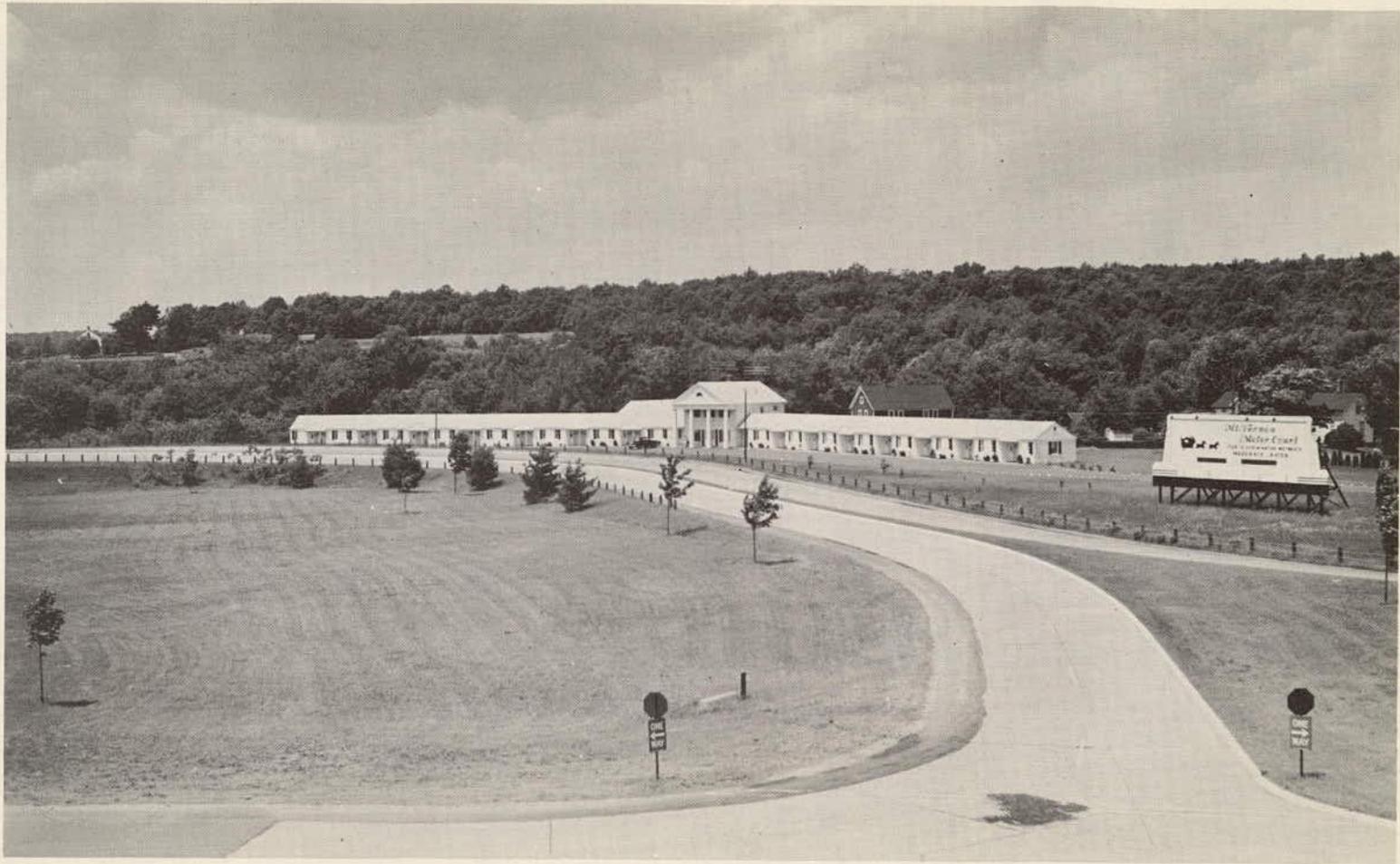
The Storrs Agricultural Experiment Station at The University of Connecticut has long been interested in suburbanization and has produced a number of monographs on this topic. Notably absent from research in suburbanization has been any attempt to analyze the suburbanization process under experimental conditions. Social scientists seldom can conduct research in the laboratory and must depend upon "social" experiments that are planned and carried out for reasons unrelated to research design. The construction of the Connecticut Turnpike is fortunately a social experiment that permits the analysis of an area before suburbanization takes place and enables one to isolate various elements in the suburbanization process. Controlled comparisons can be made in this instance with both time and area dimensions.

Before-and-after comparisons become more meaningful when the individual elements in the situation can be traced longitudinally and related to other elements both before and after the introduction of the independent event (in this case before and after the opening of the Connecticut Turnpike). For example, cross-sectional analyses of population composition could be made preceding and subsequent to the opening of the turnpike. This rather static approach would have limited value, however, in an attempt to assess the effects of the turnpike. An analysis of population change with reference to the factors that attracted population to the area and to the changes that resulted from in-migration is more likely to uncover the effects of the turnpike. In other words, dynamic situations require dynamic techniques.

Controlled comparisons also may be designed on an area basis. If the effects of the turnpike are more pronounced in the area immediately adjacent to it and become less noticeable as the distance from the turnpike increases, an analysis of changes that occur in areas with varying degrees of intensity will provide useful comparisons. The influence of the turnpike may not follow this pattern and the relation between distance and effect may vary from one kind of influence to another. (For example, population growth may be greatest at a point somewhat removed from the turnpike.) These zonal gradients will then be useful in demonstrating the relation that does apply, provided the step-by-step development of the effects can be determined.

Topics Covered. Six topics included in this project may be pertinent to research on the economic impact of highway improvement. Broadly stated, these are: 1. Population shifts and composition. 2. Decentralization of manufacturing plants. 3. Changes in retail trade and professional services. 4. Development of the recreation industry. 5. Changes in local government services and costs. 6. Shifts in land use and property values.

Period Covered. The Connecticut Turnpike is scheduled for completion in 1957. In general, 1954 and 1955 have been used as the base period of comparison for all secondary sources of information. Field investigations did not begin until 1956, therefore most of the primary data begin with 1956 or 1957. After completion of the turnpike comparisons probably will be made on an annual basis for an indefinite period.



A view of a motor court development adjacent to the Wilbur Cross Highway at Rockville, Connecticut. An extensive economic impact study of the Connecticut Turnpike is now under way, sponsored by the Connecticut State Highway Department, at the University of Connecticut.

Areas Included. The project will be concerned with that portion of the Connecticut Turnpike that lies in New London and Windham Counties. Seven areas have been identified with reference to the turnpike and, insofar as possible, each phase of the investigation will cover all of these areas. In order of intensity they are as follows:

1. A 1-mile area surrounding each interchange or pair of interchanges.
2. A 5-mile strip on each side of the turnpike.
3. Towns (townships) traversed by the turnpike and lying wholly within the 10-mile strip.
4. Towns traversed by the turnpike and lying partly within the 10-mile strip.
5. Towns not traversed by the highway but lying wholly within the 10-mile strip.
6. Towns not traversed by the highway but lying partly within the 10-mile strip.
7. Towns in Windham and New London Counties lying wholly outside the 10-mile strip.

Research Procedure. Population estimates are available from the State Department of Health for each of the towns in the two counties for 1954 and 1955 and estimates are being prepared for the 10-mile strip. The latter estimates are based on the construction of new dwelling units as reported by local assessors, the annual school census and other school records, utility installations, and periodic field reports. After the turnpike is opened for traffic in-migrant households will be interviewed and their relation to the turnpike determined.

Manufacturing plants have been classified and mapped for the entire area and a schedule of information has been obtained for all plants with ten or more employees for 1956. The commuting patterns of the workers have been plotted. Information concerning payrolls and monthly fluctuation in employment has been obtained from the State Department of Labor for 1954 and 1955. Comparisons are available for all the areas of intensity and annual changes following the completion of the turnpike will be recorded.

All commercial establishments and home enterprises have been plotted for each area for 1956. The State Tax Department has made available the gross sales and the taxable sales on a quarterly basis for each establishment in 1954 and 1955. Professional services have been charted from lists available in state or county headquarters. Changes in all of these items will be reported for the years following the opening of the turnpike.

The recreational use of land is being obtained for each area of intensity from assessors' records for 1954. This has been limited to summer home and shore properties, summer boarding houses, summer camps and winter sports facilities. Retirement homes are being listed from the same source. Certain recreational facilities have been covered under retail services. A listing of other recreational uses of land will be made from field investigation. Motels and other tourist accommodations will be canvassed to determine present capacity. All of these items will be checked on an annual basis when the turnpike is completed and any change in recreational facilities will be related to the turnpike by field investigation.

A list of local government services, including some quasi-governmental services, has been prepared and data for each town will be secured by field investigators for 1956. The form of local government, tax rates, and

zoning or planning activities will also be listed. Changes in type or amount of service and changes in the costs will be noted after the turnpike is completed.

All property sales in each area have been recorded for 1954 and 1955, together with a description of the property involved. This will permit comparisons with sales following the opening of the turnpike. Land use changes will also be noted, with special attention being given to the disposition of farm land. Housing developments, manufacturing sites, and commercial developments (such as shopping centers) will be subject to separate field investigation.

Photographs of land adjacent to main highways at interchange points will be taken in 1957 and a pictorial story of the present highway usage will be made. Aerial views of interchange areas are also planned. Similar views after the turnpike is opened will be obtained.

The State Highway Department has made traffic counts on many roads and will expand its coverage to include the Connecticut Turnpike.

### **Integrating Land Use and Highway Planning in Detroit** **Glenn Richards, Department of Public Works, Detroit**

It seems that the people of the United States have decided to have a big highway system, and they want it built in a hurry; that is, in from 10 to 12 years. Whether or not the things that have happened in the past should be looked into, and whether what is going to be done should be based on what has happened to the highways in the past, the important thing is what is going to happen in the future.

There is a great value in studies like this. In these highway hearings, we have to be able to point out to the people why a certain highway should be built and why it should be located as planned. But as far as the impact on the economy is concerned, it would seem that the decision has been personal. Almost every state has increased its taxes and the federal taxes have been increased. But as one who is going to spend a great deal of money in the urban area of Detroit, I am anxious to know how and where to spend that money.

In the past land use change has followed highway improvement. Industry has been developed along highways, an effect still being evidenced as fast as new highways are built. In fact, many times we have ruined highways by developing industry and business along them.

If we are smart, in the future we shall look ahead and avoid some of our past mistakes. To this end we have been giving some thought to the future in the Detroit metropolitan area. Primarily there are the metropolitan origin-and-destination studies made by Carroll, from which we know about how much traffic to expect in the future. We have a city land use plan, a regional land use plan, and some industrial studies. How can we pull all those together and make something out of them?

The city planning commission completed a master plan in 1950, after about ten years of work, and now we have our new origin-destination study. The problem is whether or not to use this origin-destination study as the basis for remaking of the land use plan, or whether to take the land use plan and add to it the expressways and secondary roads. I have come to

the conclusion that we are going to try to fit the highways into the new concept of land use.

We need advance studies of how we are going to redevelop our cities. What sections are we going to tear down and rebuild? If we are going into redevelopment, our highways should follow the new land use requirements.

A lot of thought should be given as to what the highway impact is going to be and how highways can be planned so that they will fit into the anticipated changes in land use. Transportation and highways probably are going to be the most important element that we ought to consider in their economic impact. Where are we going to build these highways? Are we going to build them as we have in the past and let industry follow, or are we going to try to plan our land use in advance, and then lay our highway system out on our land use plan?

The State Highway Department has gone along very well with our planning in the past, and the Bureau of Public Roads located the interstate system through Detroit so that it will follow our present land use plan. We have been doing a lot of pioneering work in origin-and-destination studies and land use studies, and we have laid out our expressway plan to date, with the help of the planners and the traffic people, so that it would be laid down with the idea of coordination with land use.

Now we want to go one step further. We want to plan far in advance—not just six months in advance, but far in advance—of a decision as to the location of the interstate system, as well as the other systems. We must have connecting roads and access roads to the interstate system. But far in advance of actual location and design we have to ask if they are going to be located where they should be to complement best the land uses.

We have a joint technical staff in the city of Detroit. It is chair-manned by my assistant, but the city planner and the city traffic engineer and their assistants are all a very important part of this staff. The city planner recently suggested increasing the planning staff in Detroit with the idea that well in advance of the decision as to the exact location of an expressway serving any particular area of the city, the planner should complete studies of different redevelopment programs, including industrial, housing, or recreation. By the time the detailed highway location phase is reached they will be ready to bring in their redevelopment studies. Quite a large redevelopment program is now going on in the Detroit area in cooperation with federal bureaus.

Actually, two types of planning should be involved: planning right along with the detailed expressway location, and, well in advance of that, planning with respect to what we want to make of our cities of the future. We know that old cities are going to be torn down and rebuilt. That seems to be the trend. It is thought that in Detroit this job might be telescoped into a couple of years rather than have it take seven or eight years. Enough people might be employed on it to prepare a new land use plan of the city under this new concept and take into consideration where the expressway should fit in. By working with the Highway Research Board and other agencies, perhaps research projects could be conducted in Detroit which would be helpful to other urban areas.

## Discussion on Land Use Studies

### PLANT LOCATION—TOTAL VS NET IMPACT

The outline of the proposed study of the impact of Route 128 around Boston led to considerable comment. Mr. Carroll asked what would have been the net increase in the tax base if Route 128 had not been built. Did the highway stimulate new expansion or did it merely redirect or concentrate that which would have occurred in any case? Mr. Bone's opinion was that it did both. About 80 percent of the businesses came out of Boston, Cambridge, and South Boston. The intention is to study those areas to see if any net loss had taken place there. He emphasized the importance of the activity of promoters in concentrating development along Route 128.

Mr. Wetmore cited a study made by the City Planning Department of the Massachusetts Institute of Technology, which concluded that industry in New England which might have been located elsewhere had been drawn by the highway to the Boston area. He adds that the town of Needham estimated that its tax rate would be held down by \$10 per \$1,000 during approximately the next ten years, because of the industrial development attracted by the highway.

Mr. Kanwit pointed out that the only way to get the net effects of the highway would be to try to find out what management had under consideration at the time the decision to expand was made. Was out-migration halted? Was the timing of their expansion affected? Mr. Bone agreed, saying that most of the industries had been contemplating a move for sometime. Some would have gone elsewhere had it not been for Route 128, and the availability of sites often precipitated their moves. Mr. Scofield asked if, from the national standpoint, there was really any net gain?

