NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM REPORT 18

COMMUNITY CONSEQUENCES OF HIGHWAY IMPROVEMENT

HIGHWAY RESEARCH BOARD NATIONAL ACADEMY OF SCIENCES - NATIONAL RESEARCH COUNCIL

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REPORT 18

COMMUNITY CONSEQUENCES OF HIGHWAY IMPROVEMENT

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Bureau of Public Roads, United States Department of Commerce.

The Highway Research Board of the National Academy of Sciences-National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway departments and by committees of AASHO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Highway Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

This report is one of a series of reports issued from a continuing research program conducted under a three-way agreement entered into in June 1962 by and among the National Academy of Sciences-National Research Council, the American Association of State Highway Officials, and the U. S. Bureau of Public Roads. Individual fiscal agreements are executed annually by the Academy-Research Council, the Bureau of Public Roads, and participating state highway departments, members of the American Association of State Highway Officials.

This report was prepared by the contracting research agency. It has been reviewed by the appropriate Advisory Panel for clarity, documentation, and fulfillment of the research plan. It has been accepted by the Highway Research Board and published in the interest of an effectual dissemination of findings and their application in the formulation of policies, procedures, and practices in the subject problem area.

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FOREWORD

By Staff

Highway Research Board

This report will be of particular interest to the highway economist, planner, and right-of-way agent. It provides a state-of-the-art appraisal of studies conducted throughout the United States concerning the economic impact of the construction of various types of freeway facilities. Also included are the results of a survey of state highway officials to determine both the utility of economic impact studies and existing gaps in knowledge in the area of nonuser benefits. Some general guidelines for conducting future impact studies are discussed and areas for future research are proposed.

The research on the "Community Consequences of Highway Improvement" was initiated in response to the increased attention that has been directed toward the nonuser benefits derived from construction of new highway facilities. Although a considerable body of information has been collected in economic impact studies conducted at many locations, there had not been an adequate correlation or appraisal of the findings. This evaluation was undertaken, therefore, to develop guidelines for highway agencies to follow in considering the community consequences of highway improvements, and to indicate those aspects in most urgent need of detailed research.

The research agency studied various types of economic impact studies classified according to the primary function or purpose of the freeway facility involved. The largest body of available literature related to the study of the bypass. Averages and ranges of the values for the various parameters studied are listed in relation to the size of the town being bypassed, and the effects measured are discussed.

The results and methodology of six urban circumferential studies dealing primarily with the effects of such facilities on property values and on apparent land-use were analyzed.

The third type of facility studied was the limited or partially-limited access highway forming a radial route for commuters in relatively large urban areas. Here the major emphasis was on the effects of the construction of this facility on property values and property taxes. A critique is presented of the methodology applied in the four studies analyzed.

The results from a survey of ten state highway departments are presented to explain the utility of the various studies conducted to date and to indicate the gaps in knowledge in the area of highway economic impact analyses. This section of the report is intended to provide a guide for future research. Brief descriptions of three specific studies which reflect new approaches taken by the research agency are presented in the introductory summary. In these studies new evaluative techniques are considered for use in future research.

Although the technical report submitted by the research agency includes five

volumes, only the first volume (Summary Report), which presents the research findings, is published herein. The second volume describes in detail the special studies conducted to go beyond the limits presented by the available literature. The third, fourth, and fifth volumes contain descriptions of the Automated Indexing System, the Automated Bibliography, and the Automated Indexes, respectively. The information contained in the additional four volumes is of value to persons conducting research in the area of nonuser benefits. These volumes have not been printed, but may be obtained through special ordering and printing.

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The assistance and cooperation of many persons and agencies in furnishing information and making suggestions on specific details of the conduct of this study are acknowledged. Inquiries to the several highway departments and research organizations mentioned in this report yielded much helpful information.

For the University of Washington, Edgar M. Horwood, Professor of Civil Engineering, and Myer R. Wolfe, Professor of Urban Planning, served as joint principal investigators for the work reported herein; Arthur L. Grey, Jr., Professor of Urban Planning, was consultant; and Carl A. Zellner was principal research assistant and coordinator. Other research assistants included Richard Anderson, Hugh Calkins, Robert Dial, Richard L. Ludwig, Alvin S. Marsden, Melinda McCreary, Dana Roberts, John L. Robertson, and Hiram Walker, all of the University of Washington; Eugene N. Heap and Joyce Herman, of the University of Southern California; and David I. Chale, of the University of California.

This summary volume was primarily the responsibility of Professor Horwood, with assistance from Mr. Zellner. Mr. Ludwig contributed Chapter Two and Appendix A. Special appreciation is expressed to Mr. Zellner, who in addition to co-authoring two volumes of this series had the major responsibility for the production of all of the publications and coordination of the office staff.

For the unpublished volumes referred to herein, primary responsibility was as follows:

Volume II—Part 1, Mr. Robertson, Mr. Walker, and Professor Wolfe.
Part 2, Professor Horwood and Mr. Chale.
Part 3, Professor Grey and Miss Herman.
Part 4, Professor Wolfe, Professor Grey, Mr. Heap, and Mr. Marsden.

Volume III—Part 1, Mr. Zellner.
Part 2, Mr. Dial.

Volumes IV and V (computer printouts)—Mr. Zellner.

The University of Washington, through its several colleges, departments, and research branches, provided facilities and support conducive to the effective prosecution of the work.

COMMUNITY CONSEQUENCES OF HIGHWAY IMPROVEMENT

SUMMARY

The research reported herein consisted of a review of the existing body of literature on nonuser or community consequences of highway improvements, with the objects of correlating and evaluating the published information, developing guidelines for highway agencies to follow in considering the community consequences of highway improvements, and specifying those aspects of the problem in most urgent need of detailed research.

The evaluation of existing studies was conducted through the development of an automated library, which involved a classification system for the literature by which it was examined for comparability of findings and correlation of results. The automated library comprises Volumes IV and V of the research report, with Volume IV consisting of an abstract of the studies available and Volume V being a keyword-in-context index. Volume III describes the entire methodological approach to the development of the library. These three volumes are not published, but qualified researchers may obtain loan copies by writing to the Highway Research Board.

Volume II presents four case-study probes into the little-explored areas of spatially integrated and theoretically oriented studies in the subject field, carried out as part of this project to orient the research analysis of the existing studies to some reasonable framework for correlation. These studies are summarized in Appendix C of this volume in lieu of publication of Volume II. However, qualified researchers may obtain loan copies of Volume II by writing to the Highway Research Board.

This summary report (Volume I) presents the evaluation of the existing studies and the four case history studies, together with the synthesis derived therefrom. The latter includes (a) interpretation of the results of both the current field studies and those already published, (b) appraisal of the several methods of making the studies and the validity of the results obtained, and (c) a discussion of the several ways in which those results can be applied by highway agency personnel and planners to achieve their expressed goals in providing better highways and highway service.

By far the largest volume of literature occurs in the analysis of the effects of bypasses, particularly upon small communities. The subsequent findings arising out of these studies reveal that no generalization can be made that bypasses aid local business in the bypassed community, other than in some reduction of congestion or increase of pedestrian amenity along the bypassed routes. There is, however, fairly conclusive evidence that bypasses affect communities differentially. By changing the nature of trade area boundaries and by altering the relationship of one town to another, a bypass can substantially depreciate economic activity in one community and appreciate it in another.

Next in significance to the bypass studies by way of reputation are the urban radial freeway studies, which have dealt mainly with land value changes in various distance bands from an urban radial freeway and at various distances from the

central focus of the urban region. The apparent conclusion from these studies is that land values are materially enhanced by proximity to a freeway in an urban radial corridor. Although these studies have been generally larger and represent more economic input than the bypass studies, most suffer from the bias of translating information about parcels which sold into general conclusions for all land in their vicinity.

The few studies dealing with circumferential roads in urban areas are too diverse in their nature to lead to any integrated results. The most famous of these studies, dealing with Route 128 around Boston, imputes a significant movement of industry to the vicinity of the freeway as a result of the transportation improvement. This study comes the closest of any in this class toward showing a substantial freeway impact on an area, although many exogenous factors have not been dealt with in order to separate out the freeway influence from that of other developments in the region.

The most important factor of development near Route 128 is induced traffic, a feature researched in only a very limited way.

Concerning the utility of the studies there are essentially three overriding reasons why the nonuser highway economic impact studies have been made. Most admittedly have been made for public relations purposes, in response to actual or foreseeable problems arising out of anticipated access control or highway relocation activities. Others were made in response to Section 210 of the Highway Revenue Act of 1956, and apparently mounting concern by the Bureau of the Public Roads over excessive severance damages as the Interstate System got under way. In a few states there has been legislative interest in highway cost allocation problems, particularly the potential for special assessment districts to finance extraordinary developments.

Many of the studies termed "community consequences" are actually studies of severance damages, which have been dismissed from analysis in this research because of the lack of real relationship to community consequences.

Gaps in knowledge expressed by interviewees relate mainly to uncertainty over methodological approaches to highway impact analysis, as well as a sharper understanding of the impacts themselves. Examples of the former are the means of isolating the impacts of highway change from other economic effects and the design and identification of control study areas. Examples of the latter are the lack of knowledge over a change in the economic base of the community affected by the highway improvement and changes in public service districts of schools, libraries, and similar services. Expressed gaps in knowledge further affect new problems such as the effects of the highway on urban renewal, the impact of billboard legislation on highway-oriented businesses, the consequences of route adoption announcements on right-of-way costs, land-use impacts regarding congestion at interchanges, the effect of urban area development on freeway service itself, and the relationship of highway development to regional economic development.

If it is expected to gain a rather broad understanding of the community consequences of highway development, such knowledge will not be found from the type of studies that have characterized highway economic impact research in the past. Most of these studies have been done to accomplish rather limited objectives, and they have not been designed to answer questions of community changes in a larger framework. Some of the larger questions that may be of substantial interest to highway agency people, as well as legislators and local officials, concern large-scale changes in the nature of the economic base of the region which may arise out of transportation system developments.

CHAPTER ONE

INTRODUCTION

The contents of this volume and the additional four unpublished volumes (described in Appendix C) of this report constitute the record of a research project conducted at the University of Washington between August 1963 and August 1964 for the National Cooperative Highway Research Program. The research problem and the objectives are stated in the contract itself, as follows:

> Consideration of the nonuser or "community" consequences of highway location and design decisions has become increasingly important to highway agencies, particularly as their urban construction program has grown. Yet we are still largely without any acceptable approach to the identification and prediction of such consequences. Furthermore, the considerable body of information already available on the problem (in the form of economic impact studies, for example) has never been adequately correlated or appraised; nor has any clear specification yet been made of those aspects of this overall problem which require further study.
>
> The general objective of this project is to establish guidelines for identification and prediction of community consequences, both favorable and unfavorable, of highway improvement. This would involve: (a) Correlation and evaluation of existing studies on economic impact and other community consequences; (b) Development of guidelines for highway agencies to follow in considering the community consequences of highway improvements; and (c) specification of those aspects of this problem in most urgent need of detailed research.

The work undertaken on this project has been documented in the volumes previously referred to, under the general title "Community Consequences of Highway Improvement." By way of a brief review of definitions, the economic consequences of highway development have been traditionally discussed and researched in two specific ways—the consequences of highway development to the user of the highway itself, and consequences to the nonuser and the community.

The economic impact of highway development upon the user is obviously a saving of time, fuel, economic outlay for accidents, and the translation of all other benefits, including psychic and esthetic, into economic terms to the extent that they can be evaluated. Of these variables, fuel savings, accident losses, and the time of commercial vehicles are easiest to obtain. Approximations can be made as to the value of time saved for noncommercial drivers and very rough estimates can be made as to the value of esthetic impact upon the driver. These questions, however, have not been the subject of this analysis but are enumerated essentially to differentiate the user from the nonuser impacts.

Nonuser impacts may or may not be general community consequences of highway development. An example of a community benefit is the increase of pedestrian amenity along a shopping street following the removal of a majority of the traffic by the use of a bypass. This may occur whether or not the individual merchants benefit from the highway improvement themselves. A nonuser beneficiary of highway development may be either a person or a firm whose property gains in value as a result of the highway improvement or whose business operations are facilitated in some way, such as by increased sales or the reduction of manufacturing costs.

Often it is very difficult to distinguish between user and nonuser benefits. For example, a manufacturing firm may benefit from highway development because it can make pickup and delivery of goods more efficiently over a new facility and at the same time benefit by the fact that increased specialization may take place in the vicinity which increases subcontracting or supply potential and reduces manufacturing costs. The reduced haulage costs may become community benefits if reduced rates are passed on to the public; otherwise, they are user benefits only. The benefits from increased manufacturing efficiency are nonuser benefits unless cost reductions in the goods manufactured are passed on to the public. But even if passed on, these cost reductions in manufacturing may not have any impact in the region of the highway improvement itself. They may even be reflected in savings to purchasers in distant or foreign markets. The complex nature of highway benefits has been well documented by Mohring and Harwitz (*1*).

As the foregoing discussion implies, the whole question of highway economic impact can become quite involved. There is also undoubtedly a considerable difference between the view of highway economic impact taken by economists and that taken by highway engineers and planners. Economists tend to be substantially interested in the very broad transfer of benefits, or examining the question in a very broad framework. Highway agency people, on the other hand, tend to be concerned with questions of justification of highway development, and usually justification within a very narrow framework. The fact that the majority of the so-called highway economic impact studies examines the effects of bypasses testifies to this latter point. In fact, the theoretical economist could well dismiss virtually all of the highway economic impact literature as being trivial, as it well may be when viewed within the larger context.

The reader of the findings in subsequent chapters of this report, whether he be a transportation economist or an official of a highway agency, is alerted to the question of the entire framework of analysis. The findings on existing studies as presented in Chapters Two, Three, Four, and Five treat these studies generally within the more specific contexts in which they were commissioned. Further critique on this whole question is reserved for Chapter Six, the interpretation.

The philosophy of the given statement of the problem and research objective is one of a "feedback" nature rather than one concerned with *de novo* research. In other words, the main charges are to examine critically the existing body of literature and correlate the findings as a basis for developing guidelines for action.

An assignment of this nature typically arises after the consummation of a significant amount of research in a particular field. As indicated by Figure 1, aside from a few very early probes the main body of research along nonuser impact lines has taken place within the decade from 1955 to 1964. In fact, the most significant spurt came shortly after the passage of the National Highway Revenue Act of 1956, under Section 210 of which Congress requested information deemed necessary to specify an equitable allocation of the cost of Federally-aided highway improvements.

It is only natural that questions be posed of a feedback nature following this type of research effort, undertaken by many states and many research organizations. Consequently, the given research problem statement implies a "summing up" concept to determine the current status of this entire field of inquiry, as well as prospects and trends indicated for the future. The University of Washington research team felt the obligation to provide this type of a feedback, which is documented in Chapters Two, Three, Four, and Five.

The second paragraph of the problem statement and research objective, however, goes beyond correlation and evaluation of existing studies into the area of providing both guidelines for highway agencies to follow in the study of community consequences of highway improvements and, particularly, the specification of aspects of the problem in most urgent need of detailed research. The latter objective assumes a point of departure. With this in mind the project team found it necessary to go beyond the limited universe of the available literature and probe into new conceptions toward the evaluation of nonuser consequences of highway improvement; thus, the four studies of Volume II (see Appendix C) were made to constitute the framework for the reevaluation of the problem.

The studies of Volume II (unpublished) are presented apart from their relationship to the existing body of literature. They are interpreted, however, in regard to the present literature in Chapter Six of this report in order to present all of the findings in this one summary volume.

THE RESEARCH APPROACH

The general research plan consisted of three phases—evaluation of existing studies, identification and prediction of nonuser or community consequences, and a general synthesis. The evaluation of existing studies was conducted through the development of an automated library, which involved a classification system for the literature by which it was examined for comparability of findings and correlation of results. The automated library comprises Volumes IV and V of the research report, with Volume IV consisting of an abstract of the studies available and Volume V being a keyword-in-context index. Volume III describes the entire methodologic approach to the development of the library. This volume presents the evaluation of the existing studies and the synthesis.

Although not called for specifically in the work order elements of the contract, the automated library forms an important basis for continuing research through updating. In view of the many researches on this topic conducted over the past decade, it seemed only logical to make use of the newly emerging automation library technology.