Mr. Garrison suggested that the improvement in transportation represented a net benefit not only to the local area but also to the region and the nation as a whole. Chairman Levin asked if it was necessary to study an entire region or nation to ascertain the net highway impact. He quoted a statement written by Zettel which pointed out that land values and industrial and residential use changes will tend to diminish as free-way construction expands in a given area.

Mr. Wetmore emphasized the need for studying highway impact with reference to the prevailing role of growth in a particular area. He proposed examining actual growth in relation to projections or regional growth with and without the implications of the highway effects upon new development.

Mr. Carroll suggested that the research might be directed toward determining the operating costs of industries in alternate locations in terms of site advantage. He thought that any net operating economies would represent the economic gain of that site selection, a gain tied to the highway. And, in this respect, there is a gain over an immediate alternative, which represents a benefit to society that can be measured without worrying about the whole input-output matrix.

Mr. Wehrly, thought that rather than attempting to analyze the impact of highways on land use, we should look at the existing and potential impact of land use on highways. He pointed to fantastic changes that had occurred in land values in Phoenix, largely without any introduction of a



International Business Machines Corporation recently completed this \$25,000,000 plant near the Kingston Interchange on the New York State Thruway.



The Ford Motor Company has located a \$20,000,000 assembly plant within sight of the Suffern Interchange on the New York State Thruway. The economics of this location obviously involve access to markets through excellence of highway transportation.

highway as an element in the picture. The fundamental consideration is how highway location may fit into a land use pattern, either as it exists or as it is projected. He felt that land use planning should not be ignored simply for the sake of engineering or cost considerations.

#### FARM LAND AND HIGHWAY LOCATION

Mr. Wetmore thought that more attention should be devoted to the structure of land ownership and use on highway location. For example, following section lines would avoid splitting farms, and might save money. Mr. Morf explained that the section-line roads were needed to connect places between interchanges. Building along section lines would require a great many more frontage roads to carry short-distance traffic. In other cases diagonal routes must be followed on some highways, as from Chicago to St. Louis. Mr. Wetmore thought that studies ought to be made of alternatives in routing and the effect on land costs. Mr. Hess stated that all factors (cost, cut-and-fill, routing, and distance) are considered as an inherent part of a design department of an organization.

Mr. Scofield commented that the tendency had been to think almost entirely of property rights in connection with throughways. He thought that the greatest value to farm land probably came with the initial improvement of the highway. Only 10 percent of farms remain located on dirt roads. The benefits of highway improvement might be easier to measure at lower highway system levels. On the throughways, some losses in farm land values may occur after an initial increase. The effect on these values, he stated, is very difficult to measure.

Both Mr. Levin and Mr. Steele emphasized that impact studies of other primary, secondary, and even dirt roads should be made, in addition to studies of various types of primary roads.

#### ALTERNATIVES IN METROPOLITAN DEVELOPMENT

Chairman Levin asked the group how we could relate the various possible alternatives in the pattern of metropolitan area development indicated by Mr. Wetmore and the effect of various highway systems upon them. Mr. Garrison cited the work done, attempting to describe and systematize urban functions, growing out of a study in Germany of urban agglomerations of different sizes. At the University of Chicago, he said, the concept of metropolitan dominance and subdominance applied to urban centers of varying magnitude indicated distinct differences in function. The use pattern sets the pattern of values.

Mr. Kanwit, pointing out the changing functions of a suburban area (as in Long Island, which moved from bedroom to employment centers), suggested that actual study of these developments would aid the theoretical approach. At present it is not known whether the expressway will result in future employment concentration or dispersal, but unless such a dispersal actually occurred one insoluble problem might be piled on another. He felt that there was urgent need for research to try to estimate what the net effect was likely to be, more concentration or dispersal.

Mr. Wetmore recommended the smaller-size metropolitan area for study not only because they are more easily handled but also because they are significant problems in themselves. Case studies and testing theoretical approaches in the smaller cities might be quite useful.

## THE ROLE OF ZONING

Referring to the Detroit area plan for comprehensive planning and directed development, Mr. Scofield asked Mr. Richards whether they had the regulations and zoning power to carry out the plan. The question was referred to Mr. Tomlinson, who stated that a zoning plan was necessary, and that although their zoning extended only to the city limits, the suburbs also had zoning plans. Mr. Carroll pointed out that zoning was negative in that it prevented people from doing certain things. Zoning and planning are not synonymous; zoning is important to the enforcement of a land use plan.

### INTEGRATING LAND USE, POPULATION TRENDS AND HIGHWAY LOCATION

After Mr. Richards had discussed land use planning and highway planning in Detroit, Mr. Wetmore advocated experimental studies in a number of areas that would concern the reciprocal relationships of land use, population, distribution patterns, and highway location patterns. He felt that more of this type of work ought to be done. Mr. Sharpe advised that several cities were undertaking this type of research. Tulsa's City Planning Commission is collaborating with the state highway department, and Dallas is also engaged in a similar study.

Mr. Steiner stated that the United States Chamber of Commerce is encouraging this type of planning, first beginning with the technological trends that influence basic employment, and then relating land use to the potential economic development. He said: "This is the direction that we are encouraging a great number of business leaders to take...I think that the getting together of highway planning people...with the land planning groups is certainly a step in the right direction. We hope to encourage and see more over-all metropolitan area planning into which these pieces of jigsaw puzzle will fit."

### RESOURCES AND TIME FOR RESEARCH

Mr. Wetmore advocated expanded relationships between state highway departments and university groups to further this type of work. He felt that shorter-range projects would supply additional case study materials on which to base better long-term research thinking and programming. He also recommended conferences for synthesis of present knowledge. Mr. St. Clair indicated that up to now he had believed that the planning and right-of-way groups of state highway departments would be too occupied to undertake these studies, but they now felt they might want to do so and perhaps they might be involved. He inquired whether or not the universities would be interested in a so-called short-term "crash" program.

Messrs. Wetmore, Garrison and others indicated interest, and the matter of funds was immediately raised. Mr. St. Clair indicated the possibility of using Bureau administrative funds in connection with the Section 210 report, subject to the approval of Mr. Tallamy, and of  $1\frac{1}{2}$  percent planning funds with Bureau of Public Roads and state highway department approval. Mr. Thompson emphasized the size of the job ahead. He said: "I don't think that you can talk in terms of crash programs alone. You have to build a partnership between the state highway departments and the universities."

He felt, in addition, that the universities were not going to be attracted by short-term commitments. "We are face-to-face with an emergency.

We just don't have time to get this job done by the time the Congress has asked for certain answers."

He added: "If we take the leadership...the state highway departments will begin to pass resolutions through their bodies regionally and nationally...their united voice might have a big effect on making money available, making it free, influencing the agencies in Washington, and also producing some speed, which we so direly need."

**Session III**  
**Special Problems:**  
**Bypasses, Traffic Interrelationships,**  
**General Economic Orientation**

**BYPASS IMPACT**

**Planning Bypass Research in Virginia—  
The Lexington Pilot Project**

**Arthur L. Straub, Highway Research Engineer,  
Virginia Council of Highway Investigation and Research**

About three years ago, a research project was begun to study the economic effects of limited access highways and bypasses on roadside business, land value, and land use. We are nearing completion of the phase of the study dealing with the roadside businesses. The project is sponsored jointly by the Bureau of Public Roads and the Virginia Department of Highways under the  $1\frac{1}{2}$  percent highway planning funds. The study was begun under the direction of R. B. Goode, now of the University of New Mexico, who selected the Route 11 bypass of Lexington as a pilot study road because it was the first limited access bypass to be available for study in Virginia, and because it was fairly typical of many other bypasses being planned for construction. Lexington is a town of about 7,000 people and is a shopping center for a rural county.

The principal source of data is state business license applications, which report gross receipts and which are filed by retail business with the County Commissioner of Revenue each January. Special permission was secured from the Governor to examine these forms, with the condition that the identity of individual businesses remain strictly confidential. Data for all retail businesses (approximately 700) were secured for the period from 1950 through 1956. The bypass was opened to traffic in November, 1955; therefore, the data cover several years before and one full year after the construction of the bypass.

The mass of data is now being examined case by case in an effort to trace the history of each business through the study period. To those who have not worked with this kind of data it should be pointed out that considerable difficulty in processing is caused by ownership or location changes, and by incomplete or illegible data on the original forms. Great care must be exercised in order to minimize bias when decisions are made to cast out certain unusable cases. After initial processing, questionable cases need to be checked individually by follow-up interviews in the study area in an effort to clear up questions before analysis proceeds.

In Virginia, some businesses, such as motels, are not required to file gross receipts tax forms, and so this source of data is not available. For these businesses, individual interviews with owners and managers will be undertaken to secure data. A pilot study has shown that about 75 percent of the motel operators have good business records, which they will make available once they are assured that the information obtained from them will not be made public so as to reveal their identity.

After the information reflecting individual case histories has been refined to our satisfaction, the mass of data will be put on IBM punched cards. The analysis will use accepted statistical techniques. A careful analysis will be made of business fluctuations annually over the period of study. Appropriate test areas and control areas will be chosen, and businesses will be classified by type.

Fluctuations in business volumes might be expected to occur for many reasons. Changes in local population, purchasing power, traffic volumes, and wage levels in the area, and other factors, can affect business activity. All of these factors must be taken into account before the effect of the bypass itself can be determined. We will look for explanations for observed changes in business volumes by examining all reasonable factors which are probably operating. If a change in volume of business coincides with the opening of the bypass, and if it cannot be explained by the other factors operating, it may be concluded safely that the change was probably caused by the bypass. The approach to conclusions will be distinctly more conservative than that employed in studies that have not thoroughly explored the other factors operating in addition to the bypass.

It is hoped that the results of the phase dealing with the effects of the bypass on business volumes can be reported by September 1957. The results of this study should satisfy, in part, two needs mentioned during this conference. First, it should provide specific data on the effect of the bypass on the particular community under study. Thus it will add another case study to the too few now available for review by administrators on the threshold of the vast highway improvement program. Second, and probably more important, the study will devote much needed attention to adapting or developing methods of analysis to this type of economic problem. One of the principal reports of this study will be a master's thesis being developed at the University of Virginia.

If the pilot study proves to be successful, the methodology will be applied to several other study areas in Virginia. The phase of the project dealing with land values and land use is expected to become active during the summer of 1957.

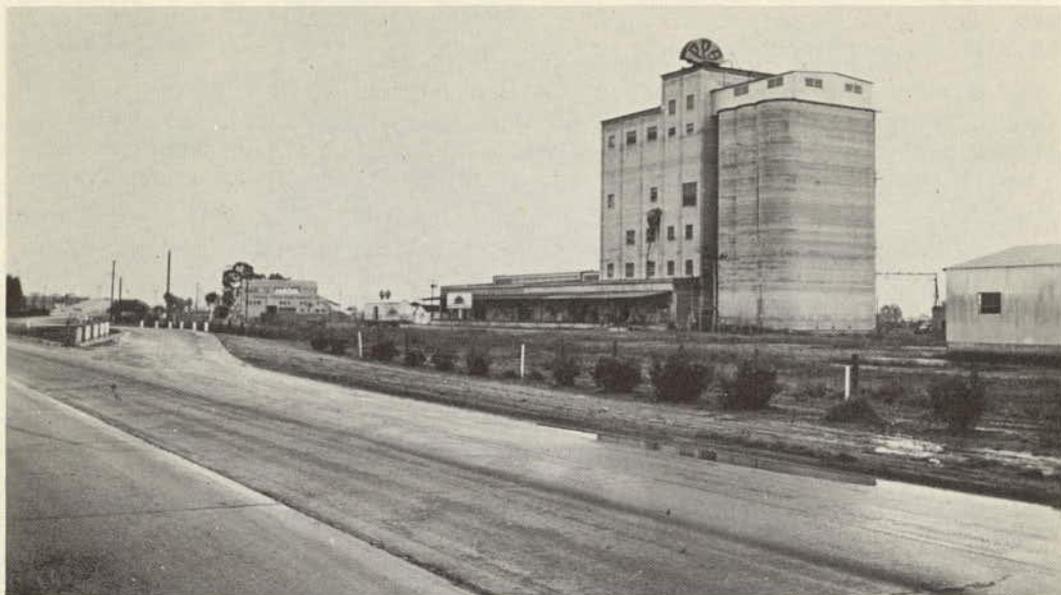
### **Limited Access Bypasses in California** **Rudolph Hess, California Division of Highways**

Limited access bypass studies of twelve California towns have been completed. Each of these studies has taken into account the various indices that are being considered in the Virginia study.

From a practical viewpoint, there are two functions for this type of project. One is the long-range record that has been built up in the files on these towns; this will continue to be studied over a period of years. The other is to get something out in a short time that is readily understandable.

To achieve both objectives requires the study of identical factors. To take immediate advantage of available material, however, an attempt was made to find the closest comparable unit of measure: in other words, had the area under study followed the pattern of the county, the state, or some nearby community?

If all of the business activity, population growth and general community development were analyzed and the subject community was found to



This grain elevator and warehouse, constructed adjacent to the Fresno Freeway in California, is typical of many similar uses along this highway of modern design. It has access to a county road to the rear. The economics of the Fresno Freeway have also been investigated.



Property abutting the frontage road of this recently improved section of a California arterial constituted the subject of another land economics study.

compare favorably or about the same in its advance or decrease with other comparable cities or counties, it could be assumed that it would continue to follow that trend, all things being equal.

Having arrived at this point and having decided that things were equal, the comparison was fitted to the other area. Thus, there was obtained not only an individual comparison before and after, but a comparison in relationship to another area to which it compared reasonably well through its past history.

In bringing this information to the public, certain problems arise. All of the studies will have a great mountain of information behind them. There are files and files on California areas affected by highway improvement. But when it comes to publication of the information, the data must be arranged and presented so that people understand them. Otherwise they are academic in nature and not usable. On the other hand, even despite the simplification that has been attempted in the California studies, the press has taken the studies and over-simplified them. In some cases it would be better to develop a simple approach and direct comparison that can be depicted in a chart. This is a plea for simplification.

The following is an example of how the information given to the public becomes misinterpreted. A certain magazine took all of the California studies and just combined percentages. In this case, the percentages come out fairly well, except that they failed to differentiate between the various types of bypasses, and there are all kinds of bypasses—some bypass towns at quite a distance, whereas others are only a block or so away from business districts.

There are many types of bypasses that should be studied. For example, in Oakland, where a bypass goes through a completely built-up area, the main concern is the resulting effect on a group of businesses that are just a block removed. But the traffic will be raised overhead and put down on both sides of these businesses just a few blocks away.

What effect will this have on these businesses? The area is completely built up and is largely self-supporting. It has a backing of residential area to support the business. This is just one type of bypass effect on which no information has so far been collected.

In conclusion, a plea is made for short studies produced in as concise and simple a form as possible for initial publication.

## **Indiana Bypass Research Combines Economic and Traffic Data**

**Harold L. Michael, Assistant Director**

**Joint Highway Research Project, Purdue University**

All of the studies by the Joint Highway Research Project actually are made in cooperation with the Indiana State Highway Department. Under this arrangement it was decided several years ago to undertake studies to determine what the effects of bypasses were on communities.

The case study approach was used; in other words, before-and-after studies were made in two Indiana cities. Not only were the two cities different in size, but the bypasses also were located differently in relation to the cities. One was a city of about 50,000, the other of about 10,000. In the case of the larger community location was very near the developed area; in the other, the location was some distance from the developed area.

Neither of the highways were of limited access type, and both were primary highways. One might say that they were, however, in areas that were going to be developed in the future, so they might be considered suburban.

Among the types of surveys made were origin-destination studies, travel-time studies, accident studies, and other studies to give the traffic benefits, both before and after. In addition, land use surveys, land value studies, and business effect studies were made. The origin-destination studies were conducted both immediately before and six months after each bypass was opened. The other surveys extended over different periods of time.

Land use and the land value data were compiled for 1945 from records and aerial photographs, from interviews with real estate men, and from records of real estate sales for land value. They were also compiled for 1950, immediately before the improvements were completed, and for 1951, six months after the bypasses had been opened to traffic. Another review is now in progress, five to six years after the bypasses were opened to traffic. Initial findings were reported. It is planned, moreover, to issue additional reports covering the review studies now being conducted.

Obviously, there are traffic benefits, but for the current discussion interest is centered in the non-highway user benefits. Therefore, the following concentrates on the land value and land use studies. These were measured in 1945, 1950, and 1951, and are being measured again in 1957. They are based on sales made in the area, and on "asking prices" of people who have their property for sale or had their property for sale at the various times. There were, of course, very few sales in each area, but there were some. On this basis, a strip 0.3 miles wide on each side of the improvement was evaluated, and the total value for the initial three periods of time was obtained. The land use study was primarily evaluated from aerial photographs taken during each period.

It was found that the land value increased approximately 50 percent due to the presence of the bypass. It increased more than that from 1945 to 1951, but the additional amount merely represented inflation. This was measured through use of a control area on the other side of the city where no highway improvement existed.

The land use change was found to be accelerated by the bypass. However, the land value increase was variable, being dependent on distance from the highway improvement and closeness to intersections. It also was found to be dependent on the type of land use. In fact, land value and land use were almost directly correlated, the land value increase being due to a change in land use type (from agricultural to industrial, commercial, or residential purposes) or to an acceleration of development of a particular land use type (such as the development of an area for residential purposes that had already been designated as residential).

Another portion of the study was to determine the effect on business. An attempt was made to use gross sales of various types of businesses, as had been done in other areas. It was felt that this would give the best information, but it was not possible to come to an agreement with the state agencies that have this particular information, and the desired information could not be obtained.

As a consequence, the businessmen were interviewed directly, both before and after, to determine what effect they felt the bypass would

have and did have upon their retail sales. In this case the actual dollar value was not requested but they were requested to give the change in sales, percentage-wise, that had actually occurred. The businessmen were agreed that the bypass did not hurt their businesses.

The use made of these data is an important phase of any such study. These Indiana studies were made to determine the influences of the highway upon a particular area after the location had been selected. This material was used, or could be used, to combat objections of businessmen to highways bypassing their cities. It was also used to evaluate the traffic use of bypasses in Indiana. We are quite proud of the fact, for example, that at Lebanon the traffic predicted was within 1 percent of the actual amount that used the bypass after it was open for a six-month period.

These data also were used to point out that in right-of-way acquisition more thought should be given to benefits that accrue to the land directly affected, as well as to damages to that land. This material could also be used to evaluate the influence of a location on land development in that particular area, or on land use. As Mr. Richards suggested, perhaps highways should be located in urban, suburban, and rural areas to best serve the desired land use as well as to serve eventual traffic. We certainly found that highway improvement has an effect on types of land use.

This is not to say that the increases in value in a particular location, and other changes found, represent net benefits to the community. This particular problem was not studied. In fact, two problems are involved here. These are: (a) What change or influence does a highway improvement have on a particular area? And (b) Do these local benefits contribute to the net highway and community benefits, and to the national benefits?

As previously pointed out, these studies are being continued, with the research directed primarily to the influences in a particular location. But there also is a need to determine the net benefit to the entire community. Lack of men and lack of money are not necessarily the most important deterrents to research in this area. One of the most important problems involved is that of time. But as important, perhaps, as time is the need to define the problem. If the problem can be defined and broken down into "bite-size" chunks, so that many graduate researchers can attack the problem, something definite will be obtained. The men will be found, and the money will be found also.

## **TRAFFIC INTERRELATIONSHIPS**

### **Expressways, Mass Transit, and Other Traffic Interrelationships**

#### **D. Grant Mickle, Automotive Safety Foundation**

It is apparent that a lot of work is being done by the various departments and the various universities both in the field of bypass routes and in other economic impact studies. It would seem, however, that perhaps that information is not getting around to other highway departments and other universities for their guidance and stimulation and use.

The newly created Joint Committee of the American Municipal Association and the American Association of State Highway Officials might be a perfectly logical vehicle for the collection of information from the highway departments and universities. If it could summarize the worthwhile



The Shirley Memorial Highway from atop State Route 7, looking northeast toward Shirlington. Extensive multiple-family dwellings and shopping centers have sprung up along this modern highway in the Washington Metropolitan Area.



Another view of the Shirley Memorial Highway in Virginia in the vicinity of the rotary intersection in Arlington County. The Shirley Highway has had a profound economic impact on adjacent land uses, as well as on the larger portion of the Washington Metropolitan Area.

studies and disseminate the findings to all the other departments it would serve a great need.

Every limited access highway in an urban area is, in effect, a bypass; it bypasses something because of the fact that it is either an elevated or depressed expressway for at least a certain distance, and whatever distance that is, it is bypassing something. Such a highway should bring about certain collateral benefits beyond those that are immediately apparent. For instance, not enough attention is being given to the benefits that may accrue to transit operation, for example, in the city areas. Certainly some of these expressways are going to aid transit service by making it possible to provide some kind of express service.

In the areas that have been relieved of the traffic from existing streets, truck deliveries and pickups certainly will be improved. That is a benefit to business that may be difficult to measure, but in the long run it would have some relationship to the cost of doing business, and therefore should be reflected in the level of business activity.

Safety has been mentioned in one or two of the preceding reports as being a collateral or fringe benefit. Ridding the existing streets of unnecessary traffic ought to have very definite and measurable safety benefits. What have been the results of the improved traffic operational conditions on the surfaced streets after the expressway has been built? Obviously, the remaining streets should operate more efficiently and more as they were originally designed to operate, when the unwanted or the unnecessary traffic is removed from them.

Finally, if business benefits are to be achieved in the downtown areas of cities by the construction of expressways, off-street parking must be provided along with the expressway or highway program.

## **Traffic Studies and Economic Impact Research**

**Roy T. Messer, Bureau of Public Roads**

Although traffic studies are necessary to determine the economic benefits to the highway user, many of those benefits can be translated into economic benefits accruing to the land or the use to which that land is being put.

Often, one of the reasons for building a bypass and determining its location is the industry located in the area. What is the influence of the availability of additional traffic capacity in attracting new industry along limited access highway improvements that are really basically in the nature of bypasses?

To what extent does availability of a bypass motivate industry to locate there? Is this new industry or is it industry moving from a present location to a more favored location?

The traffic problem has not always been fully investigated, but it seems like a logical aspect to include. Traffic is one thing that can often be measured relatively easily, although origin-destination studies sometimes involve considerable effort. Any economic study might well include an origin-destination analysis of the traffic that is using the route, to determine the amount of traffic that is generated by use of the land directly served, as against that which is diverted from other areas.

Mr. Bone mentioned that on Route 128 it has been necessary to build an additional interchange to serve some industrial plants. It is presumed that considerations leading to establishing the interchange at that location included, at least, consideration of the possibility of building a service road between the two existing interchanges serving that area. This would also reopen the subject as to the economic benefits of adding a service road.

## **Relating Highway Improvement to People** **Gordon Sharpe, Bureau of Public Roads**

Our main concern or interest is the method of relating the influence of traffic to people, in all of their activities.

When bypasses are built or when any highway improvement is undertaken, planners ought to know what effect to expect, not only in terms of the economic impact, but in all activities related to the improvement. In these improvements, traffic is being diverted and generated. In addition, the movement of industries, people, and goods is being stimulated and the whole complexion of urban areas and rural areas is being changed.

Bertram Tallamy, Federal Highway Administrator, pointed out in one of his articles that the New York Thruway at each of its interchanges will have a new urban or industrial complex. This type of information is important. These changes will certainly have a measurable quantity in dollars and also in their effect on traffic.

These are some of the basic things that we are interested in: relating highway improvement to people; to where they live, where they work, and where they shop; and to their business.

Some pilot studies were inaugurated by the Bureau in the Washington area to find out the effect of highway improvement on the number of trips to the central business district and to suburban centers. As cities grow in size, does the central business district retain its same degree of attraction as distance from downtown increases? We have studied employment centers and residential land uses to determine the relationships between land uses and traffic. Mr. Carroll has done somewhat the same thing, although in more detail, as to the effect of distance and time on travel patterns.

Highway improvement does have a very serious economic impact on the whole nation. How can some of these things be measured? The effect on traffic and on improvement of land might be very small in the case of an expressway located in an already highly developed area as compared with one built in a completely undeveloped area close to the central business district. The rapidity of the rate of growth in the latter instance probably would be extremely high in comparison to the first instance.

Such information is needed for forecasting traffic, which has been, outside of Mr. Michael's case, almost uniformly underestimated. It would aid study of the impact of a highway improvement in the general trend of city growth versus one built to an area that is more or less blighted or dead.

There was case in Puerto Rico back in 1948, where the planning board wanted to give priority to the building of a highway from the proposed airport to the central business district through a congested blighted area. From a traffic standpoint, a reliable forecast based on current traffic

figures was questionable because there was no airport in existence. But it was indicated that there would be an increase in traffic, and that the highway should have first priority not only from a traffic viewpoint but also as an aid in the redevelopment and upgrading of land use.

It was estimated by the planning board that the upgrading of the land into apartments and hotels, along the ocean front, would more than pay for the highway improvement. Such a development definitely would constitute economic impact and be a valid reason for building the highway, in addition to its serving the present and future traffic.

It is urged specifically that all planning commissions produce land use maps, both for current land use and for projected land use. This is not accomplished in a week. It is very necessary to have land use in both economic studies and in traffic studies. The success of the whole highway program hinges to a large degree on developing data and factors as to the relation of traffic and highways to land use.

### **The Highway and the Businessman** **J. Edward Johnston, U. S. Chamber of Commerce**

The discussions so far recalls a statement made by the Federal Highway Administrator suggesting the interests that the National Chamber of Commerce has in the economic impact of the highway program. He related an experience in connection with the New York Thruway, in which a trucking concern wrote him that during the year they had spent \$48,000 in tolls on the New York Thruway, but during that same period, because of greater safety in operation, among other things, they had made a saving in insurance costs of around \$50,000.

This is the kind of testimony that is needed in trying to sell businessmen on the highway program. Those working on the job of trying to sell the public on the road program agree that the businessman certainly needs to be sold on the importance of good roads so he will get behind the program in a positive way and not simply oppose ill-advised route locations and access control.

Mr. Michael commented earlier that the problem is two-fold. One aspect is the specific problem of trying to justify a certain route location on its economic benefits; the other, is to find the economic benefits of the road program as a whole. One phase is specific; the other, general.

Data coming to hand recently demonstrate the kind of information needed in dealing with the general economic impact. This information was developed by the Council for Economic and Industry Research, Inc., of Virginia. It had to do with the impact of the road construction program as it was estimated by an electronic computing system. It shows the impact of the road program on some 194 different types of businesses. If that kind of information had been available earlier, to help sell this road program, the support of many businessmen probably would have been obtained much sooner.

Strange as it may seem, the business community as a whole has been very slow to see the value of the road program. In the years to come businessmen as a group may be one of the major obstacles in getting the job done.

In a comment in regard to our booklet, "How Bypasses Affect Business,"

someone has said that it is unfortunate that a document of that kind had to be based primarily on the work of one or two states, and that there is a great need for more information. I am sure that the people of Virginia, where economic studies are being made, will benefit a great deal by the work being done there. Such studies certainly will be a better sales ticket than where one has to rely on data from other states, in which there is always the question as to how this applies to the local area.

Although the problem admittedly is two-fold, there is particular interest at this time in research into the field of the general economic impact. This new road program is beyond any expressed conception in its impact upon our entire way of life. It has a chain reaction which extends into every phase of our community way of life in so complex a pattern that we probably could never devise methods whereby its full impact can be truly measured. But anything in that direction would be a great help in selling the highway program.

### **Implications of Highway Improvement to Mass Transit J. Douglas Carroll, Chicago Area Transportation Study**

The economic effect of this new highway program on mass transportation is going to be extreme, with Los Angeles representing, perhaps, an extreme example of what can occur.

It is not pretended that this is good or bad; but the direction is well marked, and points out a number of major policy questions which will have to be resolved.

In Illinois there is a request before the state legislature to add to the gasoline tax to support the transit facilities of Chicago; a case could be made for such legislation. The availability of mass transit has been decreased because highways and transit are under two different economic systems. It is true that these new highways can be used to some extent by buses, but all would have to agree that as better and better expressways are available it becomes more and more reasonable and convenient for people to drive automobiles, especially as population thins out in the suburban areas.

It probably will be impossible to avoid considering this as a definite economic consequence of this program and one which will require a critical review of policies as to what the optimum mix of facilities in a community should be. To be concerned merely with property study, and not consider these allied effects, might be dangerous.

For example, it can be argued that the unit costs of moving people by mass transit, as opposed to highways, can be easily ascertained. Therefore, in a free market, where people have choices and choose a less economical outlet, we do not need to concern ourselves very much about it.

On the other hand, let me describe the difficult problem that we have to face as traffic planners. The people in the central business district of Chicago assert that they want these property values to be preserved and to grow, because they represent a heavy investment in utilities and buildings. But if we improve the highway facilities to that center and then provide the necessary parking, it becomes impossible to maintain those land values in that kind of density. In other words, you cannot have both.