Within the past 15 years there has been developed a body of more than 600 research reports, critical articles, books, and other writings on the subject of nonuser or community consequences of highway development. Since the report of the Secretary of Commerce to the Congress in 1961 (*2*), reporting on the outcome of activity under Section 210 of the National Highway Revenue Act of 1956, there has been little correlation or appraisal of this body of literature and no clear specification as to the aspects of the problem requiring further study.

A general objective of the research project reported herein has been to correlate and evaluate this existing body of literature, develop guidelines for highway agencies to follow in considering the community consequences of highway improvements, and specify those aspects of the problem in most urgent need of detailed research.

To assist in the matter of definition, a classification system consisting of "highway types" and "impact variables" is presented. This system facilitates discussion of the existing body of literature and definition of the kinds of studies that have been developed under the general heading of "Community Consequences of Highway Development." The impact variables include such factors as retail sales, land values, and land uses. The highway types refer to such physical configurations as highway bypasses, urban radial freeways, and circumferential bypasses. The existing reports tend to analyze a particular highway facility according to one or more of its impact variables.

By and large, it is extremely difficult to get statistical correlations which digest the results of the various studies with any degree of rigor. The differing methodological approaches and the lack of uniformity in the variables examined really preclude anything but a descriptive evaluation of studies in the different categories. Nevertheless, some attempt is made to provide crude averages of data which may serve as guidelines in the effort to arrive at a consensus regarding the findings.

By far the largest volume of literature occurs in the analysis of the effects of bypasses, particularly upon small communities. The subsequent findings arising out of these studies reveal that there can be no generalization made that bypasses aid local business in the bypassed community other than in some reduction of congestion or increase of pedestrian amenity along the bypassed routes. A large majority of the bypass studies failed to separate in a conclusive way the impacts of the transportation improvements from general conditions of economic activity as affected by exogenous factors. Of greater significance is the fact that the bypass studies have tended to go only as far and as deep as the agencies or researchers felt it was necessary to go in order to assuage public concern

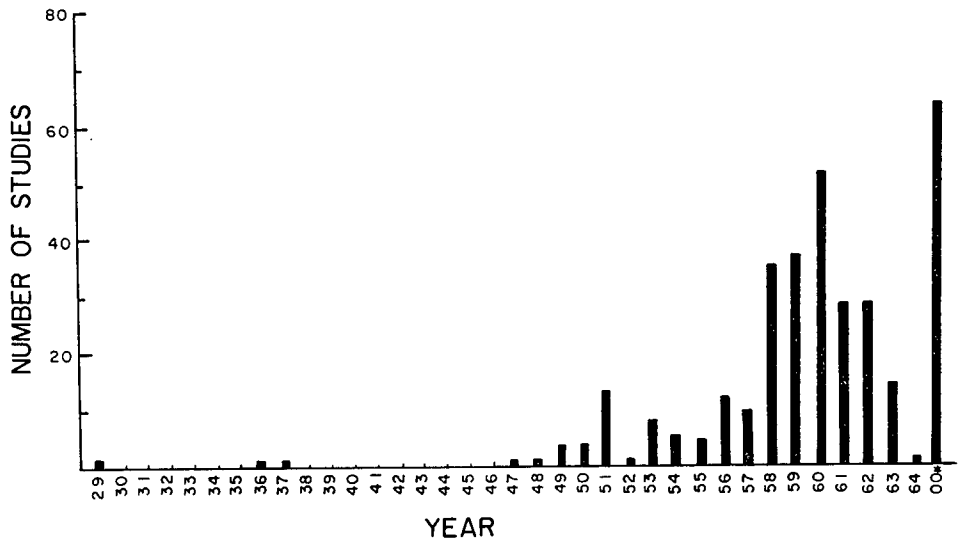

Figure 1. Nonuser impact studies, by year (indicates studies in progress as of report date, June 1964).*

regarding changes planned or projected for the highway system. There is fairly conclusive evidence that bypasses affect communities differentially. By changing the nature of trade area boundaries and by altering the relationship of one town to another, the bypasses can substantially depreciate economic activity in one community and appreciate it in another. It is highly probable that many small communities are adversely affected by highway bypasses when travel times are changed to permit a greater accumulation of goods and services in a larger neighboring community.

Next in significance to the bypass studies by way of reputation are the urban radial freeway studies, such as the study of land values and use changes along the Gulf Freeway in Houston. These urban radial freeway studies have dealt mainly with land value changes in various distance bands from an urban radial freeway and at various distances from the central focus of the urban region. The apparent conclusion from these studies is that land values are materially enhanced by proximity to a freeway in an urban radial corridor. Although these studies have been generally larger and represent more economic input than the bypass studies, most suffer from the bias of translating information about parcels which sold into general conclusions for all land in their vicinity. The lots which sold are obviously a biased sample and efforts to use assessed valuation to compensate have run into the problem of unrealistic assessment policies, or assessments which substantially lag the market. Added to this limitation, these studies were unable to consider the time effect of total freeway systems development in an urban region, wherein the temporary advantages of location in one corridor will soon be offset by the development of other freeways in other sectors of the region as the Interstate System is built. Thus, over an increasing time span, the benefits to any one radial corridor become diffused, and one cannot impute as a lasting benefit to an initial corridor the very great increases of land value changes recorded for the specific parcels which sold. The utility of these studies has probably been in the facilitating of partial takings of land by presenting the evidence that the remainder parcels will gain in value, as well as allaying concerns of property interests and public officials that the freeway will depreciate property.

There have been only a few studies dealing with circumferential roads in urban areas, and these are too diverse in their nature to lead to any integrated results. The most famous of these studies is the one dealing with Route 128 around Boston, which imputes a significant movement of industry to the vicinity of the freeway as a result of the transportation improvement. This study comes the closest of any in this class toward showing a substantial freeway impact to an area, although there are many exogenous factors which have not been dealt with in order to separate out the freeway influence from that of other developments in the region. For example, the location of Harvard University and Massachusetts Institute of Technology as great centers of research activity within close proximity of Route 128, as well as the burgeoning of entire new industries related to space activities, imply economic changes that are at most only partially associated with the highway. Furthermore, the activities of the real estate development firms which promoted sites along Route 128 had substantial bearing on the total regional development in that vicinity. The most important factor of development near Route 128 is induced traffic, and this feature was researched in only a very limited way.

Concerning the utility of the studies there are essentially three overriding reasons why the nonuser highway economic impact studies have been made. Most admittedly have been made for public relations purposes. These have been in response to actual or foreseeable problems arising out of anticipated access control or highway relocation activities. They have been measureably successful in allay-

ing the fears arising out of proposed access control. A second reason advanced by most state officials in response to being interviewed regarding utility of the studies was existence of pressure from the Bureau of Public Roads, particularly in relation to Section 210 of the Highway Revenue Act of 1956, and apparently mounting concern by the Bureau over excessive severance damages as the Interstate System got under way. Third, in a few states there has been some legislative interest in highway cost allocation problems, particularly as regards the potential for special assessment districts to finance extraordinary developments.

Many of the studies termed "community consequences" are studies of severance damages, which have been dismissed from analysis in this research because of the actual lack of relationship to community consequences. Although severance damage studies can save states money in land acquisition or condemnation, and they can affect beneficially or detrimentally land owners whose property is purchased or condemned, such benefits or malefits are not the result of transportation improvement *per se*.

An important factor in the evaluation of the existing studies was a series of interviews conducted at strategic locations where considerable work had been done, whereby the results of past work could be discussed and evaluated. These interviews also are summarized in this report.

Gaps in knowledge expressed by interviewees relate mainly to uncertainty over methodological approaches to highway impact analysis, as well as a sharper understanding of the impacts themselves. Examples of the former are the means of isolating the impacts of highway change from other economic effects and the design and identification of control study areas. Examples of the latter are the lack of knowledge over a change in the economic base of the community affected by the highway improvement and changes in public service districts of schools, libraries, and similar services. Expressed gaps in knowledge further affect new problems such as the effects of the highway on urban renewal, the impact of billboard legislation on highway-oriented businesses, the consequences of route adoption announcements on right-of-way costs, land-use impacts regarding congestion at interchanges, the effect of urban area development on freeway service itself, and the relationship of highway development to regional economic development.

If it is expected to gain a rather broad understanding of the community consequences of highway development, such knowledge will not be found from the type of studies that have characterized highway economic impact research in the past. Most of these studies have been done to accomplish rather limited objectives, and they have not been designed to answer questions of community changes in a larger framework. Some of the larger questions that may be of substantial interest to highway agency people, as well as legislators and local officials, concern large-scale changes in the nature of the economic base of the region which may arise out of transportation system developments.

A limited number of case studies was made to demonstrate the range and probabilities of community consequences of highway improvement, with an effort being made to develop case studies which have only been implicitly touched upon in the past. Obviously the research resources were limited for conducting field investigations and an early decision had to be made to select case studies and topics for analysis which might become more significant in the immediate future. These case studies, or probes, are presented in Volume II (unpublished; see Appendix C for summary).

The Case Studies

Dealing with the identification and prediction of nonuser or community consequences, the Mohawk-Piedmont Transportation Corridor Studies are probes dealing with the ecological, demographic, and centralization-decentralization changes in the two regional transportation corridors selected. The significance of this study is that it is examining the potential for community change within a regional framework.

One of the probes developed in this research effort points to fairly interesting changes in the economic base of the various communities along the New York Thruway. The major conclusion which can be drawn is that accessibility provided by a major highway improvement such as the New York Thruway is a significant influence on employment patterns in communities within the commutershed of large urbanized areas. Further, economic opportunities along a regional corridor will become concentrated in nodal locations, probably spaced at intervals relating to tolerable commuting times along the corridor. With significant growth of many linear regional corridors of settlement, a comprehensive study of changes in the structure of the economic base of all of the communities along the corridor is needed to avoid the pitfalls inherent in the examinations of individual communities that have been commissioned in the past. Certainly more research is needed in this comprehensive type of impact analysis to relate changes in any given community to changes in neighboring ones.

Moving now from the linear regional corridor development to the urban conurbation, it is evident that a new type of calculus is necessary by which to examine in a theoretical way the settlement patterns and density attributes of urban establishments.

Although not specifically called for in the scope of the contract, theoretical models were developed to examine population allocation and distribution in an urban regional framework, particularly in regard to a transportation network. The first, an urban population distribution model, provides a system in which to examine residential population distribution in an urban complex and by which an analysis may be made of the probable values of residential densities at particular locations under varying limits of total urban-region population.

The second model, termed a population allocation model, provides a calculus for estimating development in various portions of an urban area according to differing policies, plans, and criteria from municipality to municipality or community to community. This model would enable one to compensate between the summation of the

various population projections of subcomponent parts of an urban region and the projection for the region itself—in other words, to adjust inconsistent estimates of growth.

These models constituted the theoretical frame of reference for the studies made of Los Angeles freeway impact, examining land-use change, density change, and trade area structure relating to changes in the level of highway transportation. Although both of these models are relatively crude tools, they do present a look into new kinds of evaluative techniques and new kinds of theory by which to examine the emerging metropolis of 10 to 25 million people which will be in existence by the end of the century. From theoretical exercises using these tools it may be a shorter step to estimate long-range transport requirements and induced traffic on the scarce resources being provided through the Interstate as well as state freeway systems.

In contrast to the theory to be presented in the two models just discussed, an extensive research was made into land-use and residential density changes in the Los Angeles Urban Area between 1940 and 1960 by juxtaposition of these changes with the emerging freeway system through visual examination in a series of sixteen maps. This analysis made application of graphic techniques of computer analysis as well as new methods of handling large-scale data inputs for urban analysis developed over the past few years at the University of Washington. What was accomplished in six man-months with the aid of these computer programs would otherwise have taken approximately ten man-years to produce.

The results of this study are of two types:

1. In terms of technique or method, it presents large amounts of information concerning a geographic area visually and representationally for analysis and interpretation.

2. Subsequently, the study indicated findings applicable to one very populous urban area and from which the implications may be inferred concerning others.

The Los Angeles Urban Region has a long history of freeway development. Its Pasadena Freeway, opened in December 1940, was the first such urban link completed in the country, and since that time highway mileage has been extensively increased. Substantive findings with respect to the freeways are threefold:

1. Freeway construction has had a differential impact, the nature of its effect upon population density and land use depending on time or phase of the freeway construction under particular consideration. The study identifies three stages of development as regards the relationship of freeway construction to population density and land use—the substitution phase, the transition phase, and a developmental or deterministic phase. Los Angeles Urban Region experience suggests that when the pace of achievement of the freeway program has arrived at the third stage, its impact with respect to population density and land use will be greatest.

2. During the period 1940-1960 the greatest increases in population density occurred within ranges usually considered modest (less than 15 persons per acre), while no increases (even some decline) occurred in the importance of the high-density ranges. This suggests that the expanding freeway system, increasing mobility and land accessibility with the Los Angeles Urban Region further dispersed population, rather than centralized it, in an area one of whose notable advantages was comparatively low levels of population density.

3. The study showed that when freeways do affect the patterns of land use the most pronounced contiguous relationship is found with respect to industrial land use, although other types of land use showed responsiveness as well. The exact causes of the considerable responsiveness on the part of industrial land utilization found in this study would presumably reflect a greater conscious concern of industrial decision makers with maximizing transportation advantages, although another potentially important factor —namely, the effect of local land-use zoning—deserves further study.

One of the most difficult elements to structure in the research plan was the identification of visual changes within some reasonable framework for research analysis. This is a very subjective field of inquiry and one which has not been institutionalized to any significant extent in the past. The esthetic environment has no standard units of measurement or uniform definitions; there are no dollar values to add up as in the case of other types of highway economic impact studies. This element of the research plan called for considerable attention to be given to the methodology for analyzing the view from the road and its user-nonuser interactions. The research plan of this study set out to measure the visual change in respect to open space adjacent to the road and the intensity of roadside signs as a function of average daily traffic volumes. A substantial effort was expended in this rather elusive aspect of the entire research program.

CHAPTER TWO

ANALYSIS OF THE BYPASS STUDIES

PURPOSE

Bypass studies have explored the economic effects on small to medium-sized communities (approximately 5,000 to 30,000 people) caused by rerouting a highway around the town to avoid central area conflicts and congestion. These studies have been largely done for public information and public relations purposes to reduce the frictions of controversy arising mainly from business interests in the bypassed towns, who fear that removal of through traffic from the main street will undercut their sales and impair the community's economic health. Hence, protracted battles in public hearings and in court have arisen over such questions as the bypass studies were designed to answer: Are retail sales harmed by bypassing? Does the community economy suffer? What specific types of outlets are disbenefited, if any?

Of the 70 bypass studies known to exist, 45 were available for examination in this reporting. Although this percentage may seem small, the body of literature examined included most of the principal bypass studies. Some of the minor studies and a few of the major ones were out of print, or copies could not be obtained in time for inclusion in the analysis. (The missing reports were abstracted from secondary sources for inclusion in Volume IV). The report to Congress on the Highway Cost Allocation Study (*1*) lists 52 bypass studies, there being approximately 18 additional ones recorded as completed since that report. Whereas the report to Congress presents information on the various bypass studies analyzed without summary data, the analysis in the following pages does attempt to bring together information in summary form.

METHODOLOGY OF ANALYSIS

Thirty-one variables are treated in the 24 bypass study documents examined, relating to 72 communities. Some of these appear once, others are nearly universal. In a number of cases study data were so reported as to be inapplicable for this analysis because of incompatible reporting procedures.