This is not admitted by the city people. Therefore, if you want to achieve the first goal (that of preserving the central business district) you must not build highways and parking. We have now made the decision to build highways. Therefore, what are the consequences which we have to face in our central districts, and how can we persuade the central district businessman to accept them? This is an important question, which is going to show up sooner or later.

We have made a decision, and it is going to be a vital one in terms of what happens to our central properties. This is one of the major impacts of the program—that of a rearrangement of land values.

## **Detroit's Use of Expressways for Transit**

### **Glenn Richards, National Committee on Urban Transportation**

Perhaps highway people have not properly stressed the use of expressways as a medium for mass transit use. A decision was made in Detroit years ago to eliminate the street cars and interurban cars in an attempt to prove that highways could be used as a means of moving mass transit. Every expressway planned for Detroit was designed with the idea of making it easier for buses to operate. Every mile opened up was more and more convincing that for a city like Detroit this was the answer to handling mass transit.

In 1956 the National Committee on Urban Transportation and its consultants met in Detroit. During the meeting, use of expressways as a means of mass transit was discussed. The group was invited to take a ride on the expressways at 5 P.M., when the traffic was at its peak. Many of them, after seeing the local buses as well as the suburban buses traveling at high speed on the expressways to all parts of the city without any tie-ups, were convinced that full use should be made of expressways in helping to solve the transit problem of cities.

It is hoped that the National Committee on Urban Transportation will come up with the factual information needed as to whether or not cities can have a good mass transit system on the express highways, which can be used then not only for personal cars and trucks, but for mass transit as well.

## **The Transit Problem and the Central Business District**

### **J. Edward Johnston, U. S. Chamber of Commerce**

There has been considerable confusion about this matter of transit and the effect that freeway planning is having or may have on the central business district.

All we are actually doing in the new road program is trying to catch up, and then keep up, with the increased use of the automobile. There is still a basic demand for transit riders. The transit problems and the central business district problems are tied closely together.

Many people believe that the central business district is deteriorating because it is not expanding at the same rate as the suburban areas. This is not true, however, and the central business district is and always will be the most important factor in the health and welfare of every city. The problem is to get the maximum possible number of people into the central business district. Of course, some central business districts seem

to have reached a saturation point, and where such saturation exists it is a mistake to build freeways into the heart of the central city, thereby adding not only more people but also more automobiles.

The problem is static as far as the business district is concerned, but is dynamic as far as the private automobile is concerned. Underlying these opposites is the basic demand to move people, and transit more nearly fits the needs. There must be greater emphasis on the development of transit in keeping with greater use of the automobile.

The matter of paying for transit is a terrific problem. Thought must be given to how transit facilities can be financed without public subsidy. It certainly is most important that the transit problem be taken into consideration during the design of these expressways and freeways.

There is no need to fear losing mass transit completely; it will survive and must survive. Some radical adjustments may be needed to keep it, but it certainly is an integral part of maintaining the health of the central business district.

## GENERAL ECONOMIC ORIENTATION

### The Broad Approach to Highway Impact—National and Regional Edward A. Ackerman, Resources for the Future, Inc.

The comments addressed in the direction of a broader highway impact picture than a locality, or a very small region are most interesting. However, it seems that one profitably could start at the other end. This is a Federal highway program and perhaps such planning is the responsibility of an agency of the Federal establishment. Whatever the agency, outlining a framework within which planning can be undertaken at the national or regional level should be helpful.

Of course there are decided imperfections in looking at so large an area as the United States over the period during which one would want to plan, say, 25 or 30 years hence. Even recognizing the imperfections that exist in techniques, in data, in outlook, it still seems that an effort in that direction is desirable. In its absence we have, at best, impressions. And all of us, even when we seek to be accurate, make certain assumptions which may be based on impressions.

There are other forces influencing growth in this nation than the direction that highway construction takes, although that is very influential and one of the ways in which the other forces are channeled.

I think, for example, of resource development. What has been done in the development of water resources over, say, more than one-half of the geographical area of the country, is extremely important as far as the future is concerned. What is done about reforestation, although possibly not as important as water resources, still can influence the direction that development takes.

The balance of the energy resources indicates certain trends. Let's take the matter of rising prices of petroleum products as against new forms of energy that are coming in, or of coal compared with petroleum products, and so on. Those who specialize in these subjects consider them to be significant factors in the future economic development and settlement in most parts of the country.

Another example may be cited in agricultural trends, such as the coming of irrigation in eastern agriculture, particularly as far as the development of the Lower Mississippi Valley is concerned. Certain social considerations furnish one more example of forces that we have to think about. For instance, the shorter work week, the longer life span of most of the population, and the increasing demand for recreation will have effects on the needs for transportation. The role of highways in meeting recreational needs will be vastly greater in the future than it is at the present time.

Somewhere along the line I hope that we can have a study which looks at the nation with the objective of determining what the forces are that favor certain types of general traffic patterns for the country or for regions within it. One can forecast trends for some of these forces; for example, trends in the nature of resource exploitation (such as water, minerals, and others) and some of the basic social changes which are inherent within our society at the present time may be at least generally seen. To that might be added, of course, the fact that we are in a growth economy, and that through measures such as gross national product, it is possible to arrive at some idea of what that growth amounts to.

The highway system is now concerned with freight traffic as well as with passenger traffic. Up to this point no distinction has been made between the passenger and freight highway traffic in planning, although the two do not necessarily always go together.

This is mentioned because freight traffic is still largely handled by other parts of the national transportation system—the waterways, insofar as they have been developed, and, of course, the railroads. It is important, in planning for the highway system and in understanding the economic impact of that planning, to understand what is happening in other parts of the transportation system of the country.

An obvious example is the development of the St. Lawrence Seaway. Chicago has been trying to discover what the impact of that will be. But it goes much beyond Chicago and the lake cities. Another is the proposed development of a navigation channel on the Arkansas River as far as Oklahoma. This will have an impact, not only an impact on the rail system, but also a general effect on the economy of the area.

In these economic studies of the future, it will be necessary to start with a larger view and a consciousness that there is a national and regional traffic pattern that must be considered, as well as these numerous more local patterns that have been discussed so much in this meeting.

### **Three Decades of Experience Along Westchester County Expressway Frank L. Dieter, Office of Planning, Arlington County, Va. \***

The Westchester County Planning Department made a study on the effect of expressways and parkways on surrounding land uses under a grant of \$14,000 from David Rockefeller, a member of the Westchester County Planning Commission. The investigation began with a study of the impact of land uses on one another; for instance, commercial on residential. Then the effect of the various types of highways on surrounding land uses, particularly residential land uses, was investigated.

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\*Formerly Chief Planner, Westchester (N.Y.) County Planning Department.

Two sections of divided parkway, well landscaped and with wide rights-of-way, were selected, together with two ordinary major thoroughfares or undivided state roads through Westchester County.

This was felt to be a good laboratory, in that some of the Westchester parkways were the forerunners of the divided highway and limited access parkway system, some of them being built around 1924 and 1925, and some of the newer projects around 1938.

This study resulted in publication of a popular report, followed by a technical report entitled "Traffic Impact." One thing that considerably influenced the thinking in the planning field is that the location and the right-of-way widths of these major thoroughfares through developed communities, as differing from the farm or rural type of location, may have an impact on the development and the economy of the area far greater than the damages which might accrue in the way of right-of-way cost and property damage.

In other words, an attempt was made to answer the ever-present question of what influence this major thoroughfare will have on the neighborhood in which people have built their homes and invested their life savings. That was the idea of the study. It was found that the wider the right-of-way, and the more care taken with the roadside (such as landscaping, and so on), the least amount of impact there is on the surrounding property. At the same time, it improves and enhances roadside development, to the extent that those values are now stable and are increasing, whereas in a control area (that is, a similar area elsewhere in the same city) these effects are not felt as much.

Where these roads are placed through rural districts and where there is a need for industrial expansion, that is where the industrial expansion is going to take place. When they are built through existing cities and existing neighborhoods, a different set of problems arises. The effect on land values depends on the convenience of the road.

Arlington County, Va., is the corridor through which most of the westbound and southbound traffic must pass from the Washington metropolitan area. The trans-Potomac traffic is in the neighborhood of 225,000 or 230,000 vehicles a day.

In the regional plan of the area, Fairfax County, which adjoins Arlington, is planning for three or four expressways.

Those expressways will be extended through Arlington whether Arlington wants them or not, so the idea is to locate them in such a way as to take full advantage of them and at the same time not split up existing residential and commercial districts to disadvantage.

## **Operations Research: The Multi-Discipline Technique**

**Robert H. Roy, Dean, School of Engineering**  
**The Johns Hopkins University**

Some of the methodology and techniques of the mixed-team approach to the study of operations can have desirable effects on complex systems such as are under discussion.

Such problems might well be attacked by putting together a multi-discipline team of economists, demographers, statisticians, mathema-

ticians, and other pertinent disciplines. It probably also ought to have, as a member of the team, someone who is cognizant of Highway Research Board problems internally, and perhaps someone cognizant of the political impact of the kinds of things that might result.

But one cannot escape the feeling that some of the very tools described (linear programming, matrix algebra, operation gaming, Monte Carlo processes), coupled with the facilities of high-speed computers, could bring results beyond those obtained by groups of people studying problems like this within highway departments. The university is uniquely a desirable place in which to center such studies, because of the wealth of diverse resources available, either on a direct participation basis or a consulting basis.

It is gratifying to hear that some operations research is being done in this area and it is hoped that this technique can make some contribution toward the solution of this immensely complex problem.

### **Community Planning and Highway Improvement Must be Joined at the Local Level**

**Joseph L. Intermaggio, Highway Research Board**

The Highway Research Board Committee on Urban Research is interested broadly in the areas that have been particularized here, especially in the interrelationships of community development and transportation systems.

Several of the preceding participants have spoken of the national highway program, with some very broad objectives requiring a national viewpoint. We have gone a long way in setting forth a national highway development policy. But we have not gone as far in articulating another essential—a national development policy which this national highway program can help to achieve. This is something which must be spelled out on local levels.

If community planners do not indicate what the range of local alternatives is, and what the land use plans are, or what they should be, there is not going to be very much chance to develop an effective highway program for the local areas.

Neither can one measure the effectiveness nationally nor achieve the optimum results in a national highway program unless these broad objectives are spelled out within the range of a great number of alternatives, taking into account the dynamics of population growth, changing technology, and other factors.

With respect to population growth, New York City provides an excellent illustration. New York's anticipated regional growth has been estimated at about four or five million people in the next 25 years. This would amount to wrapping Los Angeles around the New York metropolitan area.

In such a situation, the measurement of economic impact is a difficult thing. Nevertheless, determination of an objective may make it far easier to achieve these goals and to institute directive devices as the local economy is developed.

There have been many evidences at this conference of the great amount of study and work that has been done, and that there is a need for educational dissemination of the ideas that have been expressed here. There is no question but that the uncovering of these ideas can have far-reaching

effects. This is said in the full knowledge of the kind of problems arising in the Washington metropolitan area, requiring decisions with respect to highways and bridges that will affect the values in the growing outlying communities, as well as the values in the older downtown communities.

To determine public policy on the basis of the information now available may actually involve a total transportation cost in excess of what should be undertaken. These decisions cannot be made unless the available knowledge is refined and applied to operating practices which take broadly into account the effects that these decisions will have on the communities.

## Discussion on Special Problems

### Bypasses, Traffic Interrelationships, General Economic Orientation

#### BYPASSES

The discussion on the economic impact of bypasses brought out the need for establishment of control of access if the bypass is to continue to accomplish its basic function of facilitating traffic. It was brought out that business in general, in the central business areas, was not impaired although some specific types of business were. Mr. Michael suggested that the closer the bypass was located to an urban area, the more rapid would be the development of abutting and nearby land.

Mr. Carroll asked what would happen if a study indicated that business had suffered as a result of a bypass. He thought that the studies should help find an optimum location rather than prove a particular location good or bad. Mr. Straub felt that better criteria for location might be determined by comparing the findings of studies of a number of various types of highway improvements. He indicated that, once the methodology has been worked out, Virginia hopes to make a dozen studies during the coming year. Mr. Waters pointed out some difficulties in obtaining uniform reporting of data.

#### TRAFFIC INTERRELATIONSHIPS

Mr. Wetmore stated that origin-destination studies had been handicapped by inadequate land use materials to permit analysis of the economic structure of the city. He believed that census tracting conforming to land use would help increase the usefulness of O-D studies and emphasized the desirability of studying the impact of different types of bypasses on the economic development of cities of various sizes. Expressways themselves can be regarded as a type of bypass to certain areas.

Mr. Richards described the depressed express highways of Detroit as bypasses that go through the city. He stressed the impressive economic savings involved in decreased accident rates on Detroit expressways. He also endorsed the idea of preparing a bibliography on completed economic impact studies for distribution to the states and cities.

Mr. Michael pointed out the advantage of the bypass to Kokomo, Ind. Although it did not solve the traffic problem on the old route, the local people had better access to downtown stores and through traffic has benefited by being routed away from this congested area. He added that their origin-destination study had included and analyzed data on purpose of trip and stops, and the effect of the bypass on local shopping.

Mr. Sharpe also noted the potential value of origin-destination

studies as an aid in urban planning. In Washington, D. C., such a study is just being completed, including future projection based on land use patterns proposed by the National Capital Regional Planning Council. He suggested that land use projections ought to be evaluated by a panel representative of local interests.

#### CENTRAL BUSINESS DISTRICT AND MASS TRANSIT

Mr. Carroll's discussion of the relationship of property values and parking problems of the central business district to urban expressways and mass transit touched off some animated comment. Mr. Mickle stated that highway experts must become increasingly involved in the problems of the larger city. To maintain downtown property values, better mass transportation must be provided. Mr. Carroll noted that experimental work was under way in Cook County, Ill., to determine the effect of waiting, distance, cost, and other factors under various situations of the choice of mode of travel. This will be an objective statistical analysis rather than a motivational study. Mr. Adkins, pointing out the greater cost of providing facilities for and of using private automobiles, asked what was known about the reasons for their increased use. Mr. Carroll asserted that whatever the reason, highway improvement would reduce the use of mass transit, and in turn the service provided, and thereby further reduce the use of transit. The choice, therefore, is not made on the basis of economy, but of individual satisfactions.

Mr. Carroll agreed, but added that whatever the reasons for these choices the effect will be economic for the users, and that the consequences for the city will have severe economic impact.

Mr. Garrison offered a comment and a query. He felt that it would be a mistake to attempt to divorce the problems of the central business district, the outlying shopping centers, and those of one town versus another. They are all the product of the same changing trends. He asked what techniques and definitions were used to determine the optimum transportation mix, which had been referred to by Mr. Carroll and others.

Mr. Carroll replied that it was a matter of cost: the minimum total transportation cost. He suggested that use of mathematical programming and use of high-speed computers will afford a determination of the consequences of each alternative. Beyond that it is a problem of assembling public goals so that the desired result is known. Does the public want to let everyone drive at 15 miles per hour and provide that much capacity? Is it desired to take money out of health and welfare and put it into highways? The community must determine how much it wants to do because it is profitable.

Mr. Wetmore re-emphasized Mr. Garrison's observations that concern is not limited to the central business district alone, nor the central city, nor its suburbs—the problem is much broader than this. But somewhere along the way lines must be drawn and choices made for study. In speaking of the inconsistencies of desires of people to maintain certain land values and densities in urban areas despite the impact of highway improvement, he said that the key problems are still the future land use and the relationships and implications between land use and highway systems.

Mr. Mickle brought up the question of governmental relationships. He

felt that more thought should be given to a regional organization whereby the tax load could be adjusted or spread over the whole broad area affected by specific improvements. Mr. Wetmore envisioned interlocking constellations of metropolitan areas, calling attention to the emergence of certain changes resulting from the growth of and readjustment in the centers of economic activity, and with them the structure of transportation, and suggested that they form one of the major areas of exploration needed to complement the studies under discussion in terms of highway systems and relationships.

#### EXCHANGE OF INFORMATION

A number of the members of the conference emphasized the great need for the exchange and distribution of information on completed studies and progress on those which are in process. It was suggested that a central group be created to circularize at fairly regular intervals, persons doing work in the field. The possibility that the Committee on Urban Research of the Highway Research Board might undertake this work was mentioned. Another group which might function in this capacity was the newly created Joint Committee of the American Municipal Association and the American Association of State Highway Officials.

Mr. Richards, a member of both the Urban Research Committee and the Joint Committee, thought that the job of compiling the information might be done by the former, and that of disseminating the information through the joint meetings sponsored by the latter group. The attendance of many important state and local officials at these meetings was noted.

The need for distributing information on techniques and methodology at the research group level and for distributing broader and less technical information to a larger group was noted.

Mr. Scheick said that the building construction industry should be represented in such an exchange, because the planners, the designers, and the builders of the cities ought to be brought together with the people who design and build the highway systems.

The third session ended with several references to successful efforts to promote public understanding of highway and land use relationships. For example, data from the "Study of Land Values Along the Gulf Freeway" (Houston) was incorporated in sound and color movies. Sponsored by the Texas Good Roads Association, these movies have been used all over the state to indicate the need for a bond issue to finance acquisition of rights-of-way for Texas expressways.

Another example mentioned was the set of slides prepared in California to illustrate the need for and development of freeways, and their economic impact on land and sales.

## *Session IV*

# *Application of Economic Research to the Highway Cost Allocation Study*

The final session of the Conference was devoted to a discussion of the application of research on the economic impact of highway improvement to the highway cost allocation study, the so-called "210 Study," being conducted by the Bureau of Public Roads. A series of five resolutions incorporating the suggestions of the conferees on appropriate steps to be taken to expedite the necessary research was passed. Mr. St. Clair, Chairman of the Department of Economics, Finance, and Administration of the Highway Research Board, presided.

### RESPONSIBILITY OF THE BUREAU OF PUBLIC ROADS

In his opening remarks, Mr. St. Clair pointed out that Congress had directed that an inquiry be made into both the benefits derived by the vehicle user and other benefits obtained by various classes of persons. The Bureau of Public Roads has set up a Committee on Benefit Analysis, recognizing the fact that the study has the two major phases of user benefits and indirect non-vehicular benefits. C. A. Steele is chairman of the committee. D. R. Levin, one of the members, will be primarily concerned with the non-vehicular aspects; Carl Saal, Chief of the Vehicle Operations Branch, is interested primarily in the vehicular phase. Mr. Steele will coordinate these two separate, but by no means exclusive, activities.

Mr. St. Clair expressed his general agreement (with the point of view stated by Mr. Zettel earlier in the Conference) that the benefits to property and the changes in land use which result from highway improvement are, for the most part, benefits transferred from the vehicle to the land. Only a few types of benefits accrue to land or are capitalized elsewhere which are not associated in some way with vehicular use.

Even the benefits obtained by public utilities through the location of their lines along or beneath the right-of-way perhaps derive mainly from the ability to travel by means of the motor vehicle to the facilities and repair them. He thought that most increases in property value represent capitalization of savings and benefits arising primarily out of highway use. Such strictly non-vehicular benefits as drainage, street lighting, and sidewalks are incidental to the major highway complex.

Apart from these non-vehicular benefits, Mr. St. Clair felt that, if the land were taxed both the vehicle and the land would be taxed for the same thing. Today the tax is primarily on the benefit to the vehicle, and the land or general tax base are sharers in the taxation imposed for highway support.

In the past it was the other way around. First the land was taxed. The states assessed a special tax on property along or adjacent to a highway under the assumption that it obtained special benefits. First and generally, there was the road tax levy; next, the general appropriation from

local general funds. Federal aid was defrayed out of general revenues for a long time; in fact at law, and in the eyes of Congress, this situation obtained until July 1, 1956.

Thus, there is a past history of tax contributions from land, from property, and from general revenues; nonetheless, motor vehicle taxation has been growing, and has certainly become dominant at present. Now the question is what are the implications of this phase of the study with respect to federal taxation for support of the federal-aid program. There is no fear that these studies would result in federal taxation of property; this is considered outside the constitutional sphere of the Federal Government. The most that would be implied would be perhaps justification of existing local and state property taxes for highways. The study would not in any way tell the states how to tax for highways.

The possibility seems rather remote that part of the support for the federal-aid program will again be derived from the general fund of the Treasury. Even if the findings of this study were favorable, it seems unlikely that a significant action in this direction would take place. The Highway Trust Fund now gets about 62 percent of the total federal automotive excise taxes imposed; it is quite unlikely that the findings of the Bureau's study would come anywhere near absorbing the 28 percent that still goes into the general fund of the Treasury regardless of the outcome. Mr. St. Clair added that it was the duty of the Bureau to submit impartial findings in accordance with the directive of Congress.

He observed that property taxes and other non-motor vehicle taxes still have considerable use and support for local roads and streets.

#### AVAILABILITY OF FUNDS FOR STUDIES

The Bureau of Public Roads is able to finance cooperative research with the universities through its own administrative funds within limits. Section 210 of the 1956 Act authorizes appropriation out of the Highway Trust Fund. "...such sums as may be necessary to carry out the provisions of this section....," but in actuality the Bureau is not in a position to be excessively freehanded with money for setting up projects. It is interested in work that will be available for absorption into its general final report, which must be completed by March 1, 1959.

Mr. Holmes indicated that the amount of money available for research depended on the success of the Bureau's request before Congress for additional funds through fiscal years 1957 and 1958. He recommended proceeding to "work out a program of the desirable studies that it is felt can be made and that will contribute to this requirement of Section 210, and then undertaking to find some agencies which can do them within the time available."

While emphasizing the immediate needs to meet Congress's directive, Mr. Holmes also expressed the hope that the Conference would develop the need for a long-range research program which would continue after the report is submitted to Congress. He referred to the two purposes for which the Conference was called, assistance for the 210 Study and aid to the state highway departments in conducting hearings and acquiring rights-of-way. Mr. Holmes believes that the type of land value and economic study made by Mr. Hess and others would be more productive immediately for operating purposes than for the 210 Study.

## TAXATION TRENDS

Mr. Morf expressed concern regarding the viewpoint that practically all benefits were vehicular. This might encourage local governments to lean further on the states and might undermine existing financing arrangements. Mr. St. Clair pointed out, in reply, that vehicle-mile costs were two or three times higher for local roads than for primary state highways. Thus, a contribution from property is justified as a part of the total benefit tax.

Mr. Wetmore supported this viewpoint by contrasting the basic access role performed by local roads with the general service function of expressways. He argued that the percentages of benefit realized by vehicle user and land user differed significantly, depending on the type of road service provided.

Mr. Zettel thought that, apart from purely local access roads, the highway user gets the initial benefits, and then some of these benefits are transmitted to others. He pointed out that the long-run trend has been to move away from property taxation for the support of roads; in fact, that it may be desirable to keep under local financing the other things (such as the school and educational system, and roads that are purely local in character) that it seems only property can support and that have such high costs that they could never be appropriately financed under the crudity of the user-tax structure.

Freeway systems, and more particularly the Interstate System, provide a service that has many kinds of benefits, some of which are transmitted in many directions, such as operating economies in business, or perhaps increases in land values in certain areas.

Mr. Zettel raised the practical question of whether or not it was possible to distinguish for taxation purposes between properties which were affected (either favorably or unfavorably) and those which were unaffected. The trend seems to be that of considering the highway as a commercial or public utility operation and pricing its service as well as can be done through a user-tax structure.

All of the highway needs cannot be met from the users' tax, according to Mr. Richards. Strictly local needs must be met increasingly from local funds.

The problem of determining the actual beneficiary was discussed by Mr. Levin. After a new expressway is built, who obtains these transferred benefits; real estate operators, land speculators, home builders, new business enterprises? Would the home owner pay both an increased amount for his home and a higher property tax as well? If it were desired to capture those increments on the basis of equity, how could one determine the increments as they accrued from the highway and what kinds of taxes would be levied?

Mr. St. Clair admitted the complexity of the question, then proceeded to direct the attention of the group to the main issue: What studies should be made and how can a program be started?

## WAYS AND MEANS OF GETTING RESEARCH STARTED

The two types of research needed, as indicated by Mr. St. Clair, are:

1. Research in depth, and on a national or regional basis, to determine the economic ramifications and interrelationships of highway improvement. These studies would suggest the magnitude of non-vehicular benefits, and supply the theoretical framework to analyze more detailed local impact studies. They tend to be broad in scope and long-range in perspective. They would be made largely by universities and private research organizations.

2. Additional local studies specifically on land values, land use, and other highway effects. These studies would tend to be shorter range, detailed projects, and would be carried on largely through university and state highway department cooperation.

In general, there was agreement that both types of research were needed. The Conference participants, however, differed considerably in the degree of emphasis which they placed on the two types of studies. Mr. Hess emphasized the practical operating value and ready accessibility of the data obtained from local studies. He felt that practical results can be achieved with a great deal more ease if use is made of the advantage gained in collecting base material from the various highway departments with university cooperation.

He added that each state highway department must be cognizant of land values and the reaction of land prices and that the collection of these materials is an integral part of their operations. He urged that each state undertake to put these data together, and expressed a doubt that personnel would be a problem. Finally, he stated that a great deal of basic material for any study in depth would be so obtained.

Messrs. Waters and Morf advocated close cooperation with University research agencies in economic impact research. Mr. Morf also pointed to the highway department's interest in the work being carried on under Mr. Carroll in the Chicago Area Transportation Study.

Mr. Garrison suggested the need for a coordinating study to bring together work that has been done on the impact problem; the local, state, and national studies; and the empirical experience of the highway departments. To him, such a synthesis of work actually done represents an appropriate first step. Mr. Wetmore thought that this objective would be aided by calling a series of regional meetings to discuss needs and survey resources. He thought that one major result might be the completion of work now under way or contemplated in time to be used for the 210 Study.

Mr. St. Clair pointed out the need for geographic coverage and the inclusion of various types of highway systems in the studies of nonvehicular benefits.

Mr. Stewart thought that a small group might be set up to undertake an economic analysis of the financial issues. He suggested a centralized analytic approach using representatives of the professional associations as a kind of advisory committee. He mentioned the American Farm Economics Association, the American Economic Association, and the American Institute of Planners, as examples of groups which might be approached. This would not be a substitute for, but would complement the local study approach.

#### RESOLUTIONS OF CONFERENCE

Further emphasis on the need for the national approach came from Mr. Ackerman. He expressed the view that more precise definition of the

meaning of economic impact and a fuller identification of the community values to be obtained were needed. The general economic orientation should involve a determination of the environment within which highway and community planning would be undertaken, both nationally and regionally. With this in mind he proposed the first resolution considered by the Conference:

Resolution 1. The Conference recognizes the significance of a comprehensive view of highway construction on a national scale. With this in mind, it recommends that the Highway Research Board examine ways and means of organizing and completing a study of forces influencing the origin and destination and flow of highway traffic on an anticipated national pattern. The objective of such a study would be the determination of the general extent and direction of potential traffic pressure generated by resource development and other economic growth factors, social changes, and the development of other parts of the transportation system. The period of projection envisaged is in the order of 20 to 30 years, with completion of a preliminary study by March 1, 1959, if feasible.

The Ackerman proposal touched off some discussion as to whether or not it fell within the scope of Resolution 4 as passed by the American Association of State Highway Officials (See Appendix A).

Speaking on behalf of the Highway Research Board, Mr. Burggraf stated that the Conference was an open one, and that he would carry its proposals to the Executive Committee of the Board. He did not consider that the Conference should be restricted in any manner in its recommendations.

There was some discussion regarding the propriety of using state  $1\frac{1}{2}$  percent funds 1/ on a national impact study, should this come about. Mr. St. Clair pointed out that data from the states were being gathered on interstate highway needs, and for traffic and weight studies on this basis. Mr. Holmes felt that Bureau funds would be available to a limited extent.

Mr. Ackerman claimed that if studies were to be made on a state or local basis the economic environment in which the state would operate and do business must be determined.

Mr. Steele suggested a series of steps for getting research studies under way. He advocated regional meetings and conferences with state highway, university, and Bureau of Public Roads representatives. Definite research projects would be presented at these meetings.

Mr. Wetmore, with the assistance of Mr. Garrison, offered a corollary resolution to that of Mr. Ackerman:

Resolution 2. ...And be it further resolved that it is the consensus of the Conference that the Bureau of Public Roads and the Highway Research Board stimulate, encourage, and coordinate state and local research on the economic impact of highway improvements in both urban and rural areas, especially by the state highway departments, and that a working partnership with university and other qualified agencies would help achieve significant accomplishment in the analyses needed.

The prevailing opinion was that both broad national and local approaches should be sought, and that the two resolutions were not mutually

exclusive. Both resolutions were passed.

The discussion following, however, indicated some loose ends. Mr. Adkins thought that the resolutions merely restated the purpose of the Conference. Mr. Taylor felt that there was insufficient indication of the specific types of research needed. He added that he was looking toward some discussion of measuring the benefits to the user-groups, including the portion which might be considered as transferred vehicular benefits.