The 31 economic indicators fall into two broad classifications, the first including retail businesses whose fluctuations affect their proprietors, suppliers, and employees, and the second being general indicators of overall economic activity. These indicators are as follows:

- Retail business classification
  - Total retail sales
  - Highway-oriented sales
    - Service stations
    - Restaurants (including cafes and bars)
    - Motels and hotels
  - Non-highway-oriented sales
    - Apparel
    - General merchandise
    - Automotive
    - Furniture
    - Lumber and building
    - Groceries
    - Drugs
    - Liquor
    - Hardware
    - Specialty
    - Tourism
    - Service
- General economic indicators
  - Telephones
  - Parking meters
  - Water meters
  - Electricity use
  - Postal receipts
  - Bank deposits
  - Business starts and stops
  - Community attitudes
  - Land use
  - Property value
  - New construction
  - Industry
  - Employment

A majority of the studies treat service stations, restaurants, and motels as separate elements in the retail business classification, and handle all others collectively, designating them as "non-highway-oriented" or some similar term. A few break retail trade into only two categories—highway-oriented and non-highway-oriented. Fifteen other studies include up to eight variables in the non-highway-oriented group for detailed analysis. The diversity of reporting methods and procedures makes it impossible to compare the studies as a whole. Parts of various studies had to be extracted and compared to determine what impact bypass highways had on specific elements of the studied economy.

It was apparent from the first look at the reports that direct comparison of the percentage change in retail sales in bypassed towns was not going to be meaningful for analysis of economic impacts except where comparisons were made with a control town. The national and regional economic picture was very different between studies; this obviously had some effect on business trends in bypassed towns. Fortunately, a number of studies included information on control areas. Because essentially the same macroscopic economic influences work on both study and control areas, the impact of the bypasses could be measured as the difference between the percentage

changes in the study area and the control area. These differences could then be meaningfully compared and analyzed.

There is much less information given in the general indicators classification and in no cases were data reported for both study and control area. Thus, there is little analysis in that section of this report. For the most part the findings of other reports are summarized and their significance is pointed out. General conclusions are presented where the data are sufficient to warrant them.

ANALYSIS

With few exceptions, investigators working on the bypass studies used sales tax data. This was supplied by an appropriate state agency to establish retail sales in various categories. The study periods were commonly for two years before and two years after the opening of the bypass facility. Exceptions to this include studies lasting five to seven years.

The first attempt to organize the study statistics into meaningful groupings was to array the bypassed routes by percentage change in average daily traffic (ADT). Few studies treated this element, however, and there was no significant trend indicated in those that did. Had traffic volumes been available for additional studies, even more implications might have been suggested. Towns were also grouped by economic function to see if one type of town was disproportionately affected.

The most useful results occur when bypassed towns are arrayed by population. A bypass has distinctly different effects on towns of 5,000 persons and under, and on cities over 5,000 population. There is nothing magic about 5,000 people, but analysis indicates that small towns will more likely reflect the impact of the bypass than will larger places (see Table 1). The standard BPR town size breakdown is included, illustrating effects on each population group.

It is important that the reader understand the gain or loss over the control areas. If the control has been carefully selected, it will be as similar as possible to the study area in every respect except being bypassed. The difference between these two areas is then ascribed to the highway bypass impact. Conceivably, a study area might decline in sales following the opening of a bypass and yet not decline as much as its control. The economic impact of the bypass is thus a positive one. If a study area showed growth in sales unequal to that of its control, a detrimental effect is observed. Any growth in the study area above that of the control area is measured as benefit from bypassing. Loss over that of the control is disbenefit.

RETAIL BUSINESS CLASSIFICATION

Only 45 of 72 towns could be universally compared in the retail business classification. This classification was further broken down, as indicated previously, into total retail sales; highway-oriented sales or service stations, restaurants, and motels; and non-highway-oriented sales. Each of these indicators is analyzed separately in the following.

TABLE 1
SALES CHANGE IN BYPASSED TOWNS[a]

POPULATION CATEGORY	AVG. CHANGE IN RETAIL SALES (%)	NO. OF TOWNS WITH GAIN IN SALES	NO. OF TOWNS WITH LOSS IN SALES	RANGE (%)	AVG. GAIN (%)	AVG. LOSS (%)	NO. OF TOWNS WITH CONTROL AREA	NO. OF TOWNS WITH MORE GAIN OR LESS LOSS THAN CONTROL	AVG. GAIN OR LOSS OVER CONTROL (%)
				(a) TOTAL RETAIL SALES					
Under 5,000	+ 5.6	16/20	3/20	− 6.4 – +22.5	+ 8.2	− 6.6	18	6/18	− 3.5
Over 5,000	+12.2	12/16	4/16	−13.0 – +49.0	+20.4	− 7.5	14	11/14	+ 3.7
5,000-10,000	+16.9	5/6	1/6	−13.0 – +38.0	+17.7	−13.0	6	4/6	+ 0.85
10,000-25,000	+ 7.3	5/7	2/7	− 3.1 – +40.5	+12.5	− 4.8	7	6/7	+ 4.1
25,000-50,000	−11.4	0/1	1/1	—	—	−11.4	—	—	—
50,000-100,000	—	—	—	—	—	—	—	—	—
100,000 & over	+22.6	2/2	0/2	+ 4.3 – +49.0	+22.6	—	1	1/1	+19.0
All towns	+ 8.5	28/36	7/36	−13.0 – +49.0	+12.9	—	32	17/32	− 0.30
				(b) HIGHWAY-ORIENTED SALES					
Under 5,000	+20.8	3/6	3/6	−14.7 – +60.9	+51.8	−10.3			
Over 5,000	+21.2	3/4	1/4	−11.8 – +50.4	+32.3	−11.8			
5,000-10,000	+41.5	1/1	0/1	—	+41.5	—			
10,000-25,000	+50.4	1/1	0/1	—	+50.4	—			
25,000-50,000	−11.8	0/1	1/1	—	—	−11.8			
50,000-100,000	—	—	—	—	—	—			
100,000 & over	+ 4.9	1/1	0/1	—	+ 4.9	—			
All towns	+21.0	6/10	4/10	−14.7 – +60.9	+42.5	−10.6			

[a] 16/20 indicates "16 of 20."

TABLE 2
SERVICE STATION SALES CHANGE IN BYPASSED TOWNS [a]

POPULATION CATEGORY	AVG. CHANGE IN RETAIL SALES (%)	NO. OF TOWNS WITH GAIN IN SALES	NO. OF TOWNS WITH LOSS IN SALES	RANGE (%)	AVG. GAIN (%)	AVG. LOSS (%)	NO. OF TOWNS WITH CONTROL AREA	NO. OF TOWNS WITH MORE GAIN OR LESS LOSS THAN CONTROL	AVG. GAIN OR LOSS OVER CONTROL (%)
Under 5,000	− 0.47	8/17	9/17	−33.0 − +39.4	+14.3	−13.6	11	5/11	− 0.86
Over 5,000	+ 5.5	7/15	8/15	−21.0 − +39.0	+20.0	− 7.3	10	6/10	− 5.75
5,000-10,000	− 1.8	2/4	2/4	−21.0 − +17.0	+11.3	−15.0	3	2/3	−20.0
10,000-25,000	− 4.2	3/7	4/7	−10.0 − +33.9	+19.1	− 7.5	6	3/6	− 6.1
25,000-50,000	− 4.8	0/2	2/2	− 7.0 − − 2.5	—	− 4.8	—	—	—
50,000-100,000	—	—	—	—	—	—	—	—	—
100,000 & over	+30.3	2/2	0/2	+21.5 − +39.0	+30.3	—	1	1/1	+21.0
All towns	+ 2.3	15/32	17/32	−33.0 − +39.4	+16.9	−10.6	21	11/21	− 3.2

[a] 9/17 indicates "9 of 17."

Total Retail Sales

Of the 45 studies included in the retail business section, 36 report the impact of bypass highways on total retail sales in bypassed towns. Table 1a reveals that 7 of these 36 towns showed a sales revenue loss, 28 increased, and 1 indicated no change. Average sales increase was 8.5 percent for all towns. Towns over 5,000 population showed an average increase over twice that of towns under 5,000. Places showing the greatest changes were Hopkinton and Richmond, R. I. (*3*), which lost 13 percent, and North Sacramento, Calif. (*4*), where sales revenue increased 49 percent.

When the percentage change differences in the study and control areas of the 32 studies using controls are compared, different effects are revealed. Only 6 of the 18 towns below 5,000 population show greater changes than their control areas. The average change for these 18 towns is 3.5 percent below their controls' average change. On the other hand, 11 of 14 towns over 5,000 population showed greater gain or less loss than their controls' gain or loss. The average for all 14 towns was 3.7 percent more sales than their control areas' average.

In effect, for this category of analysis bypassing had mildly detrimental effects on towns below 5,000 population, and only a slightly beneficial influence on larger ones. If the 32 towns are taken collectively, the effect is insignificant. The average difference between the study areas and the control areas is only −0.3 percent.

Highway-Oriented Sales

Ten studies reported highway-oriented retail sales. In each case this group included all businesses providing fuel, food, and lodging for transients. None of the reports provided a control, however, so only actual changes in sales can be considered.

Of 6 towns below 5,000 persons, 3 gained in highway-oriented sales and three lost (Table 1b). The average gain of 51.8 percent far exceeded the average loss of −10.3 percent. However, the overall average retail sales increase for these 6 towns was 20.8 percent.

The 3 towns with populations of 5,000 or over which showed gains averaged 32.3 percent increases and the only town which lost sales in this group declined by 11.8 percent. The overall average change was a 21.0 percent increase. How much of this resulted from bypassing cannot be determined, as the economic effects cannot be isolated without control areas.

It should be noted that the one town over 5,000 population which declined in highway-oriented retail sales experienced a similar decline in total retail sales. Perhaps this reflects more general economic conditions. This was not true of the smaller towns which experienced decline. In Tyndall, S. Dak. (*5*), the total retail sales decrease was less than one-half that of the highway-oriented sales decrease; in Beloit, Kans. (*6*), there was actually a significant increase. In Temecula, Calif. (*7*), there was no information on total retail sales.

SERVICE STATIONS

Service stations were listed separately as impact indicators in 32 studies: 8 towns under 5,000 population showed gains averaging 14.3 percent, the remaining nine showed losses averaging 13.6 percent. Similar results occur in towns over 5,000 population: 7 of 15 towns showed an average gain of 20 percent, and 8 showed an average loss of 7.3 percent. The difference between the two categories is about 6 percent for towns gaining or losing in service station retail sales (Table 2).

Although losses go as low as 33 percent and gains as high as 39.4 percent (Fairfield, Calif. (*25*), and Mason, Mich. (*13*), respectively), the average change in service station sales is only +2.3 percent.

Control areas were used for service station sales in 21 studies. Eleven of these, 6 over 5,000 and 5 under 5,000 population, had gains of greater magnitude or losses of lesser magnitude than their controls. In other words, they were influenced beneficially by the bypass. Nevertheless,

TABLE 3
RESTAURANT SALES CHANGE IN BYPASSED TOWNS[a]

POPULATION CATEGORY	AVG. CHANGE IN RETAIL SALES (%)	NO. OF TOWNS WITH GAIN IN SALES	NO. OF TOWNS WITH LOSS IN SALES	RANGE (%)	AVG. GAIN (%)	AVG. LOSS (%)	NO. OF TOWNS WITH CONTROL AREA	NO. OF TOWNS WITH MORE GAIN OR LESS LOSS THAN CONTROL	AVG. GAIN OR LOSS OVER CONTROL (%)
Under 5,000	—16.1	4/15	11/15	—50.0 – + 4.6	+ 2.2	—22.8	9	1/9	—10.6
Over 5,000	— 8.9	3/11	8/11	—26.0 – +14.0	+ 9.1	—13.1	6	5/6	— 0.25
5,000-10,000	— 9.2	1/4	3/4	—26.0 – + 2.4	+ 2.4	—13.0	3	2/3	— 5.8
10,000-25,000	— 7.3	1/3	2/3	—21.0 – +11.0	+11.0	— 8.3	2	2/2	+ 1.5
25,000-50,000	— 8.3	0/2	2/2	—14.6 – — 2.0	—	— 8.3	—	—	—
50,000-100,000	—	—	—	—	—	—	—	—	—
100,000 & over	— 1.1	1/2	1/2	—16.2 – +14.0	+14.0	—16.2	1	1/1	+13.0
All towns	—13.0	7/26	19/26	—50.0 – +14.0	+ 5.1	—18.7	15	6/15	— 6.4

[a] 11/15 indicates "11 of 15."

where losses occurred they were somewhat greater than gains; service stations lost an average 3.2 percent of expected retail sales compared to control areas.

Hardest hit were towns over 5,000. Their average loss was 5.7 percent, compared with an almost insignificant 0.85 percent loss smaller towns experienced in service station retail sales.

RESTAURANT SALES

Restaurant, cafe, and bar sales declined considerably in bypassed towns. Among the indicators studied, only lodging facilities show a greater loss of clientele and revenue. Of 26 reports investigating restaurant sales, only 7 indicated an increase. The average for these was only 5.1 percent. Conversely, 19 towns showed declines, averaging 18.7 percent sales loss (Table 3).

The greatest losses occurred in small towns: 11 of 15 showed losses and many restaurants closed. Declines of from 50 to 30 percent were reported in this category; the average change in retail sales was −16.1 percent. Larger towns fared little better than small ones: 8 towns lost and 3 gained. The average change was somewhat less, however, only 8.9 percent loss. The overall average change for restaurant retail sales was −13 percent. It should be noted that every population category shows a total sales loss.

The impact appears less injurious, however, when the control areas are considered. Towns below 5,000 population still experienced significant negative impact; only 1 town showed greater gain or less loss than its control area. The average difference is −10.6 percent.

On the other hand, 5 of 6 towns over 5,000 showed less loss or more gain than their control areas. The single loss (Lexington, Va.) (*8*) was so great, however, that the average difference for these 6 towns was negative, though only 0.25 percent. Overall, bypasses have detrimentally affected restaurant sales in towns with control areas less than might have been suspected. The average loss in this group was 6.4 percent.

MOTELS AND HOTELS

Few bypass studies report statistical information on motels and hotels, particularly in small towns. Investigators could never reveal information on specific enterprises; therefore, data were suppressed. In addition, data for these studies come from state tax records, and in many states lodging accommodations are not taxable. Thus, only 8 studies reported retail sales information on motels and hotels (Table 4).

In each broad population category (under 5,000 and over 5,000) 3 of 4 towns show losses in this classification. Only Hood River, Ore. (*9*), and Austin, Tex. (*10*), experienced gains.

As with a majority of the indicators, small towns experienced greater effects. The average change in rental revenues was −32.4 percent for towns under 5,000 and −23.1 percent for all 8 towns studied. The range of economic impact was considerable in these studies, from −65 percent in Drain, Ore. (*9*), to +34 percent in Austin, Tex. (*10*).

Losses of 54 percent, 33.3 percent, and 30 percent were reported in Temple, Tex. (*11*), Union, Ore. (*9*), and Marysville, Wash. (*12*), respectively. None of the reports except Marysville considered control areas; therefore, bypass impact could not be conclusively identified. Several reports indicated that rental dropoffs began immediately after bypassing; a motel in Drain, Ore., ". . . was fully occupied the night before the bypass opened and was without a patron the following night" (*9*).

Non-Highway-Oriented Sales

A majority of the retail items in towns are oriented to local, rather than transient, clientele. Logically, any benefit from the bypass would accrue to these enterprises. The bypass studies have generally concluded that diverting through traffic and consequently reducing congestion in business districts improves shopping conditions; thereby, non-highway-oriented retail sales are increased.

Table 5 shows that 3 of 24 studies found losses in non-

TABLE 4
MOTEL AND HOTEL SALES CHANGE IN BYPASSED TOWNS

POPULATION CATEGORY	AVG. CHANGE IN RETAIL SALES (%)	NO. OF TOWNS WITH GAIN IN SALES	NO. OF TOWNS WITH LOSS IN SALES	RANGE (%)	AVG. GAIN (%)	AVG. LOSS (%)
Under 5,000	—32.4	1/4	3/4	—65.0 – + 2.0	+ 2.0	—43.8
Over 5,000	—13.9	1/4	3/4	—54.0 – +34.0	+34.0	—29.8
5,000-10,000	—	—	—	—	—	—
10,000-25,000	—15.5	0/1	1/1	—	—	—15.5
25,000-50,000	—37.0	0/2	2/2	—54.0 – +20.0	—	—37.0
50,000-100,000	—	—	—	—	—	—
100,000 & over	+34.0	1/1	0/1	—	+34.0	—
All towns	—23.1	2/8	6/8	—65.0 – +34.0	+18.0	+36.8

[a] 3/4 indicates "3 of 4."

highway-oriented sales. In 2 cases the reports attributed the business dropoff to other than bypass factors. Tyndall, S. Dak. (*5*), which showed a 10.6 percent sales decrease, was actually recovering from an economic recession experienced the year previous to the bypass. The base year for the study was two years prior to the bypass opening; comparing actual sales failed to reveal the recession's effects. The Niles, Mich. (*13*), study also attributed losses to an overall economic setback; its total deficit was 5.5 percent. Rockwall, Tex. (*21*), showed the heaviest losses in this category, a decrease of 18.4 percent, all attributed to the bypass.