Mr. Stewart, aided by Mr. Wehrly, offered the following resolution:

Resolution 3. Resolved that an advisory committee be established with the Bureau of Public Roads and the Highway Research Board, whose primary purposes will be to establish, analyze, and evaluate the economic effects of the highway program as they bear on urban and rural land use and land values, taxation, and related matters; that among its duties shall be the promotion of analyses by professionals in the relevant fields for discussion in national, regional, and institutional groups; and that the committee promote clarification of the public interest in the various tax aspects of highway development under Federal promotion as may give largest value and acceptance to the Bureau's reports required by the Congress on March 1, 1959.

This resolution was seconded by Mr. Carroll and passed.

Mr. Wehrly thought that the group should include a broad representation of experts, including some groups not represented at the Conference, such as urban land economists, appraisers, and business interests, so that the full implications which arise out of the program might not be missed. The suggestion met with general approval.

The ideas advanced by Mr. Steele were then incorporated in a resolution offered by Mr. Zettel:

Resolution 4. Resolved that it be recommended that the Bureau of Public Roads proceed through its regular channels to devise a series of project proposals for study in the field of economic impact of highways, and that these projects be discussed in a series of regional meetings with representatives of the Bureau, the Highway Research Board, the state highway departments, and the colleges and universities, and that projects be set up at that time if possible.

This resolution, seconded by Mr. Wetmore, was passed.

A final resolution was offered by Mr. Intermaggio:

Resolution 5. Resolved that the city and regional planning agencies throughout the country should be encouraged to accelerate local planning as an aid in the development of highway programs in their communities.

This resolution was carried.

The Conference was adjourned after voicing appreciation and commendation to the two chairmen of the sessions, Mr. Levin and Mr. St. Clair, and to officials of the Highway Research Board and the Bureau of Public Roads who had organized the Conference, and words of appreciation from Chairman Levin and Mr. Burggraf to the participants for their attendance and contributions to the meeting.

## *Summary*

The Conference on Economic Impact of Highway Improvement brought together some 40 urban planners, engineers, economists, sociologists, lawyers, geographers and others who have been studying the effects of improved highways on land values, patterns of land use, and economic activity. They were assembled at the invitation of the Highway Research Board at the suggestion of the American Association of State Highway Officials. They represented the Federal government, the states, municipalities, and a number of private organizations and universities. The purpose was to discuss research findings, review the techniques used, and stimulate more research on economic changes wrought by highway improvements on non-vehicular users.

The conferees heard descriptions of completed and current projects from the researchers themselves, including the older studies of agricultural land, Westchester County parkways, a large group of California studies, recently completed studies of suburban and rural impact in the State of Washington, current work on the Dallas Expressway and the Gulf Freeway, the Boston Circumferential Highway, studies in Oklahoma, the Connecticut Turnpike, and others. Searching questions were asked, techniques of analysis described, and sources of data indicated.

State highway department representatives underscored their immediate need for economic data for public hearings on highway relocations and community bypasses and for the appraisal of land in right-of-way acquisition. Bureau of Public Roads staff members spoke about their responsibilities and needs to meet the directions of Congress for a Highway Cost Allocation Study under Section 210 of the 1956 Highway Revenue Act.

The Conference succeeded in directing a multi-disciplined attack on the problems posed by its sponsors. This is well illustrated in the summaries and discussions detailed in these proceedings.

Some of the far-reaching interrelations between highway improvement, the central business district, mass transit, local government structures, and urban land and community planning were discussed by specialists, though not exhaustively. Thus, the many-faceted implications of the new program of highway construction and of highway improvement in general were pointed up.

Considering the diverse backgrounds of the participants, the Conference developed few areas of controversy, but some significant contrasts in emphasis. The Conference generally accepted the notion that there were at least three types of studies: (a) short-range, operational, spot or local; (b) long-range; and (c) theoretical or conceptual studies.

The Conference produced a number of suggestions on subjects for further research, and aired the chief problems in getting research under way in good time; namely, adequate personnel and funds.

## *Appendix A*

### **Resolution by AASHO Requesting Conference on Economic Impact of Highway Improvement**

RESOLUTIONS ADOPTED BY AASHO  
42nd ANNUAL MEETING, ATLANTIC CITY, N. J.  
NOVEMBER 27-30, 1956

\* \* \*

#### *Resolution No. 4*

WHEREAS an increasing number of state highway departments are aware of the desirability of undertaking studies that seek to evaluate the economic impact of highway improvements on urban and rural communities, on business and industry, and on residence;

WHEREAS an impressive number of such studies have been undertaken or are under way now;

WHEREAS the data derived from economic impact research can save state highway departments millions of dollars in rights-of-way costs; can assist the state in its efforts to establish the most feasible routes of highway travel, especially in urban areas; and can be helpful in generally clarifying misunderstandings concerning the effect of highway improvement; Now therefore be it

*Resolved*, That the American Association of State Highway Officials in annual convention assembled in Atlantic City, New Jersey, November 27-30, 1956, hereby recommends that every state highway department consider the initiation of such economic impact studies, to the extent deemed feasible in each state.

The Association also recommends that the Highway Research Board be urged to sponsor a conference at an appropriate time of all those engaged in such studies and those interested in them, in order to exchange experiences concerning techniques and findings of such economic impact research.

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# **Appendix B**

## **AGENDA**

### **CONFERENCE ON ECONOMIC IMPACT OF HIGHWAY IMPROVEMENT**

MONDAY, March 18:

#### **INTRODUCTORY**

Presiding: David R. Levin, Chairman, Committee on Land Acquisition and Control of Highway Access and Adjacent Areas, Highway Research Board

Welcome: Fred Burggraf, Director, Highway Research Board

Problem Orientation: G. P. St. Clair, Chairman, Department of Economics, Finance and Administration, Highway Research Board.

Remarks by Chairman: David R. Levin

#### **Session I Impact of Highway Improvement on Land Values**

Review of several illustrations of present research  
Variation of technique with:

- (1) Area—urban, suburban, rural, rural
- (2) Kind of highway improvement—expressway, primary, secondary, etc.

Before-and-after analyses

Comparative area studies—affected and unaffected areas

Correlation methods—multiple regression analysis

Opinion and motivational research

Tax assessments versus market values

#### **Session II Impact of Highway Improvement on Land Use**

Examples of research treatment

Classes of uses

- (1) Agricultural
- (2) Residential
- (3) Business and industry
- (4) Government
- (5) Other

Methods of study

TUESDAY, March 19:

#### **Session III Special Problems**

The urban by-pass

Illustrative research on effects on existing businesses and establishment of new enterprises

Traffic interrelationship

- (1) Studies undertaken to date
- (2) Traffic volume, O & D studies, etc.

General economic orientation

- (1) Population, level of business activity, etc.
- (2) Area setting—regional, state, national

Other aspects of economic impact research

#### **Session IV Application to Highway Cost Allocation Study**

Nature and significance of the study

Kinds of work to be done

- (1) General economic analysis of highway benefits in relation to cost responsibility
- (2) Specific studies of economic impact

Extent of possible coverage in limited time

Techniques that will speed up completion of studies

#### **Session V Findings and Recommendations of Conference**

Adjournment

## *Appendix C*

### Statements on Research Prepared by Participants for the Conference on Economic Impact of Highway Improvement

*Requests for Copies of These Statements  
Should be Directed to the Authors*

- "Connecticut Turnpike Towns," by Walter C. McKain, Jr., Head, Department of Rural Sociology, University of Connecticut, Storrs, Connecticut.
- "Farm Land Values as Affected by Road Type and Distance," by Charles L. Stewart, University of Illinois, Urbana, Illinois.
- "By-Passes—Their Use, Effect and Control," by Harold L. Michael, Research Assistant, Joint Highway Research Project, Purdue University, Lafayette, Indiana.
- "Economic and Traffic Studies of By-Passes," by Harold L. Michael, Assistant Director, Joint Highway Research Project, Purdue University, Lafayette, Indiana.
- "Economic Study of Influence of Highway Route 128," by A. J. Bone, Director, Joint Highway Research Project, Massachusetts Institute of Technology, Cambridge, Massachusetts.
- "Preliminary Outline of Report on Economic Impact of Route 128 on Town of Needham, Massachusetts," by A. J. Bone, Director, Joint Highway Research Project, Massachusetts Institute of Technology, Cambridge, Massachusetts.
- "The Beneficiaries of Highways and Their Responsibility," by Maurice C. Taylor, Associate Professor, Agricultural Experiment Station, Montana State College, Bozeman, Montana.
- "Benefits from Highway Development User and Non-User," by Maurice C. Taylor and Carlton A. Infanger, Department of Agricultural Economics and Rural Sociology, Agricultural Experiment Station, Montana State College, Bozeman, Montana.
- "The Permanence of Limited Access Highways," by Adolf D. May, Jr., Assistant Professor of Civil Engineering, Clarkson College of Technology, Potsdam, New York.
- Paper prepared by Jerome J. Waters, Jr., Assistant Engineer, Economic Survey Section, Oklahoma Highway Department.
- "Manual of Procedure for Conducting an Economic Survey," Department of Statistics, Oklahoma State Highway Department, (Sept. 1956).
- "Proposed Working Plan—A Study of the Economic Effects of Limited Access Highways and By-Passes," by R. B. Goode, Highway Finance Research

Associate, Virginia Council of Highway Investigation and Research, University of Virginia, Charlottesville, Virginia, (March 1954).

"Charts Used in Presentation," by A. L. Straub, Virginia Council of Highway Investigation and Research, University of Virginia, Charlottesville, Virginia.

"Bibliography: The Economic Effects of Limited-Access Highways and Bypasses," by Joseph W. Harrison, Highway Economist, Virginia Council of Highway Investigation and Research, University of Virginia, Charlottesville, Virginia, (Dec. 1956).

"Statistical Analysis of a Road Improvement Impact Problem," by William L. Garrison, Department of Civil Engineering, University of Washington, Seattle, Washington.

"Obtaining Data for a Highway Impact Study," by William L. Garrison, Department of Civil Engineering, University of Washington, Seattle, Washington.

"A Source of Theory for Highway Impact Studies," by William L. Garrison and Brian J. L. Berry, Department of Civil Engineering, University of Washington, Seattle, Washington.

## Appendix D

### SELECTED LIST OF REFERENCES

#### (Emphasizing Effect on General Economic Conditions, Land Values, Land Use, and Other Nonvehicular Functions)

##### GENERAL REFERENCES

Automotive Safety Foundation, "What Freeways Mean to Your City." Washington, D. C. (1956), 47 p.

A general summary justifying freeway construction on grounds of safety, capacity, savings in time and cost of vehicle separation. Summarizes results of many past surveys and incorporates findings of special surveys of 15 large cities. A popular non-technical and useful summary.

Balfour, Frank C., "America's Highway Problems and Their Likely Effect on Real Estate Markets." California Division of Highways, Sacramento, Calif. (1954), p. 497-524; reprinted from *Appraisal Journal* (Oct. 1954).

Removal of through traffic increases property values along relieved highway in central business area. Land values along freeways incontestably rise; this is the reason for California revolving fund.

Balfour, Frank C., "Special Benefits." *Right-of-Way* (Feb. 1957), p. 7-18.

Paper before American Right-of-Way Association meeting, Olympia, Wash., (Sept. 14, 1956).

Considers large increases in value in parcels remaining in private ownership after purchase of segments for right-of-way.

Chamber of Commerce of the United States, Transportation and Communication Department, "How Bypasses Affect Business." Washington, D. C. (1956), 23 p.

"Selected references in field of street and highway traffic improvement": p. 23. Includes brief summary of findings of many of the studies in the field.

Clark, A. C., "What Are Benefits of Controlled Access?" *Better Roads*, (Apr. 1955), p. 52, 54.

Also in *Proceedings of Association of Highway Officials of the North Atlantic States* (1955), p. 101-106.

Georgia, State College of Business Administration, Bureau of Business and Economic Research, "Economic Consequences of Highways By-Passing Urban Communities." James H. Lemly, Atlanta (1956), 50 p. (Research Paper No. 1).

A recent survey of bypass impact studies completed and in progress.

Labatut, Jean, ed., "Highways in Our National Life." Ed. by Jean Labatut and Wheaton J. Lane, Princeton, Princeton University Press (1950), 506 p.

A historical and analytical symposium by 48 specialists. Article by Shorey Peterson, "The Highway from the Point of View of the Economist," of special interest.

Mitchell, Robert B., "Urban Traffic, A Function of Land Use." Robert B. Mitchell and Chester Rapkin, New York, Columbia University Press (1954), 226 p.

Draws heavily from case study materials on Philadelphia metropolitan area.

Mumford, Lewis, "Culture of Cities." New York, Harcourt Brace (1938), 586 p.

Broad socio-historical perspective on the implications of our sprawling urban agglomerations.

Owen, Wilfred, "The Metropolitan Transportation Problem." Washington, D. C., The Brookings Institution (1956), 301 p.

A well-documented and recent analysis by one of the leading authorities. Includes materials on mass transit and community planning.

Stewart, C. L., "Farm Land Values as Affected by Road Type and Distance." Journal of Farm Economics (Nov. 1936), p. 724-735.

Includes bibliography.

One of the earliest studies in the field summarizes existing studies of road and land value relationships. Emphasizes results differ according to type of farming.

U. S. Public Roads, Bureau of, "First Progress Report of the Highway Cost Allocation Study." Washington (1957), 131 p. (85th Cong., 1st sess. House Doc. No. 106).

Viner, Jacob, "Urban Aspects of Highway Finance." Public Roads (Jan. 1926), p. 233-235, 240; (Feb. 1926), p. 260-268.

Penetrating economic analysis still pertinent after more than 30 years.

#### AREA STUDIES

Aldrich, Lloyd, "A Study of Freeway System Benefits." Los Angeles, Street and Parkway Design Division (1954), 37 p.

Quantifies traffic benefits on the major area of freeway development.

Coro Foundation, "A Study of the Effect of Land Acquisition for the Bay-shore Freeway on San Francisco Industry." San Francisco (1954), 9 p.

Studies effect of acquisition of land for freeway on San Francisco industry. Both gains and losses are indicated.

Dieter, Frank L., "Effect of Limited Access Highways on Community Development." In Proceedings of Conference on Modern Highways, Massachusetts Institute of Technology (1953), p. 149-152.

A planner's evaluation of the effect of the highway on different groups in the community.

Harding, Paul O., "By-Product Benefits of Freeways in Metropolitan Areas." American Highway (Oct. 1955), p. 6-9, 21-22.

Mentions, inter alia, relief of congestion on parallel routes, suburban development, urban redevelopment, acquisition of property for

community purposes, use of excavation sites and material, erosion control, ornamental planting, storm drainage, railroad crossing elimination, etc.

Hess, Rudolph, "Economic Effects of Freeways." In Proceedings of American Association of State Highway Officials (1955), p. 139-148.

Emphasizes, as economic effects of California freeways, (1) accelerated land use change, (2) improved competitive position of communities, and (3) stabilization of the tax-base. Draws on wealth of California data.

Kelly, John F., "Residences and Freeways." California Highways and Public Works (Mar.-Apr. 1957), p. 1-9.

Statewide study of influence of freeway construction on market value of California residential property concludes effect is "nominal".

Michaels, Harold L., "By-Passes—Their Use, Effect and Control." In Proceedings of Road School, Purdue University, Lafayette, Indiana (1953), p. 164-185.

Combines analyses of both traffic and nonvehicular aspects.

Moore, Arthur T., "Effect of the Pennsylvania Turnpike on the Economic Development of Certain Towns along Its Route." Harrisburg, Pennsylvania Turnpike Commission (1952), 16 p.

Series of newspaper articles which originally appeared in Pittsburgh Sun-Telegraph.

Moses, Robert, "The Influence of Public Improvement on Property Values." New York, Triborough Bridge and Tunnel Authority (1953), 20 p.

Compares assessed valuation of areas of New York City influenced by parkways and other types of public improvements with nonaffected comparable areas.

Nolen, John, "Parkways and Land Values." John Nolen and Henry V. Hubbard, Cambridge, Harvard University Press (1937), 135 p. (Harvard City Planning Studies, v. 11).

"List of more important references," p. 131-133. Includes classic study of Bronx River Parkway, 1910-1932.

Norris, L. V., Engineering Co., "A Study of Land Values and Land Uses along the Gulf Freeway in the City of Houston, Texas." Prepared for the Texas Highway Department and U. S. Bureau of Public Roads, Austin (1951), 190 p.

Primarily a study of land value changes along the route in contrast with "comparable" areas. 1956 edition brings study through 1955.

Oregon, University, Bureau of Business Research, "Economic Effects of Through Highways By-Passing Certain Oregon Communities." Prepared for Legislative Highway Interim Committee, Eugene (1956), 73 p.

Unfavorable effects on land values on bypassed communities attributed primarily to light traffic.

Prendergast, Frank, "Boom on Highway 128." *Industry* (June 1955), p. 17-21.

Striking account of industrial, commercial and residential impact, and effect of development on tax rate.

Tallamy, B. D., "Control of Highway Access: Experiences in New York." *American Society of Civil Engineers, Proceedings, Vol. 82, Journal of the Highway Division, No. HW 1* (Jan. 1956), p. 1-6 (Paper 871).

Reviews stimulus to economic activity provided by New York Thruway.

Van Tassel, Roger, "Economic Aspects of Expressway Construction." *American Institute of Planners Journal* (Spring 1954), p. 82-86.

Diversion of through traffic reduced congestion so that the Olneyville shopping center greatly increased its sales, property values rose and parking eased.

Washington State Council for Highway Research, "Allocation of Road and Street Costs." *Seattle, 1956.*

Part IV. "The Benefits of Rural Roads to Rural Property," by William L. Garrison. 107 p. Bibliography: p. 103-107.

Analysis employing correlation techniques of impact of highway improvement in selected rural counties.

Part V. "The Effect of Freeway Access upon Suburban Real Property Values, a Case Study of the Seattle, Washington, Area," by Bayard O. Wheeler. 142 p.

Significant rise in land prices and suburban development following the completion of the Lake Washington Floating Bridge in metropolitan Seattle.

Westchester County, N. Y., Planning, Dept. of, "Changes in Westchester and How People Feel about Them." *White Plains* (1955), 28 p.

Property values have been stabilized and protected by parkway system; residential property unprotected on main roads has declined, commercial investment and white collar employment encouraged.

Zettel, Richard M., "Effect of Limited Access Highway on Property and Business Values." *Berkeley, Institute of Transportation and Traffic Engineering, University of California* (1953), 15 p. "References": p. 95-96.

Also in *Institute of Traffic Engineers, Proceedings* (1953), p. 83-96. A careful and restrained conceptual evaluation which accepts the direct and transferred benefit theory of highway impact.

#### BIBLIOGRAPHIES

"A Bibliography of Economic Studies Published by the California Division of Highways." *California Highways and Public Works* (Sept.-Oct. 1956), p. 68.

Highway Research Board, Committee on Urban Research, "A Selected Bibliography on Economic Effects of By-Passes and Expressways." *Compiled in the Library of the Highway Research Board, Washington, D. C.* (1956), 6 p. Processed.

Highway Research Board, Library, "Economic Justification for Highways: Selected References." Washington, D. C. (1956), 4 p. Processed.

U. S. Public Roads, Bureau of, "List of Magazine Articles Discussing Highway Problems and the Highway Program." Washington, D. C. (1956), 2 p. Processed.

Virginia, Highway Investigation and Research, Council of, "Bibliography, The Economic Effects of Limited-Access Highways and By-Passes." Joseph W. Harrison, Charlottesville (1956), 16 p.

## Appendix E

### A Source of Theory for Highway Impact Studies William L. Garrison and Brian J. L. Berry University of Washington

It has long been known that transportation plays a vital role in the well-being of communities. As long ago as 1813, A. Young, the then British Secretary of Agriculture, reported:

The roadway was no sooner completed than rents rose from 7 shillings to 11 shillings per acre; nor is there a gentleman in the country who does not acknowledge and date the prosperity of the country to this road.  
(A General View of the Agriculture of Sussex, 1813)

This common knowledge has long posed problems to those who would predict or explain the impact of improved transportation routes. It has not always been clear, however, that a large body of theory is available that should serve to relate seemingly diverse impact problems, point up priorities for research, and allow generalization from limited empirical experience.

Perhaps part of the reason highway impact studies have not been oriented more closely to theory is that the nature of impact is not entirely obvious. The impact of a transportation route, say a road, is a functional impact. Routes function by connecting places. Good routes bring places close together, poor routes keep places separated. A route improvement occasions an improved functioning of the route and places served by the route are brought closer together. The impact problem, then, is a problem that treats relationships between locations and we must look to theory that treats locations explicitly for a theoretical basis for impact studies.

Other likely reasons why impact studies have not been more closely theory oriented might be mentioned. The researcher has been tempted by issues of public policy (for example, is the impact of a one-way street system more or less desirable than the impact of a two-way grid?) and rightly so, for many of these issues have been extremely important. Also, there has been much need for the traditional simple and expressive cost-benefit approach to impact problems and the researcher's attention has been rightly attracted to these problems. It will be pointed out shortly that cost-benefit analysis may have a basis in theory that treats of locations.

It must be understood that in the current statement we are not depreciating studies of the class referred to in the above paragraph, these studies have been and will continue to be important. The present statement is concerned with another subject. We wish to emphasize the availability for impact problems of theory that treats locations.

This theory, here termed location theory, may be thought of as serving in several situations. Not all of the theory that treats locations is usually termed location theory. For simplicity, however, this term is used in a broad sense in the present study. These situations are used as divisions of ensuing portions of this statement. It must, of course, be recognized that the succeeding discussion makes no pretense at providing a complete discussion of all theoretical statements available.

## EXPLANATIONS OF LAND USE

Land use tends to be the outcome of competitive bidding for locations. Relative location may change when highways are improved and, thus, land use may change. Theory that explains land use as the outcome of location is clearly pertinent to the highway impact problem.

There is a long history, dating from Thünen (1826), of theory explaining the arrangement of agricultural land uses. In this theory agricultural land uses compete for the supply of land, and ability to compete is determined by location and transportation qualities. The theory has recently been restated by Heady (1952), Dunn (1954) and Isard (1956) and treated in axiomatic form by Marble (1956). There is no doubt that the theory is a powerful conceptual tool, especially as it may be applied to broad areas. Kellogg (1935) found the notions of the theory useful in one study, but Garrison (1956) did not find the Thunen notions useful on a local level. The findings of Church (1950) are interesting in this general context.

Land use in urban areas has been approached in a manner quite similar to the Thünen scheme for agricultural land uses. Ely and Wehrwein (1940), for example, have provided an account of the process of displacement of urban land uses due to competitive bidding for locations. Park (1925), Hoyt (1939), Mitchell and Rapkin (1954), and others have also suggested schemes which serve to explain land uses, but these schemes are based on broad "ecological" notions and are less explicit than those concerned strictly with the competitive bidding for sites. Firey (1947), Durden (1955) and others have provided summary statements of these latter schemes and have reported that the theory gives mixed results when applied to actual situations.

ARRANGEMENTS OF TRANSPORTATION ROUTES,  
URBAN FUNCTIONS, AND URBAN CENTERS

Another body of theory seeks to explain the arrangements of cities and transportation routes. Transportation is basic to the system, which is defined on an ability to trade goods from urban centers to surrounding tributary areas. The approach is aggregative and geometric. Urban functions group together, giving rise to urban centers while the spacing of these centers is geometrically determined by the competition of groups of functions for market areas.

There are several sources of theory for this problem. Christaller (1933) some years ago provided a general discussion of a theory (the hierarchical class-system) and elaborated a special case of the theory. The character of this special case has been elaborated in the American literature by Ullman (1941). This theory and the associated concepts of Fetter (1924) have since been further developed by Lösch (1944) and Isard (1956) and in both cases interesting results are available, especially with reference to the arrangement of transportation routes. The theory has since been subjected to empirical testing by Green (1948), Brush (1953), Bracey (1953), and many others. Vining (1955), however, has pointed out some empirical problems of verification of the theory. On the other hand, Berry (1956) has shown that the theory is viable, at least when one is concerned with the smaller urban centers.

Alternate approaches are available for the same problem. Bogue (1950) has recently treated the notion of metropolitan dominance over tributary areas. Reilly (1931) has popularized gravitational models that seek to explain the competitive positions of cities. Models essentially of the same type have been applied to alternate location processes by other, e. g., Carroll (1955) and Stouffer (1940). It has been pointed out by Converse (1946), Ikle (1954), and others that these models produce good results when applied to data. On the other hand their conceptual bases are not clear. Thus, it is not clear how these concepts might be applied with value to highway impact problems.

#### LOCATION OF PARTICULAR ENTREPRENEURS

There are also tools available for dealing with particular entrepreneurs or particular industries, in contrast to the levels of aggregation implied in the discussion above. Weber (1909), Dean (1938) and Engländer (1926) have provided simple schemes applicable to the small producer, Kelley (1956) has discussed the problem for the retail establishment, while Chamberlin (1933) and Orr (1957) have dealt with the large producer. Samuelson (1952), Enke (1951), Fox (1953), and Orr (1957) have dealt with the equilibrium of industries as a whole. These spatial equilibrium models are important, especially if one wishes to work from cost-benefit or optimizing standpoints. For example, Fox (1953) has shown how explicit recognition may be made of changes in transport costs. Orr (1957) further demonstrated how net social returns resulting from trade could be maximized by making optimum use of the available transport system. This latter has direct implications for cost-benefit notions; here is a measure of returns from transportation.

#### THE ECONOMY AS A WHOLE

Weigmann (1931), Predohl (1925), Palander (1935), Lösche (1944) and Isard (1956) have shown how the impact of transportation is viable within the broad context of economic theory. Isard (1956) in particular has noted that if transport is considered as an input of the same nature as the classical factors of production—land, labor, and capital—then location notions can enrich the theory of economics. Economic theory has been of use in important transportation problems for many years, of course, and valuable theoretical ventures in this frame of reference are provided by the works of Beckmann (1952) and Koopmans (1949). It is noted here only that current merging of concepts may make economic theory even more valuable for the problems before us.

#### SUMMARY

A tentative attempt has been made to state the highway impact problem as one of relationships among locations. To the extent that this is proper, references to location theory serve to provide an orientation for highway impact studies.

#### SELECTED REFERENCES AND LITERATURE CITED

- M. Beckmann, "A Continuous Model of Transportation," *Econometrica* 20, 1952, pp. 643-660.
- \_\_\_\_\_, "The Partial Equilibrium of a Continuous Spatial Market," *Weltwirtschaftliches Archiv* 71, 1953, pp. 73-89.

- Brian J. L. Berry, "Geographic Aspects of the Size and Arrangement of Urban Centers," unpublished M. A. thesis, University of Washington, 1956.
- D. J. Bogue, "The Structure of the Metropolitan Community: A Study of Dominance and Subdominance," University of Michigan, 1950.
- H. E. Bracey, "Towns as Rural Service Centres," Institute of British Geographers, Transactions and Papers, 19, 1953, pp. 95-105.
- \_\_\_\_\_, "A Rural Component of Centrality Applied to Six Southern Counties of the United Kingdom," Economic Geography, 32, 1956, pp. 38-50.
- John E. Brush, "The Hierarchy of Central Places in Southwestern Wisconsin," Geographic Review, 43, 1953, pp. 380-402.
- J. D. Carroll, "Spatial Interaction and the Urban—Metropolitan Regional Description," Papers & Proceedings, 1, Regional Science Association, 1955.
- E. H. Chamberlin, "The Theory of Monopolistic Competition," Cambridge, Mass., 1933.
- Walther Christaller, "Die zentralen Orte in Suddeutschland," Jena: Gustav Fischer, 1933, translated by C. Baskin at the Bureau of Population and Urban Research, University of Virginia, 1954.
- D. E. Church, "Effect of Increases in Freight Rates on Agricultural Products," U. S. Dept. of Agriculture, Circular 947, Washington, 1950.
- P. D. Converse, "Retail Trading Areas in Illinois," University of Illinois Business Studies, 43, 1946.
- W. H. Dean, "The Theory of the Geographic Location of Economic Activities, unpublished dissertation, Harvard University, 1938.
- E. S. Dunn, "The Location of Agricultural Production," Gainesville, 1954.
- C. D. Durden, "Some Geographic Aspects of Motor Vehicle Travel in Rural Areas," unpublished Ph.D. dissertation, University of Washington, 1955.
- R. J. Ely and G. S. Wehrwein, "Land Economics," New York: Macmillan, 1940.
- O. Engländer, "Kritisches und Positives zu einer allgemeinen reinen Lehre vom Standort," Zeitschrift für Volkswirtschaft und Sozialpolitik, Neue Folge, v. 1926.
- S. Enke, "Equilibrium Among Spatially Separated Markets," Econometrica, 19, 1951, pp. 40-47.
- F. A. Fetter, "The Economic Law of Market Areas," Quarterly Journal of Economics, 1924, pp. 520-529.
- Walter Firey, "Land Use in Central Boston," Cambridge: Harvard University Press, 1947.
- K. A. Fox, "A Spatial Equilibrium Model of the Livestock-Feed Economy of the United States," Econometrica, 21, pp. 547-566, 1953.
- \_\_\_\_\_, and R. C. Tauber, "Spatial Equilibrium Models of the Livestock Feed Economy," American Economic Review, 40, pp. 584-608, 1955.
- W. L. Garrison, "Verification of a Location Model," Northwestern University Studies in Geography, 1956.
- \_\_\_\_\_, and Brian J. L. Berry, "The Functional Bases of the Central Place Hierarchy," unpublished manuscript, 1957.
- \_\_\_\_\_, and Brian J. L. Berry, "The Distribution of City Sizes," unpublished manuscript, University of Washington, 1957.
- F. H. W. Green, "Motor Bus Centres in S. W. England Considered in Relation to Population and Shopping Centres," Inst. Brit. Geographers, Trans. and Papers, 14, 1948, pp. 57-68.
- E. O. Heady, "Economics of Agricultural Production and Resource Use," New York, 1952.