Each of the first six population categories shows an increase in average change for non-highway-oriented retail sales. The average for all towns was 10.3 percent. The average change which could be attributed to bypass impact by comparing studies with their control areas was a 5.8 percent increase. Here again, Niles and Rockwall show deficits. Tyndall, although taking in less revenue than during the base year, lost less than its control area. Rocky Mount, Va. (*15*), on the other hand, showed a sales increase, but not nearly so great as its control area; the bypass apparently had negative effects there.

A few of the studies selected variables from the general category of non-highway-oriented retail sales and treated them like those discussed under highway-oriented sales. Unfortunately there are not enough observations of any one variable to support firm conclusions. The number of observations, average change, and range of changes of each variable are indicated in Table 6.

GENERAL ECONOMIC CONDITIONS CLASSIFICATION

The following variables were selected in one or more reports to indicate general economic conditions by contrast with more restrictive retail business activity previously discussed: telephone installations, parking meter revenues, water meter installations, use of electricity, postal receipts, bank deposits, business starts and stops, land use changes, property value changes, new construction, industrial development, and employment trends.

Telephone Installations.—Only two reports considered this variable; the change was insignificant in both cases. Installations of telephone equipment during the study period apparently did not reflect changes in bypass-influenced economic activity.

TABLE 5
NON-HIGHWAY-ORIENTED SALES CHANGE IN BYPASSED TOWNS

POPULATION CATEGORY	AVG. CHANGE IN RETAIL SALES (%)	NO. OF TOWNS WITH GAIN IN SALES	NO. OF TOWNS WITH LOSS IN SALES	RANGE (%)	AVG. GAIN (%)	AVG. LOSS (%)	NO. OF TOWNS WITH CONTROL AREA	NO. OF TOWNS WITH MORE GAIN OR LESS LOSS THAN CONTROL	AVG. GAIN OR LOSS OVER CONTROL (%)
Under 5,000	+ 6.7	11/13	2/13	—14.8 – +32.0	+10.3	—12.6	8	6/8	+ 5.2
Over 5,000	+14.6	10/11	1/11	— 5.5 – +55.0	+16.6	— 5.5	6	5/6	+ 4.6
5,000-10,000	+11.2	4/4	0/4	+ 1.0 – +20.0	+11.2	—	2	2/2	+ 0.3
10,000-25,000	+11.2	3/4	1/4	— 5.5 – +38.0	+17.2	— 5.5	3	2/3	— 1.9
25,000-50,000	+ 6.9	2/2	0/2	+ 1.3 – +12.4	+ 6.9	—	—	—	—
50,000-100,000	—	—	—	—	—	—	—	—	—
100,000 & over	+55.0	1/1	0/1	—	+55.0	—	1	1/1	+19.0
All towns	+10.3	21/24	3/24	—14.8 – +55.0	+13.3	—10.3	14	11/14	+ 5.8

[a] 11/13 indicates "11 of 13."

Parking Meter Revenues.—Five studies reported parking meter revenues; the effects varied widely. Increases of 41 percent, 25.6 percent, and 20 percent were recorded in Rocky Mount, Va. (*15*); Hood River, Ore. (*9*); and Lexington, Va. (*8*), respectively; decreases of 43.4 percent and 13 percent were experienced in Sutherlin and Roseburg, Ore. (*9*). Little correlation appears between this variable and any other. Any relationship to the bypass is questionable.

Water Meter Installations.—Tripp, S. Dak. (*16*), and Rolla, Mo. (*17*), examined water meter installations and removals, presumably as indicators of new construction. There was a decrease in Tripp of less than 1 percent and an increase in Rolla of 9 percent. These generally reflect overall economic conditions in these communities, but the paucity of observations makes impossible any firm conclusions related to bypasses.

Electricity Use.—Reports on Tripp (*16*) and Tyndall (*5*), S. Dak.; Sutherlin, Hood River, and Roseburg, Ore. (*9*); Blairsville, Pa. (*18*); and Rolla, Mo. (*17*), contained data on electrical power produced in the towns during their study periods. Again the variable showed no change attributable to bypassing.

Postal Receipts.—Postal receipts increased during the study periods 6.2 percent, 3.5 percent, 22 percent, and 7.3 percent in 6 towns where considered. There is no indication, however, that the bypass had any effects on this variable.

Bank Deposits.—Bank deposits average 7.1 percent increase for 6 studies. Only Union, Ore. (*9*), declined in this category. Results of these investigations could not be directly related to bypass impact.

Business Starts and Stops and New Construction.—Each of the 3 towns examined showed an increase in commercial businesses when bypassed. In Safford, Ariz. (*19*), 38 new establishments opened, 3 failed, and 3 changed their line of business in the six years following the bypass opening. In Blairsville, Pa. (*18*), the number of businesses increased by 4 percent, although this was partially attributed to nearby dam construction.

Lebanon, Mo. (*20*), showed considerable business activity during the four-year study period; 14 firms closed, and 18 began. The greatest gains were in the manufacturing and processing group.

Once again, none of the reports directly relate business increases to the highway bypass. If more studies considered this variable, and gave more indication of specific business types opening or closing, this indicator might be more important.

A number of studies scrutinized new construction in the community. This may be related to business starts and stops, though not consistently. Certainly there is a correlation between this element and the local economic picture.

It is interesting to note that 14 of 18 new firms opening after the bypass around Lebanon constructed new buildings. This indicates functional changes in the commercial economic structure. Moreover, bypasses may stimulate investment in activities that can profit from improved accessibility. In El Monte, Calif. (*21*), investment in one shopping center was more than twice the right-of-way costs for the entire bypass project.

TABLE 6

NON-HIGHWAY-ORIENTED SALES CHANGE IN BYPASSED TOWNS BY SPECIFIC VARIABLE

VARIABLE	NO. OF OBSERVATIONS	RANGE (%)	AVERAGE CHANGE (%)
Apparel	7	− 2.0 – +48.0	+13.1
General merchandise	8	−31.6 – +75.0	+13.2
Automotive	6	−25.0 – +30.9	− 2.8
Furniture	7	−12.4 – +42.0	+ 5.1
Lumber and building	7	−13.0 – +18.5	+ 1.7
Groceries	11	+ 1.9 – +48.0	+16.8
Drugs	2	−11.0 – +18.0	+ 3.5
Liquor	2	+10.0 – +53.0	+31.5
Hardware	1	—	+13.9
Specialty	4	−15.9 – +14.0	− 0.95
Tourism	1	—	−24.0
Service	3	+ 8.0 – +75.0	+34.2

Roseburg, Ore. (*9*), showed a 73.3 percent increase in new construction and Tulare, Calif. (*4*), a 38.5 percent increase. This includes permits granted during the study periods, however. It is not restricted to commercial establishments.

Land Use.—Any significant impact which a highway bypass makes upon the basic economy of a community should be reflected in land use changes. Three studies attempted to determine these effects. The Lexington, Va. (*8*), and Hopkinton and Richmond, R. I. (*3*), studies found little land use change. It had become relatively stabilized. In Blairsville, Pa. (*18*), residential uses increased 11 percent; commercial uses, 52 percent; industrial uses, 16 percent; and public uses, 2,000 percent. This study covered a nine-year period, however, and without comparing the changes to a control area it is impossible to determine the bypass' influence. Blairsville, it should be remembered, had a considerable economic boost from dam construction.

Property Values.—Land value is singled out for attention in 14 studies. Highway location frequently determines the market value of real property. Thus, it is not surprising that this variable was treated by more than twice as many studies as any other general economic indicator.

Temecula, Calif. (*7*); Cannon Beach, Drain, Sutherlin, and Hood River, Ore. (*9*); Hopkinton and Richmond, R. I. (*3*); and Petaluma, Calif. (*23*), showed no change in land value which could be attributed to the bypass. Tripp, S. Dak. (*16*), and Marysville, Wash. (*12*), showed decreases of 15 percent and 25 percent, respectively, in property values. Union, Ore. (*9*), experienced business property value declines from 25 percent to 50 percent under that prior to the bypass. The report states, however, that this cannot be entirely blamed on the bypass.

Towns with increases in property values were Fairfield, Calif. (13.8 percent); Blairsville, Pa. (32 percent); and Lexington, Va. (4.5 percent). Tulare, Calif., also experienced a "slight increase in property values attributed to

the bypass." The average change for all 14 communities is less than 1 percent.

Industry.—Imperial, Calif. (*22*), is the only city treating industrial growth as an indicator of highway bypass impact. In this town several light industries sprang up near the highway soon after the bypass opened. These additions were directly attributed to the bypass.

Employment.—In Blairsville, Pa. (*18*), employment increased 67.8 percent over the 9-year study period. Again, a new dam in the vicinity probably influenced this more than did bypassing. The only other study observing employment was that of Hopkinton and Richmond, R. I. (*3*), where a 16 percent decrease was experienced. This correlates closely with the decline in economic activity reflected in total retail sales in the same period.

SUMMARY

Analysis of bypass studies concerned with hamlets of 125 persons to cities of over 135,000 reveals that places of 5,000 and over have a somewhat better chance of adjusting to the economic changes which the bypass induces. Highway-oriented businesses (i.e., those providing fuel, food, and lodging for transients) were most seriously affected.

Service stations and restaurants were often sufficiently able to adjust to changed conditions by reorienting their merchandise to local trade. Although this precluded economic loss in the long run, there must have been costs for this reorientation. Service stations promoted tires, repairs, and parts, rather than gasoline. Restaurants switched to lunch and dinner instead of short orders. Motels and hotels, however, were unable to adjust in this manner and subsequently suffered the greatest losses.

One study concluded that the distance a bypassed town was located from the bypass highway had an effect on the total impact that town felt. The Colorado Department of Highways report (*9*) found that: "Business activity in communities more isolated by the bypass is influenced to a greater extent by the bypass. . ." The validity of this contention is well supported in the Colorado report. No other study drew this kind of conclusion; in fact, none dealt with locational theory in any way with one exception —the Marysville, Wash., study (*12*).

The most valid results came from studies which included control areas in their analysis. This was done with only four variables, but a somewhat different picture emerges than where only percentage change in variables is reported. There can be little argument with this method if the highway bypass is the only economic force affecting the community. This is never the case, of course; the bypass effects must therefore be identified and isolated by control.

Results are tempered when a control is used. Thus, it is found that even though towns of each population group gained in retail sales, there was, in fact, little affect from the highway bypass. Similarly, only about one-half the losses reflected in the average change in sales for restaurants could be attributed to bypassing, because control area restaurants were also losing sales during the study period.

Although several variables were examined as indicators of community economic conditions their relationship to the bypass cannot be established. In fact, an examination of total retail sales raises serious doubts as to whether the overall economy reflects the bypassing at all. Losses in sales to transients may well be offset by trade area extensions. That is, more remote areas can be served with better highways, providing less congested business districts for shopping enjoyment.

SPECIFIC RECOMMENDATIONS

The major problem in this particular analysis was incompatible analytic and reporting procedures among the various studies. It is recognized that certain study elements are better indicators of change than others. These should certainly be included in analysis. When presented, however, they should conform to a set of adopted conventions which permit them to be compared with other studies.

The following recommendations, most of which are discussed in "Guide for Highway Impact Studies" (*27*), are re-emphasized for future bypass analyses. If observed, they will result in uniform approaches and easier comparisons:

1. All absolute figures should be translated into percentage changes. This enables larger centers to be compared with smaller ones on a more equitable basis.
2. Sales figures should be adjusted by the Consumers Price Index (CPI) to allow for inflationary effects over the study period.
3. Before and after traffic counts (ADT) should be given for the bypassed route and, if available, for the new bypass.
4. The same spans of time before and after opening the bypass should be used in all studies. The two-year before and two-year after study periods used in a majority of the studies appear to produce representative data and should be standardized.
5. Terminology should be standardized and a glossary of terms provided for investigators.
6. The United States Standard Industrial Classification Code (SIC) should be used to establish and designate each category of variable. When variables are combined, this code should be used to designate groups.
7. Where it becomes necessary to combine establishment types to keep from revealing information on particular establishments, the same variables and only those variables should be combined in all studies; *e.g.*, only service stations, restaurants, and motels and hotels should be considered as a group. Even where data for individual variables can be published, standard combinations of variables should also be included to make them more comparable with reports which cannot publish separate variable data.
8. The travel time distance of the main business district from the bypass route should be included in the report.
9. Telephone installations, water meter installations, parking meter revenue, electricity use, postal receipts, bank deposits, and employment are subject to many extraneous factors and are not reliable indicators of highway impact. They should be omitted from future studies.

10. All studies should compare changes in the study area with changes in a carefully selected control area. This will indicate the effects which can be attributed to bypassing.

CONCLUSIONS

It is significant to note that most of the foregoing recommendations are part of the guide (*21*) drawn up by the Bureau of Public Roads in 1959. That most bypass studies fall short of the goals of methodological approach suggested by the guide is attributed to the fact that the studies were designed to accomplish a public relations objective rather than to serve as model researches for more scholarly purposes to be discussed further under Chapter Five, dealing with the utility of the studies.

That the studies are not entirely comparable does not mean that they have failed or that they were poorly conceived. Concerning the generalized substantive findings arising out of the bypass studies examined in this analysis there can be no generalization made that bypasses aid local business in the bypassed community other than in some reduction of congestion and increase of pedestrian amenity along the bypassed routes. Although the report to Congress states that ". . . of the 76 bypassed areas for which information about retail trade activities is available, 50 experienced a greater increase or a smaller decrease than occurred in a comparable area which was not bypassed." (*2*, p. 38).

The findings of the current research, however, disclosed that a minority of the bypass studies correct for changes in the consumer price index or significant exogenous changes in the local economy. In a large number of observations there was damaging effect to highway-oriented businesses. The most apparent failure in the analyses was to account for the position of the bypassed town in the hierarchy of the linear settlement pattern on the alignment of the transportation improvement. Although it has been proved only in the case of the Marysville study (*12*), it is probably a safe conjecture that bypassed towns within 15 to 25 miles of larger ones along the same highway element suffer substantially. Conversely, the larger or more centrally located communities along the transportation system are probably substantial beneficiaries of highway improvement, even though bypassed, this benefit being at the expense of their smaller sister cities. This phenomenon only became evident toward the end of this analysis, and further research should examine this facet.

An example of a study which adopted this approach, although implicitly, is the University of Denver report (*24*). The data presented for five bypassed towns in the highway corridor linking Denver and Colorado Springs suggest the following hypotheses which additional corridor studies might confirm: (a) That total business will decline in a smaller center proximate to a larger one if the smaller center has ready access to the improved highway linking it to the larger; (b) that, in the case of several isolated centers on a bypassed route, the one nearest the bypassing highway connection will be least harmed (or most advantaged) in terms of total business; and (c) that where the bypassed route is substantially separated from the improvement or represents a previously highly developed corridor, especially in terms of urbanization, harmful effects on total business in towns on the route will be minimized or may be absent.

It appears quite obvious that if more rigor had been given to a majority of the studies in their design and more financial resources had been allocated to them the results may not have been anywhere near as favorable as indicated in the general literature. Most of these studies have, in fact, commenced with the bias that bypasses are good for business, or at least do not affect business adversely in any substantial way. It is quite obvious that many have apparently selected the information to match this premise. In particular, the studies which examine only a few variables may be the most guilty ones in this respect. Also, the impact of the highway construction itself was evaluated in only a few instances, and then very superficially. Although there are many excellent researches within the scope of bypass studies examined, and many employ rigorous methods within their purview, the entire body of literature in this field is such that little more than simple averages can be obtained and generalizations be made in the comparison of one study with another. Many researches have attempted to follow the "Guide for Highway Impact Studies" (*27*). The financial resources, data resources, and manpower available in the case of each study have usually compromised the original objectives of the study to a considerable degree. This largest group of studies, those dealing with the effects of bypasses, has the greatest variance from state to state and from study to study.

CHAPTER THREE

ANALYSIS OF THE URBAN CIRCUMFERENTIAL STUDIES

BACKGROUND OF THE STUDIES

Urban expressway (circumferential or belt) studies were done as a public information and public relations device with some overtones of highway planning implications. Their purpose was to answer controversy arising from property owners, real estate interests, and city officials over the effect of such improvements on land and property values and property taxes. Also of interest to makers of the studies, and usually included, was documentation of the apparent land use changes occurring on these beltlines, especially their attraction for industrial development. Some studies, such as the Route 128 (Mass.) study (*28*) surveyed this effect in detail.

There are six studies dealing with circumferential roads or beltways; each has an emphasis different from that of the others, each seeks different information. As a result, there is little basis for their comparison. There is no single element universal to the studies; in fact, no variable appears in more than three reports.

In view of the diverse orientation and content of the reports, it appears that the most meaningful method of presenting their results is to summarize each report's findings and conclusions separately, and attempt to draw together their common elements in a final summary.

STUDY FINDINGS

Lexington, Ky. (*29*).—There has been considerable commercial and industrial growth abutting or near the Lexington Northern Belt Line since its opening in the early 1950's. The road has no access limitations. There has been no clustering of firms at intersections. In 1958, six years after opening, 40 percent of the area within 500 ft of the highway was used commercially or industrially.

This factor also influenced residential development near the Belt Line, but in a negative manner. Land previously platted for residential subdivisions has been converted to commercial and industrial tracts as its increased potential became apparent. Residential development shifted to another area, influencing unimproved farm land values outside the Belt Line's direct influence.

Land values along the beltway increased from 21 to 300 percent (depending on the parcel size), but the impact on nearby residential properties was negligible. An estimate of the effect of the Belt Line on the county is that land values in the vicinity increased in excess of $2,500,000.

The location of motels and service stations along the Belt Line resulted in a loss of trade to similar businesses on the bypassed route. Total effect on business was small, however.

Investigators compared the Lexington Northern Belt Line to the Louisville Watterson Expressway (see following) and found access to be a determinant of land value. Relatively more land was converted to more intensive use along the Belt Line, but this was confined to land within about ¼ mile of the facility. The Expressway influenced land values as far as 2 or 3 miles away.

Louisville, Ky. (*30*).—The Louisville Watterson Expressway had been in operation only 2½ years when studied. The investigators attempted to isolate the Expressway's influence, ignoring other factors that normally affect land use and property value.

Even prior to construction of this inner belt expressway, urbanization was proceeding at a rapid pace in its vicinity. This continued and was perhaps accelerated by expressway development. Commercial development took place at or near Expressway interchanges more rapidly than on land between these access points. With land use changes, property value jumped considerably and uses became more intensive. Land prices increased more than 20 times around one interchange where estimates were that the increase would have been four-fold without the Expressway. The Expressway also has had a small but positive effect on the value of nearby farm lands.

As in the Lexington study, the Louisville Expressway has had no effect on nearby residential property—either new or old—but it has affected land use. Less expensive construction has occurred near the new facility and more expensive development farther away. Finally, there are indications that the Expressway had adversely affected commercial establishments nearer the city of Louisville, but only slightly.

Minneapolis-St. Paul, Minn. (*31*).—This study is largely a predictive study made prior to the construction of a new belt line, Interstate 494. Retail service, manufacturing, and warehousing users are projected. The report is a case study of land use development adjacent to belt lines. To determine the likelihood of land use change, an older (1938) belt line was analyzed for commercial and industrial development.

Along this older route, 5.6 percent of the abutting land was commercially or industrially developed between 1945 and 1959. This represents about 10 percent of all manufacturing and warehousing and 10 to 15 percent of the retail and service land developed in the Twin Cities Metropolitan Area during that period.

There is no direct relationship between residential growth and highway pattern in the study area, but the growth of retail and service establishments has been influenced. These activities have generally located around major highway intersections.

Boston, Mass. (*28*).—The study of Route 128, the circumferential highway serving the Boston Metropolitan Area, focuses on industrial and commercial development

along that road. A survey taken by direct interview with management concentrated on site location requirements.

Of 99 industries interviewed, 81 percent were relocated and 19 percent were new plants. Space for expansion was the main reason cited for locating on Route 128, but employee access, labor procurement, and business accessibility also were important factors.

Examination of employee commuting habits revealed the average home-to-work distance on Route 128 was 15 miles or 28 min. For those not using Route 128, the averages were 8 miles and 21 min. Although the accident rate for the expressway is comparatively low (121 per 100 million miles), accidents were cited as the commuters' principal objection to the route. The strain of driving in heavy traffic was also mentioned frequently.

Washington, D. C. (*32*).—This study investigated the 22-mile section of the Capital Beltway (Interstate 495) in Virginia. It is a "before" study issued as a separate report in advance of the "after" portion. Briefly, the report seeks to identify trends in population, real estate sales, land values, business activity, and traffic in the vicinity of the Beltway.

The study area's growth rate has been declining since 1955; more inside the ring than outside. The Beltway has presented no barrier to population dispersion around Washington. Population and real estate sales figures reflect this.

The land value study revealed that the Beltway corridor showed a steady rise from 1951 to 1960, but dropped in 1961 and 1962 to 18 percent below the 1960 figure. The cause of the decline is not determined, but deflation from earlier speculation is a possibility.

Business activity is increasing; in fact, a gain of 76 percent over 1958 was anticipated for 1962. Population increase in this period was only 44 percent. Between 1953 and 1959 traffic increased in the county by 100 percent.

Baltimore, Md. (*33*).—The Baltimore Beltway, a new limited-access facility, had not yet been entirely completed when the Maryland State Roads Commission made an initial report on its impact on the localities it passes through. This study sought to determine three influences: (1) ". . . the effect of the freeway construction on the initial sales and resales of various parts of the same subdivision by comparing sale prices of those properties abutting the Beltway and those more farther (*sic*) removed therefrom"; (2) ". . . the relative effects of freeway construction on various subdivisions by comparing these subdivisions abutting the Beltway with 'control' subdivisions located beyond the area of influence of the Beltway"; (3) ". . . the effects of the expressway on individual properties as evidenced by the opinions and feelings of those persons whose properties abut the Beltway."

The investigators concluded that there was no effect on original or resale values of properties abutting the Expressway. It apparently was not a consideration for home buyers in the five subdivisions examined. It was also concluded that the Beltway does not significantly influence the growth and resale patterns of subdivisions abutting it.

The opinion survey revealed interesting facts about homeowners and their properties adjacent to the expressway. Understandably, their specific location has much to do with how owners feel about a highway abutting their properties. Except where acceleration and deceleration lanes bring excessive truck noise, most owners have positive feelings toward the expressway. Attitudes were also favorable where the roadway passed below or at the property level, but owners were negative where the paving was higher than surrounding properties.

Investigators found that most owners were not particularly concerned that the highway was unfenced. In fact, the illusion of expanse at the rear of properties was a definite positive factor. Surprisingly "sixty-three percent of those interviewed stated that if they chose or were forced to move to a new subdivision with the same relative locational factors, they would consciously select another home lying astride (*sic*) an expressway."

SUMMARY OF CIRCUMFERENTIAL STUDIES

Impact Variables.—In the six reports analyzed, statistical information was given on the following elements of circumferential highway impact:

- Land use
  - Farm
  - Residential
  - Commercial and industrial
  - Institutional
- Land Value
  - Farm
  - Old Residential
  - New residential
- Motor vehicle registration
- Average daily traffic (ADT)
- Gasoline sales

Land Use.—Lexington and Louisville found that total agricultural acreage was reduced 35.7 percent and 29 percent, respectively, after road construction. This was attributed to shorter commuting time, both for workers coming out of the city, and for those going in. There was a corresponding increase in residential, institutional, and commercial and industrial uses.

Louisville had 23.6 percent increase in residential uses, 5 percent increase in commercial and industrial uses, and 3.1 percent increase in institutional uses. Lexington had 10.1 percent, 23.3 percent, and 2.4 percent increases in the respective categories. Minneapolis-St. Paul had 605 percent increase in commercial and industrial land use along this route, where but little had previously existed.

Land Value.—Commercial lands showed the greatest increase in value. These gained on the average 535 percent in Louisville and 93 percent in Lexington. In the Louisville study, the only one to examine this, farm land near the highway increased 15 percent in value. Older residential areas were more seriously affected than newer ones in both cities. The average was a 5.5 percent decrease for older areas and a 2 percent decrease for new. Balti-

TABLE 7
EXTRANEOUS VARIABLES IN CIRCUMFERENTIAL HIGHWAY IMPACT STUDIES

LOCATION	SOURCE, REF.	CHANGE IN MOTOR VEHICLE REGISTRATION (%)	CHANGE IN AVG. DAILY TRAFFIC (%)	CHANGE IN GASOLINE SALES (%)
Louisville, Ky.	*30*	+ 61.0	+22.1	+24.9
Lexington, Ky.	*29*	+120.7	+50.1	—
Washington, D.C.	*32*	+100.0	—	—
Boston, Mass.	*28*	—	+63.2	—

more found the average land value increase to be 10 percent, but did not specify land use.

Miscellaneous.—The elements summarized in Table 7 cannot be related to highway impact in these studies but are considered in the reports as extraneous variables.

CONCLUSIONS

The common feature possessed by four of the five circumferential studies examined in the foregoing is their documentation of the relatively rapid and intense land use changes occurring along belt routes. Commercial and industrial are the predominant new uses and the increased value of land proximate to beltways reflects the space demands of these higher order uses.

Of significance to the highway planner, though little explored in these studies, is the traffic-inducing character of such decentralized employment and the future system demands it portends, including (a) the substitution of lateral for radial movements, and (b) the balancing or reversal of the direction of peak commuter flows.

CHAPTER FOUR

ANALYSIS OF THE URBAN RADIAL FREEWAY STUDIES

The studies included in this part of the review have dealt with the economic effects of limited- or partially limited-access highways of four or more lanes serving as a radial route for commuter and through traffic in relatively large urban areas. Their main concern has been with effects on land use and land value. Their use has been largely for public information and public relations in reply to questions raised by property owners, realtors, and public officials over whether such highways have a detrimental effect on property values and property taxes. Powerful urban interests have raised time consuming and costly controversy over such improvements, which these studies have attempted to assuage by examining actual benefit accruing from expressways.

Urban expressway or radial freeway studies, although relatively few in number, have perhaps been researched with most detail. They include the "classic" impact studies: Adkins' investigations of the Dallas Central Expressway (*34*) and the San Antonio expressways (*35*); Lemly's study of Atlanta's Northeast Expressway (*36*), and Norris and Elder's examination of the Gulf Freeway in Houston (*37*). Land value and land use have been the chief variables under investigation. The Wheeler study (*38*), in Washington State has been excluded from this series because of its primary concern with the impact of a bridge.

METHOD

Based on the assumption that highway influence on land value is greatest in close proximity to the facility, and becomes more diffuse with distance, the study areas have, in the four major reports examined, consisted of bands or tiers of land at succeeding distances from the highway. Distance from the central business district has also been accounted for by dividing the analysis area into zones. Control areas in other parts of the urban region have been utilized for comparison.

The problems of comparability in these studies are illustrated under the following four headings:

Time span studied.—The time periods covered by the studies were: (a) Houston, 1945-1955; (b) Atlanta, 1941-1956; (c) Dallas, 1949-1955; and (d) San Antonio, 1941-1956.

Two of the studies include the inflationary war period, another begins in the post-war boom period, and one starts during the post-war recession. These fluctuations in the

TABLE 8

CHANGES IN LAND VALUES BY LOCATIONAL RELATIONSHIP TO FREEWAY (EXPRESSWAY)

	AVERAGE INCREASE OVER BASE YEAR (%)											
	LAND WITH IMPROVEMENTS				LAND WITHOUT IMPROVEMENTS				UNIMPROVED (VACANT) LAND			
LOCATION	BAND A	BAND B	BAND C	BAND D	BAND A	BAND B	BAND C	BAND D	BAND A	BAND B	BAND C	BAND D
Dallas (*34*):												
1941 Annexation	431	100	139	106	623	123	185	130	518	383	291	166
1946 Annexation	127	26	(22)	31	1027	538	—	104	1179	766	—	136
Houston (*37*):												
Unadjusted	250	130	50	90	282	150	38	76	—	—	—	—
Adjusted	245	125	(15)	44	190	96	(70)	(12)	—	—	—	—
Atlanta (*36*):												
West	99	4	11	102	—	—	—	—	197	12	53	148
East	40	18	(35)	102	—	—	—	—	247	35	(58)	148
San Antonio (*35*)	251	181	71	(2)	377	264	127	30	—	—	—	—
Overall average	206	83	28	68	500	234	70	66	535	299	95	149
Overall range	40–251	4–181	—35–139	—2–106	100–1027	96–538	—70–185	—12–130	197–1179	12–766	—58–291	136–166

national economy likely produced some effect on price levels, but no accounting for this factor is made.

Delineation of study and control areas.—The study areas for the four reports were delineated as follows:

(a) Houston— A band, adjacent; B band, removed; C band, affected (nearby on good thoroughfares); and D area, distributed control areas.

(b) Atlanta— A, B, and C bands were variable-width segments of homogeneous uses roughly parallel to this facility; and D area, one control area supposedly similar to expressway vicinity.

(c) Dallas— A band, abutting; B band, next two blocks; C band, next two blocks; and D area, dispersed control areas.

(d) San Antonio—A band, expressway fronting; B band, expressway not fronting; C band, main thoroughfare not at expressway; and D area, dispersed control areas not on main thoroughfare or not on expressway.

Adjustment for inflation and local cost factors.—

(a) Houston— Adjusted for construction costs, inflation, and assessment factor.*

(b) Atlanta— Adjusted for inflation only.

(c) Dallas— Variety of adjustment methods, including inflation and construction costs.

(d) San Antonio—No adjustment.

* Assessment factor is defined as "the tax assessment value of improvements (used) as a base for determining the relative values. In 1950 the assessed value . . . was 70% of the actual value. In 1955 . . . 77%." The assessment factors applied were, therefore, 0.70 and 0.77 for the appropriate years (*37*).

Definitions of value.—

(a) Houston— Land values with and without improvements, adjusted and unadjusted (four methods).

(b) Atlanta— Improved land values, vacant land values, and both combined (three methods).

(c) Dallas— Land less improvements, land and improvements, unimproved land, and tax valuations of land in the 1941 and 1946 annexations (four methods).

(d) San Antonio—Land and improvements, land less improvements, and non-residentially zoned land (three methods).

This variety of definitions and approaches serves to make each study practically unique in relation to the group. Comparison of figures arrived at by such disparate means can, at best, serve only as a general indicator of common trends, not as absolute values valid for prediction purposes.

LAND VALUE AND LAND USE

To achieve at least an indication of trends according to the common denominator of percentage change between the "before" and "after" periods of the four studies, Table 8 gives the most nearly comparable values contained in the separate studies, with an overall summarization of their average percentage increase and range. They are arranged by proximity location and value (improved, vacant, adjusted, unadjusted). From these values the following generalizations ensue:

1. Unimproved or vacant land receives greatest benefit from highway improvements, ranging from two to three times the value increase received by improved property.

2. Land value computed with improvement value deducted also emerged with increases in value that were

double to triple those of land inclusive of improvements.

3. Value of land abutting the highway facility exceeded that of land further removed, as well as land in control areas, in the majority of instances.

To expand on Item 3, the value of land in the B tier, not abutting but proximate to the freeway, also exceeded the average value increase in control areas. Property in the C tier, still further removed from the facility, shows least benefit; its percentage increase usually falling below that shown for the control area or, at best, not a great deal more. The percentage increase in the B tier is usually one-third to one-half that of the A tier, indicating that the area of impact falls off rapidly. The C tier percentage increase is far below that of the A and B tiers, indicating that the impact is largely diffused at this distance (usually more than four blocks away). The fall-off of impact appears least rapid for vacant or unimproved land, reaffirming that this type of property receives greatest benefit both near and far from the facility. This impact on vacant land infers the speculative nature of highway benefits.