- H. Hoyt, "The Structure and Growth of Residential Neighborhoods in American Cities," Federal Housing Administration, G.P.O., Washington, 1939.
- F. C. Ikle, "Sociological Relationship of Traffic to Population and Distance," Traffic Quarterly, April 1954.
- Walter Isard, "Location and Space Economy," New York: Wiley, 1956.
- E. J. Kelley, "Shopping Centers," Eno Foundation, Saugatuck, 1956.
- C. E. Kellogg, "A Method of Rural Land Classification," Tech. Bull. 469, 1935, U.S.D.A.
- T. C. Koopmans, "Optimum Utilization of the Transportation System," *Econometrica* 17, 1949, pp. 136-146.
- \_\_\_\_\_ and S. Reiter, "A Model of Transportation," Ch. XIV of *Activity Analysis of Production and Allocation*, ed. T. C. Koopmans, Wiley, 1951.
- A. Lösch, "The Nature of Economic Regions," *Southern Economic Journal*, V, 1938, pp. 71-78.
- \_\_\_\_\_, "Beitrage zur Standortstheorie," *Schmollers Jahrbuch*, LXII 1938, pp. 329-335.
- \_\_\_\_\_, "Die Räumliche Ordnung der Wirtschaft," Jena: Gustav Fischer, 1944, translated by W. H. Woglom and W. F. Stolper as "The Economics of Location," New Haven: Yale University Press, 1954.
- D. F. Marble, "The Spatial Structure of the Farm Business," unpublished thesis, Dept. of Geogr., Uni. of Washington, 1956.
- R. B. Mitchell and E. Rapkin, "Urban Traffic: A Function of Land Use," New York: Columbia, 1954.
- E. W. Orr, "A Synthesis of Theories of Location, of Transport Rates, and of Spatial Price Equilibrium," *Papers and Proceedings, Regional Science Association*, 3, 1957 (forthcoming)
- T. Palander, "Beiträge zur Standortstheorie," Uppsala, 1935.
- R. E. Park et al, "The City," Chicago, 1925.
- A. Predöhl, "Das Standortproblem in der Wirtschaftstheorie," *Weltwirtschaftliches Archiv* XXI, 1925, pp. 294-331.
- \_\_\_\_\_, "The Theory of Location in its Relation to General Economics," *Journal of Political Economy* XXXVI, 1928, pp. 371-390.
- \_\_\_\_\_, "Aussenwirtschaft: Weltwirtschaft, Handelspolitik und Wahrungspolitik," Göttingen, 1949.
- W. J. Reilly, "Methods of the Study of Retail Relationships," *University of Texas Bulletin* 2944, 1929; idem, *The Law of Retail Gravitation*, New York, 1931.
- P. A. Samuelson, "Spatial Price Equilibrium and Linear Programming," *American Economic Review*, 42, pp. 283-303, 1952.
- J. Q. Stewart, "Empirical Mathematical Rules Concerning the Distribution and Equilibrium of Population," *Geogr. Rev.*, 37, 1947, pp. 461-485.
- S. A. Stouffer, "Intervening Opportunity: A Theory Relating Mobility and Distance," *American Soc. Review*, 5, 1940.
- J. H. von Thünen, "Der Isolierte Staat in Beziehung auf Landwirtschaft und National-Ökenamie," Hamburg, 1826.
- E. L. Ullman, "A Theory of Location for Cities," *American Journal of Sociology*, XLVI, 1941, pp. 853-864.
- Rutledge Vining, "A Description of Certain Spatial Aspects of an Economic System," *Economic Development and Cultural Change*, 3, 1955, pp. 147-195.
- A. Weber, "Über den Standort der Industrien," Tübingen, 1909; Translated by C. J. Freidrich as "Alfred Weber's Theory of the Location of Industries," Chicago, 1929.

Hans Weigmann, "Ideen zu einer Theorie der Raumwirtschaft," Weltwirtschaftliches Archiv XXXIV, 1931, pp. 1-40.

\_\_\_\_\_, "Standortstheorie und Raumwirtschaft," Joh. Heinr. von Thünen zum 150 Geburtstag, ed. W. Seedorf und H. Jürgen, Rostock: Carl Hinstorffs, 1933, pp. 137-157.

## Statistical Analysis of a Road Improvement Impact Problem William L. Garrison, University of Washington

Several "standard" research designs are available for the solution of problems. The present discussion illustrates how one of these standard designs, a regression design, was applied to a highway impact study. 1/ In the case in point each observation in the data set consisted of a property value matched with measures of the road service of the subject property and other qualities of the property bearing on its value (for example, land utilization). The measurements of road service were in miles of road for a cross classification of road surface type by road use type (e. g., we could speak of 10 miles of dirt road used for the journey to work).

The first problem was to estimate the association of property value with road service.

### THE ESTIMATES

The problem was handled 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 an extensive a scale as that in these studies. However, the use of electronic high-speed 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 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 studies.

In general, the postulated relationships took the form:

$$Y = a + \sum_{i=L}^n \beta_i X_i + \epsilon$$

in which Y is property value, a is a constant, and the X<sub>i</sub>'s are the variables of road use, etc.

For each study, the data were arrayed on punch cards and matrix transposition, multiplication, and inversion steps yielded the net regression coefficients (the b<sub>i</sub>'s as estimates of the β<sub>i</sub>'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 β<sub>i</sub> = 0 and β<sub>i</sub> = β<sub>j</sub> and on the basis of the contribution of each

1/See William L. Garrison, "The Benefits of Rural Roads to Rural Property", Seattle: Washington State Council for Highway Research, Part IV of the Allocation of Road and Street Costs, 1956.

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. Measurements of amount of road were made in two ways—a simple measurement and a weighted distance measurement (miles traveled per unit of time). In each study area the regression (or regressions) using the weighted measurements gave a lower error variance than the regression using simple distance measurements and in nearly all cases the simple 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 weighted distance measurements and property values. Theoretical considerations suggested that property values would vary with the inverse of distance. <sup>2/</sup>Regressions using this function were compared with linear functions and the "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.

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  $\beta_i = 0$  and were rejected in almost every instance. The remainder of the coefficients related to the distance 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 not rejected in almost every case. For the remaining trip types the hypothesis was not rejected for the paved road terms in about half the cases. Next, for the trip types where the hypothesis  $\beta_i = 0$  was rejected for poorer than paved roads, the hypothesis  $\beta_i = \beta_j$  was tested to compare the paved road coefficients with the non-paved road coefficients. This hypothesis was rejected for the paired coefficients in at least one of the trip types in every study.

#### THE IMPACT

Once the association of property values with road service was known it was a simple matter to estimate the impact of road improvements. One item of information, for example, was that travel via gravel roads for usual household shopping in one farm situation depreciated farm property values by approximately one-fifth of a cent, per acre, per mile traveled, per year. Travel of one thousand miles in a year would depreciate each acre of farmland by two dollars and fifty cents. To find the impact of road improvement all that needed to be done, then, was remove the depreciation of value by present service roads. In the example case and if the gravel road was improved to a paved road, the depreciation of two dollars and fifty cents would be removed and replaced by the lesser

<sup>2/</sup>Based on the observation that costs of transfer are concave downward over distance (see Edgar M. Hoover, "The Location of Economic Activity" New York: McGraw-Hill, 1948, pp. 19-21.)

depreciation of a paved road. The impact is taken to be the difference between the two rates of depreciation.

But will this procedure yield valid measures of impact? The derived measures of property value depreciation apply only if stable patterns of road utilization can be assumed. Put another way, it is necessary to know if the structure generating observed values will change when roads are improved. <sup>3/</sup>

This question posed the second problem for statistical analysis. It was desired to know if propensity to travel for any purpose varied from road surface type to road surface type.

#### VERIFICATION OF THE MODEL

The model for this portion of the research was also a regression model. Trip frequency was compared with road surface type in light of (1) different types of trips that may be made and (2) a presumed tendency for trip frequency to diminish with length of trip in a non-linear manner. The latter occasioned the transportation of the model to logarithms. Differences in road type were introduced into the calculations by using a separate term in the regression for each type of road. This gave the postulated relationship:

$$\log F = \alpha + \sum_{i=1}^n \beta_i (\log X_i + 1) + \epsilon$$

in which F = trip frequency (trips per week);  $\alpha$  = a constant term;  $X_1$  = distance via paved roads to the usual terminus of a trip type (distance in miles);  $X_2$  = distance via gravel roads;  $X_3$  = distance via dirt roads; and  $\beta_i$  = the parameters to be estimated. The problem to be solved is a compromise. The postulated relationship attempts to recognize both the presumed tendency of trip frequency to diminish with increased distance and the presumed tendency for trip frequency to vary with the type of road over which the trip is taken. A separate model was used for each type of trip (for example, the journey to work).

The results of calculations using this model tended to verify measures developed with the regression model discussed earlier. In general, relationships could not be developed in the form specified. This is an indirect sort of verification, of course, but it does illustrate another place where regression was found useful in a road impact study.

### Obtaining Data for a Highway Impact Study

William L. Garrison, University of Washington

How do highway improvements affect areas? The answer to this question obviously depends on a number of considerations. Thus it is not surprising that research designs addressed to the question incorporate a variety of data and data gathering techniques.

Steps used in obtaining data for a recent study in Washington State

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<sup>3/</sup>Put still another way, it was desired to know if the model could be considered to be a "uniquational complete model."

serve to illustrate data collection problems. 1/ This study was concerned with rural lands and the original hypothesis was that impact of road improvements could be measured using property value. For each observed parcel of property it was desired to obtain: (1) a measure of property value, (2) measurements of the location of the property from several reference places, (3) measurements of the location of the property in terms of the quality and quantity of service roads, and (4) measurements of other characteristics of the property that might affect property values.

These measurements were achieved in six steps:

1. A parcel of land was selected for study and the value of the property was obtained from sales records.

2. An interviewer visited the study parcel to determine the size of the parcel, the type of land utilization, and the location of the property in reference to the towns and roads.

3. The size of parcel interview data was checked against public records and the property value was converted to a unit base (one acre).

4. If the parcel was a farm or part of a farm, a land capability rating and, in cases, other ratings relating to the utility of the land were assigned using data from public records.

5. Location characteristics were assigned to each parcel using four or five reference points, depending on whether or not the parcel was used in farming, and using information from the interviews. The reference places were usually but not necessarily towns. The location reference places were:

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

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

(c) The terminus most frequently visited for purposes of amenities. Trips to church and to grange activities are examples of trips used to define this type of terminus. Amenity travel when the travel was a means rather than an end (pleasure driving) did not enter into the analysis.

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

(e) If the study parcel was a farm, the place of the usual sale by the farmer of products of the farm business.

(f) If the study parcel was the site of a non-farm residence, the terminus of the journey to work.

6. Measurements of the quality and quantity of road service to the study parcel were then made using route data from the interviews. Based on experience with the interviews it was decided to recognize, when practicable, three kinds of roads separated on the basis of type of surface: hard surfaced, gravel, and dirt. Each of these road types was allowed to vary in quantity by the assignment of a linear scale. Two scales were used:

(a) Miles to a terminus. If, for example, a study parcel was ten road miles from the terminus of usual household shopping and four of the miles were via gravel roads, none via dirt roads, and six via paved roads,

1/William L. Garrison, "The Benefits of Rural Roads to Rural Property," Seattle: Washington State Council for Highway Research, Part IV, of the Allocation of Road and Street Costs, 1956.

the study parcel would be assigned location quantities of 4, 0, 6 relative to the terminus.

(b) Miles traveled per year to a terminus. The unit of time—one year—was used for convenience. In the case used in the example in (a) above and if one year of travel over the route amounted to 500 miles, the location quantity assigned would be 200, 0, 300.

The six numbered steps listed above were used in the gathering and organization of the data. For each parcel of land studied there was an observed property value (obtained in step 1). Other items of information were obtained and organized (steps 2 through 5) in such a manner that they could be used to explain or account for the observed property value. Although the data were organized in a simple manner, the necessity of recognizing types of locations, types of roads, and variations in the use of roads lead to complex arrangement of data. A single farm might have, for example, an observed property value and: (a) a land capability class; (b) an irrigated or not irrigated rating; (c) a type of farming rating; (d) a set of linear distance measurements, up to fifteen in number; (e) a set of trip distance measurements, up to fifteen in number.

The list (a) through (e) above reveals the rather complex structure of the final aggregation of data. From the standpoint of the discussion of the studies and the analysis of the data this complex structure leaves much to be desired. On the other hand, there is no evidence that the problem is a simple one.

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**T**HE NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL is a private, nonprofit organization of scientists, dedicated to the furtherance of science and to its use for the general welfare. The ACADEMY itself was established in 1863 under a congressional charter signed by President Lincoln. Empowered to provide for all activities appropriate to academies of science, it was also required by its charter to act as an adviser to the federal government in scientific matters. This provision accounts for the close ties that have always existed between the ACADEMY and the government, although the ACADEMY is not a governmental agency.

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The HIGHWAY RESEARCH BOARD was organized November 11, 1920, as an agency of the Division of Engineering and Industrial Research, one of the eight functional divisions of the NATIONAL RESEARCH COUNCIL. The BOARD is a cooperative organization of the highway technologists of America operating under the auspices of the ACADEMY—COUNCIL and with the support of the several highway departments, the Bureau of Public Roads, and many other organizations interested in the development of highway transportation. The purposes of the BOARD are to encourage research and to provide a national clearinghouse and correlation service for research activities and information on highway administration and technology.

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