LIMITATIONS OF RADIAL CORRIDOR STUDIES

The radial corridor studies known about appear to have three distinct shortcomings—the use of assessed valuation as a criterion, the bias of the sample of land values, and the nature of the control areas. Each of these is discussed separately in the following.

First, although assessed valuations can be obtained for comprehensive areas of land, there are problems and risks in using this type of data. Assessment obviously lags the market or does not accurately reflect the market in a majority of instances, or even in a substantial number of instances.

Second, inclusion in the sample of only the parcels which have sold reflects substantial bias. The evaluation of the impact from data on the parcels which sold cannot be in the least assumed to carry over for the entire universe of parcels within the band examined. As a matter of fact, the normal action of a market is the stiffening of sales resistance with the number of sales made. For example, the fact that 10 percent of the land parcels reflected a substantial increase in value of sale may be offset by the fact that 90 percent of the parcels cannot be sold at anywhere near the same price. There has been no statistical normalizing for this phenomenon. There is no doubt that land values generally increased along urban radial facilities, but the assumption that the entire band benefitted as much as the samples is entirely erroneous.

A third important deficiency in the methodological approach of the radial studies examined was the failure to compare impact along the facility itself with the developments or changes in another corridor which did not have the same degree of highway service. This deficiency has been alluded to before in this report. It refers to the fact that impact from the initial corridor served by a freeway in an urban area will be differentiated compared to the other corridors where the highway service is less developed. In fact, there is probably a transfer of benefits to the vicinity of a newly developed radial facility from the rest of the urban area. A good example of the lack of a scientifically designated control area occurs in the study of the Northeast Atlanta expressway by Lemly (*36*). The control area is not a corridor with less degree of highway service, but a large parcel of land of mixed uses in an area where ethnic change in the composition of the population has been occurring. Adkins, in the Dallas study (*34*), did use a few samples of land in corridors of a different nature than the study corridor, but they are offset by the selection of random segments of land remote from existing major transportation corridors. In the San Antonio study Adkins (*35*) comes closest to attaining a valid control sector of any of the studies reviewed.

In any event, the freeway radial studies do not generally examine the question of the impact of a highway system and its development time phasing. What are apparently highway benefits to one corridor will ultimately be offset as other corridors are developed. In other words, there is no evaluation of systems effect in these studies.

CONCLUSIONS

There are only two valid observations to be made from the radial studies, as follows:

1. Of the parcels which sold, those in the A band fetched higher prices than those in the B band, etc. This is a valid observation considering the parcels which sold. In other words, there is valid evaluation of the distance effect on the sample (namely, the parcels which sold).
2. Some people made a lot of money.

CHAPTER FIVE

UTILITY OF THE STUDIES AND EXPRESSED GAPS IN KNOWLEDGE

This phase of the findings reports essentially on the utility of the existing studies and gaps in knowledge expressed by the interviewees. It has been felt important as a methodological approach of this study to carefully distinguish between the information obtained through interviews and the evaluation of these expressions by the research investigators. By this method, a clearer picture can be obtained as to (a) what highway officials and researchers believe the utility and gaps of knowledge to be, and (b) what the researchers of this project conclude, both from the interview experiences and other studies which have been conducted as part of the total project. Because it has been the practice in the presentation of the preceding findings to draw some preliminary conclusions at the end of each section, some are presented here, but they relate mainly to the nature of the information rather than to the substantive issues. Substantive conclusions are reserved for Chapter Six.

UTILITY

Although it was an initial premise of the research project that the utility of the studies could be determined from a questionnaire form, the complexity of the variables and the circumstances under which the studies were done soon led to a proposed questionnaire of excessive length and questionable merit. Under the circumstances gained by conducting a test interview and using the proposed questionnaire as a backdrop, the concept of the questionnaire was abandoned aside from its use as a general reminder of areas pertinent for discussion during face-to-face contact. Accordingly, an interview sample was determined, mainly to cover a cross section of the nation and according to the convenience of time and travel opportunities. The interviews were conducted by the joint project investigators and the principal research assistant. A total of ten states was covered, including Arizona, California, Colorado, Connecticut, Massachusetts, Oklahoma, Oregon, Texas, Virginia, and Washington. Coincidentally, this list includes the states which have been most active in the field of highway economic research analysis, and which have, with one or two exceptions, produced the majority of the total literature. Furthermore, the literature from these particular states was virtually all available to staff. Prior to the interviews, staff meetings were held to brief all of the literature available from the particular state in which the interviews would be conducted (see Fig. 2).

The original objective for the interviews was to contact the people who had been responsible for the commissioning of the studies in the local areas on the assumption that they were the clients of the studies and would be in the best position to evaluate the utility of the studies and discuss their outcome. It was also anticipated that the various researchers themselves would be available to give their reflections on the problems involved in conducting the study, as well as to comment on its outcome. The interviews were measurably successful in this feature.

A premise underlying the design of the interviews was that statements could be obtained regarding highway agency practice and policy as well as legislative enactments arising out of the studies. There are essentially four overriding reasons why the nonuser highway economic impact studies have been made, as borne out both by the interviews and subsequent analysis. These are as follows:

1. *Public relations problems.*—Prior to the highway cost allocation studies conducted in the late 1950's, most of the nonuser impact studies were undertaken in response to actual or anticipated public relations problems arising out of access control. From the early studies conducted in California under Balfour (*39, 40*), the main objective of most studies appears to be the allaying of fears arising out of access control, particularly the bypass highway and the limited-access expressway.

2. *Pressure from the Bureau of Public Roads.*—Most interviewees advanced that the primary reason for the impact studies being made was Bureau of Public Roads policy, particularly in relation to two concerns: (a) the provisions of Section 210 of the Highway Revenue Act of 1956, by which the Department of Commerce was directed to make a study and investigation for the purpose of aiding the Congress in determining an equitable distribution of the tax burden for the support of the Federal Aid Highway Program among the various classes of users and others benefitting from the improvement of federal aid highways; and (b) mounting concern over excessive severance damages as the Interstate System got under way.

3. *Legislative concern.*—In a few states, notably Washington, there has been a fairly long history of legislative interest in highway cost allocation problems.

Interviewees in both California and Arizona frankly admitted that most of their studies were made for public relations purposes. The California studies were, incidentally, conducted through the use of state funds with the exception of some few severance damage analyses. Many of the interviewees, in fact, felt that the Bureau of Public Roads was the client of their study rather than the state (*27*).

SEVERANCE DAMAGE STUDIES

Although severance damage studies are listed in the automated annotated bibliography of Volume IV, they have been dismissed from consideration within the scope of studies relating to community consequences. True, severance damage studies can save states money and can affect

TABLE 9

INTERVIEW SUMMARIES, HIGHWAY AND RESEARCH AGENCIES

STATE	STUDY TYPES	EXPRESSED PURPOSES	EXPRESSED UTILITY	INTERVIEWEES	EXPRESSED GAPS IN KNOWLEDGE
Arizona	Bypass Route location	1. Public relations	1. Public relations	B. W. Miller W. E. Willey	1. Impact of regional development on urban highways (Willey)
Connecticut	Freeway, non-urban corridor	1. Information 2. Public relations 3. Right-of-way acquisition 4. Depressed area aid justification (legislative inquiry) 5. Development commission inquiry into bypass effects	1. Traffic projection 2. Research information for local agencies	G. Spencer W. McKain	1. Impact of highways on general social and economic development (McKain)
Oregon	Bypass Street, one-way Public utility Residential and subdivision impact (Severance damage)	1. Right-of-way appraisal 2. Legislative inquiry 3. Electric utility benefits (state and BPR com--pensation policy) 4. Public information 5. Route location	1. Aid to appraisers 2. Public information 3. Route location decisions	L. I. Lindas W. Wright	1. Interchange land use controls (Lindas) 2. Air rights on freeways (Lindas) 3. Noise damages (Lindas)
Oklahoma	Bypass Interstate corridor Methodological guides Interchange (Severance damage)	1. Public information 2. Data for hearings 3. Justification of interchange controls (to legislature) 4. Aid to appraisers 5. Study guides for researchers	1. Public information 2. Benefits to hearings	J. J. Waters, Jr.	1. None
California	Bypass Freeway, urban radial Motel impact Relocation Residential and subdivision impact Industrial impact Route location (Severance damage)	1. Strengthen appraisal system 2. Public information 3. Increase efficiency of negotiations 4. Improve engineering and right-of-way coordination	1. Allayed fears of property owners	R. Hess H. L. Kagan B. Frankland	1. Analysis of interchange problem, land use controls (Hess) 2. Utilization of air space over or under urban area highways (Hess) 3. Billboard legislation on highway-oriented business (Hess) 4. Impact of route adoption announcements on land use and land value in the vicinity of future freeways (Hess)
Texas	Freeway, urban radial Relocation Bypass Median Roads, rural Interchange (Severance damage	1. Public relations 2. Economic justification 3. Policy formulation (BPR) 4. Aid right-of-way appraisal	1. Public relations lessened community resistance through use of data at hearings and as mailers	T. S. Huff M. D. Shelby W. F. Frey	1. Frontage road justifications (Shelby) 2. Interchange land use controls (Shelby) 3. Regional network impact studies (Frey)

TABLE 9—Continued

STATE	STUDY TYPES	EXPRESSED PURPOSES	EXPRESSED UTILITY	INTERVIEWEES	EXPRESSED GAPS IN KNOWLEDGE
Colorado	Freeway, urban radial Freeway, non-urban corridors Bypass (Severance damage)	1. Public information 2. Aid right-of-way appraisal 3. Aid highway planning 4. Tax allocation	1. Public information 2. Public hearings 3. Planning agency, public and real estate research libraries 4. Negative or little appraisal, planning, and tax allocation utility to date	J. P. McFall D. Bilisoly L. Jarrett	1. Cattle underpass justification (McFall) 2. Interchange land use controls (Bilisoly)
Massachusetts: Bureau of Socio-Economic Research, Inc.	Freeway, belt	1. Determination of community effects 2. Urban renewal implications 3. Alteration of public service areas 4. Business relocation 5. Damages to institutions and operations	1. Public information (answer objections to route location)	J. L. Phalan T. R. Overkleeft E. J. Rogan J. Fitzpatrick	1. Isolation of highway effects from other variables (Phalan) 2. Identification of a valid control community (Phalan) 3. Development of stochastic models for highway inquiry (Phalan) 4. Standardized EDP methods for highway economic impact (Phalan)
Texas: Texas Transportation Institute	Freeway, urban radials Interchange Roads, rural Median Relocation (Severance damage)	1. Highway department information 2. Public information 3. Hearings 4. Economic justification 5. BPR policy formulation 6. Aid to appraisers	1. Public information 2. Hearings 3. Highway department information 4. Aid to appraisers	W. G. Adkins C. V. Wootan J. L. Buffington	1. Relocation, costs and compensation (Adkins) 2. Aggregative analysis of severance damage (Adkins) 3. Total community effects studies to show overall net benefits vs localized benefit near the highway (Adkins)
Oklahoma: Oklahoma Center of Urban and Regional Studies	Interchange	1. Highway department information 2. Justification of controls to legislature	1. In progress: none to date	R. H. Lehr	1. Definition of limits of interchange impact (Lehr) 2. Definition of traffic-generating potential of land use (Lehr) 3. Predictive interchange model to indicate timing, level, and extent of control needed to inhibit interchange congestion (Lehr) 4. Feasibility of control alternatives: (1) purchase of access rights, (2) local zoning, (3) state zoning, (4) interchange regulations, and (5) interchange district (Lehr)
Oregon: Bureau of Business Research, U. of Oregon	Bypass Public utility	1. Legislative inquiry 2. Highway department and BPR information and policy formulation	1. Legislative and public information 2. Utility's share of pole relocation defined and charged	D. A. Watson	1. Construction employment impact (Watson) 2. Tourism effect, "transit" vs "terminal" state, tourist service centers (Watson) 3. Reorientation of wholesale trade areas; centralization and consolidation (Watson)

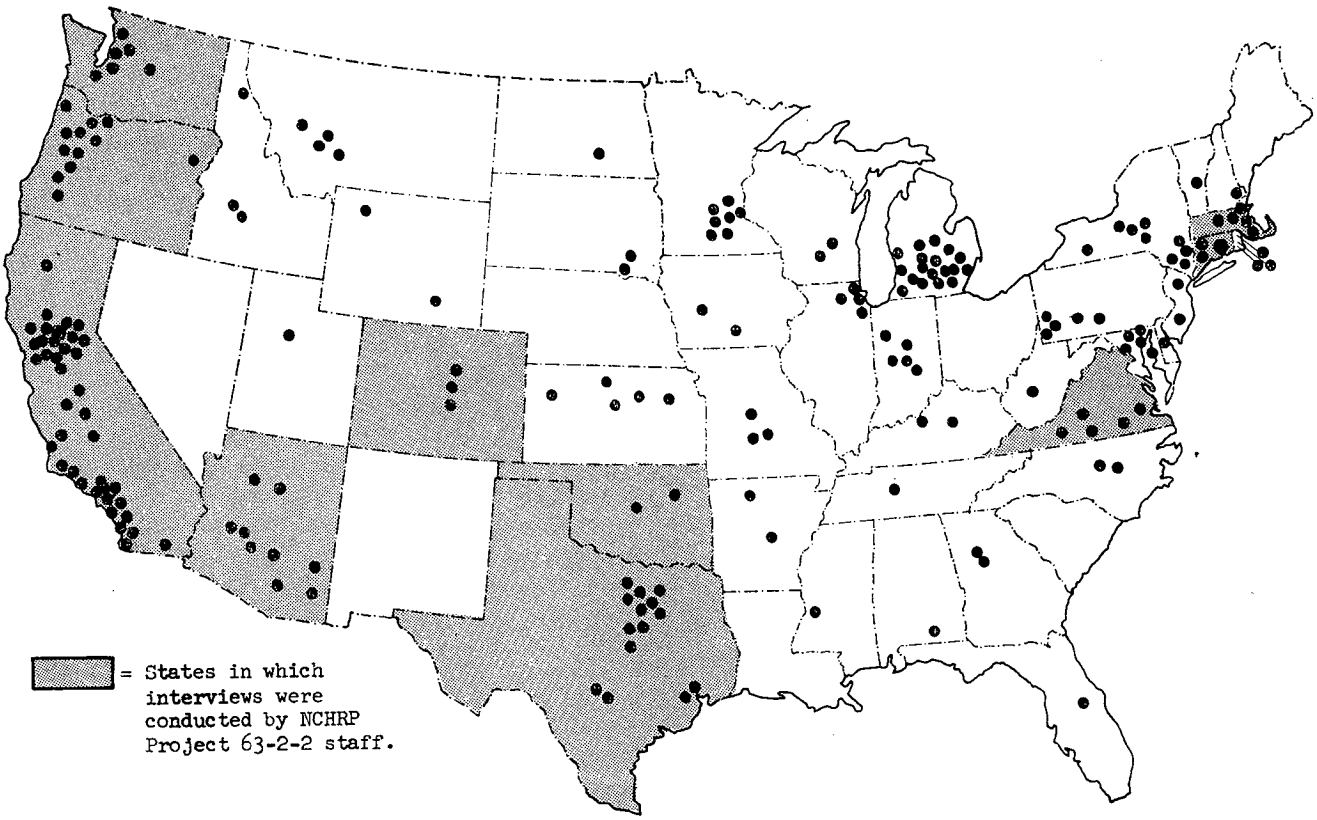

Figure 2. Location of completed studies of the economic impact of highway improvements (as of June 1964).

beneficially or detrimentally land owners whose property is purchased or condemned. Such benefits, however, are not results of the highway as a transportation instrument, but accrue predominantly from the property acquisition for the highway itself.

Although the impact of land acquisition and the highway construction itself on local economy is an important item to study in highway impact analysis, its importance lies only in the need to segregate this impact from the other impacts of the highway development relating primarily to transportation facility improvement. The omission of consideration of the severance damage studies does not depreciate their value, insofar as they may have been among the most important studies made. Nevertheless, the impact of severance damages on the nonuser, either the personal property owner or the community property owner, has been summarily eliminated from further consideration in this report as not being a valid contributor toward the community consequences of transportation improvement.

Although this research analysis dismisses the severance damage studies relating to community consequence of highway improvement, interviewees repeatedly discussed severance damage studies as being in the purview of the highway economic impact literature, which undoubtedly they are, and many interesting observations were recounted concerning them. (Oregon officials, for example, noted that there appears to be a "diminishing returns" effect from their severance damage studies. As an increasing number of studies has been made available to appraisers, their use of them in appraisals and in court cases seems to decline and they seem to increasingly rely on professional opinion and expertise.) Some very interesting remarks were made concerning the problems and the use of severance damage studies which imply that a separate research needs to be made in this area of interest.

Statements made by interviewees concerning severance damage studies have been documented, but such statements are not printed in this series of reports because of their irrelevance to the subject of the research. The interviews themselves have been written up and are part of the research archives of the Transportation Research Group at the University of Washington. Summaries of the interviews are given in Table 9.

EXPRESSED GAPS IN KNOWLEDGE

Although expressed gaps in knowledge have also been presented in Table 9 for the sake of relating them to their sources, Table 10 presents a restructuring of the information under several topical headings, with the addition of some ideas obtained from discussion and correspondence with the interviewees. It may be seen at a glance that Table 10 ranges from very specific and rather minute concerns, such as economic justification for rural cattle underpasses, to the most basic questions that have plagued all researchers

in the field, such as isolation of impact of highway change from other economic effects.

Fundamentally this list is a barometer of what kind of problems highway officials and researchers are concerned with at this point in time. These gaps reflect not only new areas of sensitivity under pressures from segments of the public, but concerns of considerable degree of sophistication regarding the research methodology itself. By way of sharpening the focus on these expressed gaps in knowledge, the first group tends to reflect the concerns of local pressure groups, the second group the concerns of the researchers themselves as to their ability to isolate impacts, and the third group reflects mainly the concerns of highway officials with the cost justification of elements of highway improvements as well as the induced demands on the highway plant itself which will change the level of service over time.

TABLE 10

GAPS IN KNOWLEDGE EXPRESSED BY INTERVIEWEES

1. *The impact of highway development on:*
   A. Local employment
   B. Tourism
   C. Wholesale trade area change
   D. Agricultural production
   E. Relocation of residents
   F. Economic base of the community
   G. Urban renewal (slum elimination)
   H. Public service district areas (schools, fire districts, library service, etc.)
2. *Methodological approaches to highway impact analysis:*
   A. Isolation of impacts of highway change from other economic effects
   B. Design or identification of control study areas
   C. Possible electronic data processing methods
   D. Standardization of research approaches for data comparability
   E. Evaluation of air and ground rights over and under freeways
   F. Assessments of noise damages
3. *Miscellaneous gaps in knowledge:*
   A. Economic justification of frontage roads
   B. Impact of billboard legislation on highway-oriented businesses
   C. Impact of route adoption announcements on right-of-way costs
   D. Economic justification for rural cattle underpasses
   E. Land-use impacts at interchanges (and logical controls)
   F. Impact of urban area development on freeway service (i.e., congestion)
   G. Impact of highway development on regional economic development

CONCLUSIONS

Although only 20 percent of the states were visited, these states represent approximately 50 percent of the highway economic analysis dollar spent over the past decade. Consequently, the climate of opinion of researchers and highway agency officials regarding highway economic impact analysis is reasonably well expressed by this sample. It is significant to note that although well over 100 major studies have been conducted in the field of highway economic consequences to nonusers, fundamental questions still need answering. The fact that the gaps in knowledge are evident does not at the same time detract from the utility of the studies in solving particular problems, although mainly to facilitate highway development programs through the dissemination of information at public hearings and through fairly popular media.

All economic studies basically suffer from the problem of precision. Nevertheless, regardless of the degree of precision, most of the studies add to the fund of knowledge, shed light on problems, and provide at least partial answers to them. All three interviewers had no doubt that in spite of the expressed gaps in knowledge most of the economic impact studies had served a rather genuine purpose.

CHAPTER SIX

INTERPRETATIONS, APPRAISAL, APPLICATION

Studies of the community consequences of highway development can range from relatively uninvolved analyses of isolated small town bypasses, dealing with only two or three impact variables, to highly complex and sophisticated studies of the diffusion of highway consequences throughout an entire urban area arising out of a system of urban freeways and the time sequences of its development.

A number of terms are often used interchangeably concerning the consequences of highway development, leading to some confusion in the interpretation of studies in this subject. The expression "highway economic impact" has been used for some years as a generic term to connote the broad consequences of highway development on both users of the highway and nonusers as well. The word "economic" when used in this context has come also to include many other associated consequences, particularly social and geographic. Still another expression of more recent coinage is the "indirect effects" of highway improve-

ment. This phase definitely implies effects on the nonuser as contrasted to effects on the user, which are obviously the "direct effects." Unfortunately, it is not always easy to separate indirect effects from direct. For example, the development of the Los Angeles freeway system has changed the distribution of the industrial base of the region. Industrial locations proximate to the freeways have in turn induced residential and commercial developments and use of the highway facilities themselves. This induced use adds to the user costs in terms of congestion delay.

The term "consequences" is no doubt the broadest term by which to describe the phenomenon of interest in this analysis. Thus, consequences of highway development may be either direct or indirect, user or nonuser oriented, economic or social, visual or esthetic, etc. In the context of this study the word "community" is used as a modifier of consequences and the consequences cover any or all of those listed in the preceding sentence. In other words, community consequences are considered here to be consequences upon the user as well as the nonuser, although user and nonuser analyses have generally been divorced in most past studies.

Because highway consequence studies have been conducted for so many reasons and under so many unique circumstances, their criticism and evaluation must clearly keep in mind the circumstances under which they were commissioned, the cost limitations imposed on them, and where they fit in the entire hierarchy of studies. By far the greatest number of the existing studies of highway consequences has been made for public relations purposes, particularly to ease the development of highways and highway changes in regard to counteracting adverse sentiment.

In 1956, however, a new angle was introduced relating to tax allocation problems facing the development of the Interstate System. Being given a Congressional mandate to develop an equitable basis for highway taxation, the Secretary of Commerce, through the Bureau of Public Roads, was required to look into the relationship between highway benefits and the potential allocation of highway costs. Section 210 of the Highway Revenue Act of 1956 documents this requirement, but does not give any further clues as to the specific linkage between highway benefits and highway tax allocation other than saying that the user and nonuser should contribute in proportion to the degree in which they are benefited. It has been relatively easier, although not easy, to evaluate the benefits of highway development or improvement upon the users of the Interstate System, than the nonuser, and particularly the commercial users who move goods in intercity and interstate transport. It is probably safe to say at this point in time, three years after the Secretary of Commerce reported back to the Congress on the results of the Highway Tax Allocation study, that there has been no workable proposal advanced to recapture the benefits of highway improvement upon nonusers. Congress is probably able to recapture nonuser benefits only through the progressive income tax, if at all. Consequently, the community consequences studies have been unable to relate community benefits to highway tax allocation theory and probably will not be able to do so in the foreseeable future. With the exception of a few unusual applications, such as the development of large-scale special benefit districts for bridges or tunnels, it is not germane to study the economic consequences of highway improvement from the standpoint of tax allocation prospects. For these reasons, those who criticize the community consequences studies as not relating to highway benefit theory are failing to consider either the nature of the studies themselves or the legislative capabilities of taxing unearned increment.

It is probable that as time goes on there will continue to be a need for conducting and repeating in many communities the type of analyses that have solved public relations problems elsewhere. The question of relating highway tax allocation to nonuser benefits will probably be de-emphasized because of inability to use this kind of information within a policy framework for tax change. The nature of community consequences studies, especially in urban areas, may well shift toward the evaluation of community consequences upon the highway service itself. There is no great importance for highway agencies in the knowledge that some properties within the area of influence of urban highways have become highly valuable unless the property is adjacent to the highway and the property owner is involved in the highway land acquisition process. Otherwise, the information concerning changes in land value is mainly of concern to commercial interests and property owners within the general vicinity of the highway. From these standpoints, as well as obtaining a general knowledge of land rents and property values, studies such as the Gulf Freeway study (*37*) are not overly significant. Aside from their public relations importance in terms showing general benefits to a region, these kinds of studies have no real purpose for highway agencies.

In other words, to be highly useful to highway agencies the emphasis of community consequences studies must move away from the analysis of limited pieces of real estate. Studies must move toward the analysis of gross land use changes, land density changes, traffic generation changes, induced use of the highway facility, changes in industrial linkages that may have an impact on the highway, and other factors that will serve as a feed-back mechanism to aid in the prediction of the long-range utility of the various elements of the urban or regional highway system itself. This point of view naturally projects the community consequences studies into the realm of general highway planning and development studies undertaken to some degree by the Urban Regional Transportation Planning agencies. Still other analyses, which include areas larger than the urban region itself, such as the Mohawk Valley of New York, require another level of operational base, such as the state or regional planning agency.

By way of suggesting guidelines for highway agency use on the subject of studies dealing with the community consequences of highway development, it appears that three types of studies must be conducted in the future.

Spatially Localized Studies

These are the public relations oriented, limited objective type of field studies that make up the majority of the present body of reports. They are the operational and practical studies necessary to present information at public hearings, to produce advanced information before development occurs, and to assist in specific ways the development of highways and their appurtenances. Although generally having a single purpose, these studies must be functionally comprehensive within the limited objectives of their scope.

It is not overly important that these studies repeat those conducted in other states, nor must these studies be theoretically defensible in terms of general highway benefit theory. Fundamental knowledge need not necessarily be the goal of these types of studies. They must be conducted as a result of particular problems or controversy and they must go at least as deep as it is necessary to delve in order to accomplish their limited objectives.

As far as methodology is concerned, it is not essential that these studies be comparable from state to state or from area to area. In all probability no single body of findings will arise from them that has more validity than the specific knowledge arising out of a specific study itself. In terms of their methodology it is important to state agencies that they are not embarrassed by those in a position to evaluate the studies for the parties to the controversy. This is not to suggest that these studies are of a "shirttail" nature. On the other hand unreasonable allocations of funds can be made for them in terms of either the theory they are capable of producing or the operational results they must produce.

There are a number of ways of improving these studies or making them less vulnerable to attack. Most of these methods were advanced in earlier guidelines established by the Bureau of Public Roads (*27*), as referred to previously. Additional ones arising out of this research are suggested in Chapters Two and Five. It is necessary that highway agency personnel contracting for these studies or setting up the studies within their own organizations consider the previously mentioned methodological requirement for sound research. On the other hand, there is no doubt that following through in the best scholarly way may weaken the case for the highway agency in local controversy. This raises a peculiar dilemma, but one which must be recognized in the strategy of highway progress. Highway agencies must represent the clientele of an entire state and not just a local community, and under these circumstances the selection of one approach or set of data to the exclusion of others may accomplish most. Two things are of concern in respect to this point: (1) Do the means justify the ends, and (2) What are the risks involved in presenting information in particular formats which fall short of good research practices. In any event, the highway agency should have a fair amount of information, probably more than it publicizes.

Gaps in knowledge in the spatially localized study classification relate either to new field problems which have arisen or to the limitations inherent in conducting past studies. In the latter sense, the gaps in knowledge can only be answered by studies with broader spatial context, as will be discussed shortly. Examples of newly emerging problems are the following:

1. *The use of air rights above or under freeways.*—There is little information as to the value of these rights, their impact on the highway itself, or the social costs or benefits of the use of such spaces. For example, should the air rights over freeways or the use of land below freeways relate to a public need such as recreation, which may not pay rents, rather than an income-producing use?

2. *The assessment of noise in the vicinity of highways.*—How are freeway noises to be separated from other locally generated sounds? How are sounds and vibrations to be measured and once measured how are their impacts upon people to be evaluated?

3. *The impact of land use changes at interchanges.*—What are the real problems of local traffic congestion resulting from land-use development in relation to the apparent problems? In many instances isolated interchanges with no development near them have been found congested because of remotely-generated traffic. In other instances interchanges with a great deal of development within their proximity run smoothly because of a lack of remotely-generated traffic. Little is known or recorded about this problem, and there is a great deal of irrational thought about its solution, if it is a problem.

4. *The efficacy of land-use controls.*—Highway agencies are prone to accept local controls as operational givens when in fact they are observed in their breach rather than in their compliance. Local agencies have not yet been oriented to providing the kind of feedback data needed to evaluate their own controls.

Spatially Integrated Studies

This type examines phenomena comprehensively in terms of space, which may be either the total urban region or space in some linear context, such as a regional development along a river valley or freeway. These studies differ substantially from the spatially localized studies in that they are comprehensive, are not concerned with the user versus nonuser differentiation, involve time sequence feedback of information, relate to the formation of spatial models, and are usually seeking to answer questions of fundamental knowledge rather than to assuage particular local concerns.

Examples of these studies are the Mohawk Valley study and the Los Angeles Urban Region study presented in Volume II, both of which present a regional type of analysis in regard to highway improvement. Studies of this nature require essentially different tools, or will require substantially different tools in the future as compared with the spatially localized studies. They tend to be involved with large-scale data systems and computerized data technology. These also tend to be studies for strategic planning purposes rather than the tactical studies needed to answer field-oriented problems.

Spatially integrated studies can rarely be accomplished by individuals, but require integrated staffs from larger consulting offices, universities, research group efforts, or regional transportation agencies. It is difficult to separate

studies of this nature from general urban area highway planning studies insofar as both should be concerned with the same consequences. In the future these studies might well become a part of the program of the ongoing transportation study groups because of their need for reiteration as time goes on. Other pilot studies in this category of a more fundamental research nature may be engaged in by public or private research agencies that are free of the vast range of demands and day-to-day problems faced by the transportation study groups.

Studies in this category of potential interest include the following:

1. *Relationship between residential, commercial and industrial settlement and the development of urban freeway systems.*—Studies of this nature can give a clue as to the rapidity with which changes take place, the scale at which the changes occur, and a rather broad knowledge of freeway system impacts.

2. *Studies of linear regional economic change.*—This type of study can examine the economic base of a linear corridor or development, such as exemplified in the Mohawk Valley study, to determine the relative changes between communities as well as differing patterns of transportation consumption.

3. *Studies of central place importance.*—Such studies could examine fundamental changes in the nature of economic activities conducted in various cities or communities and the change in their hierarchy as the transportation system itself is changed or competitive systems are introduced. These types of studies will be particularly important in the long-range future as mass rapid transit systems are developed.

4. *Studies of threshold limits of cities.*—To what extent will cities or communities remain stationary because of the nature of the critical mass of their economic base? Along these lines, to what extent may transportation improvement move a city from the limits of one threshold of size to another, thus changing its nature substantially? As an example, transportation development can centralize medical service functions, making a hospital feasible in one community of a regional hierarchy and precluding one from developing in another.

Theoretically-oriented models

This final classification of research may lead to the development of models of economic activities or settlement from which policy decisions may ensue. An example of this kind of study is the Population Allocation model presented in Volume II. Models such as these can test various patterns of regional development and suggest the needed patterns of transport development to match.

SUMMARY

A spectrum of community consequences studies has been presented here which leaves room for not only the types of studies that have been done in the past, but for the types which appear to be on the horizon. No one study can give a total measurement of community consequences or economic impact. The community consequences studies at some point merge into the general regional highway planning studies and will further merge into the overall urban region studies that will characterize the coming decades. The spatially localized studies, although limited in objective, must be conducted with a greater sophistication to protect the reputation of highway agencies. A new research program must be written dealing with spatially integrated studies as a part of the National Cooperative Highway Research Program, which may advance the type of probes suggested in Volume II and lead to a broader concept of community consequences.

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APPENDIX A

CLASSIFICATION AND COMPARABILITY OF NONUSER HIGHWAY IMPACT STUDIES

CLASSIFICATION SYSTEMS

The classification system evolved in this research consists of a keyword-in-context listing (see Fig. A-1, taken from Vol. V), and a classification matrix of highway type and impact variables (Table A-1). The development of these two elements of the system is illustrated in Figure A-2, and described in the following.

Review of Other Classification Systems

At least five researches on highway economic impact analysis have evolved classification systems of some internal consistency (*41, 42, 43, 44, 2*). These range from a very simple system based only on three major variables, developed by Garrison and Marts (*42*), to a geographically oriented cross-classification matrix developed by Levin (*41*). These five systems undoubtedly reflect specific purposes of the particular researches. The system based on geographical ordering was conducted essentially to show what different states had done. Produced by Federal

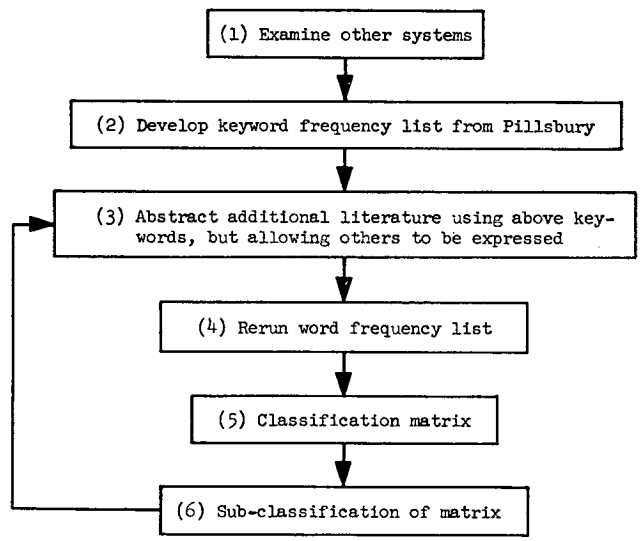

Figure A-2. Steps in development of classification matrix.

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HAT ARE THE BENEFITS OF CONTROLLED-ACCESS=                      C-US55-CLARA1
VELOPMENT.  PLANNED AND CONTROLLED, THEY CAN BE A GREAT EC      D-PA59-WILDC1
IVES THAT ARE SOUGHT IN CONTROLLING ACCESS TO MAIN ROADS I      D-US56-DAVIH1
UP AROUND OUR POLICY OF CONTROLLING HIGHWAY ACCESS.  THE L      B-US63-NETHR1
                         CONTROLLING HIGHWAY ACCESS=            D-US56-GUYTJ1
ES AND LEGAL PROVISIONS CONTROLLING LAND DEVELOPMENT, AND       B-TX63-ADKIW1
Y OF THE LEGAL MEANS OF CONTROLLING LAND USE DEVELOPMENT I      B-WS61-YANGD1
 DETERMINE THE NEED FOR CONTROLLING LAND USE ADJACENT TO H      B-WV00-WESTV1
P INFORMATION USEFUL IN CONTROLLING LAND USE, AND THE MEAN      B-WV00-WESTV1
 OF THE BASIC PLANNING, CONTROLLING POLICIES AND DETAILED       D-US58-CURTR1
SIGN AND LOCAL LAND USE CONTROLS ARE DISCUSSED AS BEING ES      C-US59-WALSS1
                 LAND USE CONTROLS AT EXPRESSWAY INTERCHANGE    D-PA59-WILDC1
DEQUACY OF PRESENT LAND CONTROLS AT THE INTERCHANGE APPROA      B-WN61-GARRW1
S OF ACHIEVING ADEQUATE CONTROLS OVER LAND USE AT THESE PO      B-TN62-TENNS1
NCES ALTERNATIVE PUBLIC CONTROLS OVER THE USE OF LAND IN I      B-US60-USAGD2
 EVALUATION OF LAND USE CONTROLS POSSIBLE UNDER EXISTING L      B-TX63-ADKIW1
ED.  SEVERAL DEVICES OR CONTROLS WHICH COULD BE USED TO AI      D-US60-LEVID3
 INTERCHANGE.  POSSIBLE CONTROLS WHICH MIGHT BE USED TO AV      D-US60-LEVID2
OCAL PLANS AND LAND USE CONTROLS.                               B-OK00-OKLAU1
ING, HIGHWAY IMPACT AND CONTROLS, AND ARE MAKING SIGNIFICA      C-PA62-FREYJ1
SED VALUATION, LAND USE CONTROLS, AND TRAFFIC PATTERNS.  A      B-NY00-NEWYP1
  LAND USE AND PLANNING CONTROLS=                               B-WV00-WESTV1
 TO DETERMINE THE LEAST CONTROVERSIAL ROUTE FOR AN EXPRESS      B-MD60-BALTC1
S THE RELATIONSHIPS AND CONTROVERSIES THAT EXIST AMONG THE      C-US59-HENNR1
 IS A DISCUSSION OF THE CONTROVERSY WHICH MAY ARISE BETWEE      C-US54-BROWC1
 THE SPEED, SAFETY, AND CONVENIENCE OF MOTOR-VEHICLE TRANS      C-US59-USCON1
EDED THESE LOSSES.  THE CONVENIENCE OF THE PARKWAY HAS BEE      B-NJ58-RUTGU1
```

Figure A-1. Sample of keyword-in-context index.

TABLE A-1

CLASSIFICATION MATRIX OF HIGHWAY NONUSER IMPACT STUDIES BY KEY WORDS

IMPACT VARIABLE / HIGHWAY TYPE	Real property values	Business	Land use	Socio-economic factors	Political and gov. factors	Community facilities	Traffic	Aesthetic values
Boulevard, shopping								
Bridge								
Bypass								
Freeway, belt								
Freeway, non-urban corridors								
Freeway, urban networks								
Freeway, urban radials								
Highway, forest								
Highway, primary								
Highway, secondary								
Interchange								
Median								
Parkway								
Road, frontage								
Road, public land								
Road, rural								
Route location								
Street, one-way								

agency personnel concerned with the integration of state highway research efforts, it is only natural that such a system should pay specific attention to a geographical classification.

Studies conducted in California reflect the concerns of the state highway agency with pressure groups impeding progress of the California highway development program. This classification system, essentially arising out of the breakdown of titles and chapter headings of California reports, contains terms like "motel," "remainder parcel," and "frontage road" as the important variables. Of particular interest is the report to Congress (*2*) arising out of the Highway Cost Allocation Study, which emphasizes by headings of parts the words "urban" and "rural." Clearly a concern here is legislative interest and the inclusion of words which will be meaningful to legislators.

A great number of variations are possible in a classification system for a body of literature such as the highway economic impact studies. For example, the "user impact" and "nonuser impact" differentiation is another very broad division, and one on the basis of which separate researches (including the one reported here) have been conducted during 1963-4 at the University of Washington.

METHODOLOGY

Development of Keyword Frequency List

Because none of the researches previously mentioned contained mandates to develop a classification system *per se,* the first step in the methodological approach of this study was the production of a keyword frequency list from the most comprehensive volume of abstracts available at the

beginning of the research, that by Pillsbury (*45*). Although others have listed the results of a great number of component studies, none has given specific abstracts and each was concerned with only a portion of the literature available, as well as using it in a specific way.

The keyword frequency list arising out of this step gave an important clue as to one element of classification; namely, "impact variables." An impact variable is defined as a consequence of highway development, or something investigated with the assumption that it will change according to highway improvement. Thus, typical impact variables are land uses, land values, and retail sales. Approximately 150 abstracts were examined from Pillsbury in this context.

Abstracting Additional Literature

With the use of the preceding word frequency list all of the available literature not abstracted by Pillsbury was read and similarly abstracted. In this process the abstracts were not limited to the keywords arising out of the Pillsbury abstracts, but new words were allowed to be expressed as they were found to be meaningful. Approximately 100 documents were handled in this manner.

Rerun of Word Frequency List

From the combined abstracts of both Pillsbury and those done at the University of Washington, and by the use of a computer program developed for the purpose, a new word frequency list was run which gave an expanded view of the keywords used by researchers in the field. This was part of the process in the development of the abstracts (Volume IV) and the keyword index (Volume V) of this series.

Development of Keyword Classification Matrix (Table A-1)

Because the keyword-in-context listings included the titles of reports as well as information from the abstracts, there were two sources of information underlying the keywords developed in the automated library. The abstractor had no latitude with the words in the titles themselves. Upon careful examination of the keywords and with prior experience with the concept of impact variables, it became apparent that the two generic types of words of importance were (a) those dealing with the facility type, such as a bypass or a beltway, and (b) the impact variables previously mentioned. The cross-classification matrix, therefore, relates a physical highway type, the independent variable, to nonuser impact factors, the dependent variables. As an example, a bypass is a particular kind of highway distinguished by a physical concept. It may be studied with respect to several variables of impact; namely, real property values, changes in retail sales, and changes in the organization of land use. Thus real property values, retail sales, and land use are the variables by which a particular type of physical configuration of a highway is studied.

In most other classification systems facility type and impact variables have not been specifically segregated. It was felt that in a study charged with examining nonuser highway economic impact a primary element of the classification system arising out of the analysis should be the impact variables themselves. Following the development of the cross-classification matrix the question arose as to whether the abstracts of the previous steps should be reevaluated to assure their inclusion of the terms in the matrix. A spot check revealed that most of the Pillsbury abstracts and virtually all of the University of Washington abstracts used these words effectively, and that within the economic limits of the research budget alterations could not be made to the approximately 600 abstracts which were by this time transferred from punch cards to magnetic tape. A factor of considerable importance relating to the matrix is that the words arise out of usage, in both the abstracts and the titles. As such they cannot be completely defended or attacked. For example, the terms urban radial, freeway belt, and secondary highway, to mention a few examples, appear over and over again in the literature and connote some sort of common understanding to most observers regarding physical configuration. The matrix, therefore, not only includes the first order of words of significance in this body of literature, but also could form an important backdrop for subsequent abstracting as well as the structuring of future research work.

The list of variables is subject to refinement, of course. Table A-2 gives subtopics under the variable "land use" as derived from a compilation of the words that modify or refer to land use in Pillsbury. It would be pointless to expand all the variables in a similar way, as this function

TABLE A-2

EXPANSION OF KEY WORDS OF VARIABLE "LAND USE"

WORD OR PHRASE	FREQ. IN PILLSBURY ABSTRACTS
Existing and changed uses	44
Development	11
Building permits	10
Community growth	7
Use changes	6
Site selection factors	4
Future development	3
Ownership and operation units	3
Right-of-way displacement	3
Land use controls	3
Buildings	2
Relocation effect	2
Future uses	2
Accessibility from highway	2
Characteristics of development	2
Urban encroachment	1
Crop patterns	1
Density	1
Utility easements	1
Proximity to highway	1
Zoning revisions	1
Land development plans	1
Condition permitting excess development	1
Physical barriers	1
Unregulated ribbon development	1
Unplanned land uses	1

TABLE A-3
TYPE OF HIGHWAY NONUSER IMPACT STUDY, BY FREQUENCY

Physical group:		*Miscellaneous group:*	
Bypass	70	Theory or method	8
Freeway, urban radial	25	Overview or summaries	7
Freeway, non-urban corridors	23	Planning	3
Freeway, urban networks or systems	17	*Variable-oriented group:*	
Route location	16	Agricultural impact	14
Interchange	10	Industrial impact	11
Freeway, belt	9	Population impact	7
Parkway	8	Tourist impact	6
Road, rural	7	Taxation impact	5
Road, frontage	6	Retail and commercial impact	5
Highway, primary	4	Residential and subdivision impact	4
Bridge	4	Public utility	3
Street, one-way	3	Relocation	3
Median	3	Government services impact	2
Highway, secondary	3	Motel impact	2
Road, public land	2	Recreation impact	1
Highway, forest	1	Construction impact	1
Boulevard, shopping	1		

is accomplished by the keyword list of the automated library (Volume V). Thus the matrix is a general frame of reference, whereas the keyword-in-context index gives specific words.

Table A-3 gives a breakdown of the types of studies by frequency of occurrence in the literature as of mid-1964. In addition to the types previously discussed, there are several studies termed "miscellaneous" for the lack of orientation with physical type. A third breakdown lists the frequency of studies which are primarily variable-oriented. This last group includes studies made predominantly to identify a single variable as it relates to one or a group of types or to highways in general.

To summarize the classification system, most studies fall generically into either the physical type, the miscellaneous group, or the variable group. Except in the case of single-variable studies, one must search through all of the types of studies listed along the left side of Table A-1. Conversely, one may study any type of facility according to the variables listed in the column headings. Rarely does one of the existing studies do both. Thus, in any one study the researcher is generally moving horizontally across the table examining one or more variables, or occasionally moving vertically down the table examining a particular variable under different circumstances of highway type.

Early in the development of the automated library considerable thought was given to the development of a code identification of studies according to either their type or the variable of analysis. Under such a system certain digits could be assigned to permit the segregation of studies either by type or by variable. As the situation developed, however, it appeared obvious that the keyword-in-context system would permit identification of studies according to either the variables analyzed or the type of study as reflected in Table A-1.

It appeared redundant to utilize a digital code for a type of study when one could examine the keyword-in-context index according to either the variable or the type and immediately obtain a cross-listing of all studies according to the desired information. Thus, one can use the keyword-in-context index (Volume V) under the heading "bypass" and thereby retrieve a list of all of the bypass studies (types), or examine an entry under the term "values" and retrieve, through the addition of the term "land," all the study references dealing with land values. Studies listed under different keywords but having common codes deal with information included under both keyword designations.

Cross-referencing is thereby possible and studies can be obtained for a specific variable and type. The value of Table A-1 is that it gives a framework for use in future abstracting in terms of important keywords to be used both in the title itself and in the abstract of the contents. Furthermore, the system is open-ended, permitting additional types to be included, as well as additional variables.

One of the greatest problems in evaluation of highway economic studies is to find several studies on one particular type which deal with the same variables. Ideally, a classification system that would give immediate focus on studies of a particular type dealing with common variables would be of interest. This level of detail was dismissed, however, because of the problems encountered in a common treatment of the same variable in more than one study. For example, in regard to retail sales, they may be weighted by the consumer price index in one study and not weighted in another, thus destroying their comparability. A second reason relates to the fact that apart from the voluminous bypass studies, most of the types have relatively few examples, and therefore subdivision according to common variables would have isolated studies into types that were entirely unique to a single study. In other words, a classification system cannot survive that degree of refinement. A working definition of each type of study enumerated in Table A-1 is presented in Appendix B. These definitions include the characteristics and purposes which these studies seem to have in common.

COMPARABILITY FACTORS

There are at least ten prime factors of concern in the comparison of the nonuser impact studies, as follows:

1. Time span of the study.
2. Type of highway facility.
3. Geographical boundaries of the study area.
4. Impact variables analyzed.
5. Techniques of analysis.
   (a) Sampling procedures.
   (b) Information sources.
   (c) Adjustment or normalization of values to base year.
6. Existence of control areas.
7. Functional changes of the community.
8. Local land use controls.
9. Technological change.
10. Economic change.
    (a) National.
    (b) Regional.
    (c) Local.

A general discussion of these factors is given in the following and specific references to these problems of comparability are documented in earlier sections of the report.

Time Span

As might be expected, there is no specific standardization of time spans either in the before or after sense, or in regard to the dates of time series data. Even when a state has made an attempt to standardize the time span of studies, as in the case of the bypass studies in California, this has not been adhered to rigidly. Obviously the longer time spans tend to give a more accurate picture of highway impacts, although on the other hand impacts become more diffused with increased time span.

Type Comparability of Facility

In comparing any two studies dealing with the same classification of facility the question always arises as to the exact nature of the two facilities. For example, some of the bypasses are substantially remote from the business districts they bypass and others are quite proximate. The bypass studies are further differentiated on the basis of access control. In some instances the bypass routes are of the limited-access type; in others they are either partially controlled as to access or, in a few cases, noncontrolled. Other characteristics of the total road network vary substantially from study to study. Knowledge of the complete transportation network is of particular concern in the urban studies, where the development status of the entire network is an important factor in judging the impact of any one element.

Geographical Boundaries

The selection of geographical boundaries has not been dealt with rigorously in most analyses, and particularly those dealing with land value changes where designation is critical. For example, if boundaries are extended sufficiently far benefits will be substantially diffused. In fact, it might be said that where there are benefits to a geographical area there must also be malefits (disbenefits) to either some portion of that area or to some adjacent area. It is insufficient to designate random control areas for an urban corridor land-value study, for example, when the control area itself could well be another radial segment of the highway network which does not have access control, or is not developed to a high-type configuration. In other instances, geographical boundaries are determined entirely intuitively or arbitrarily.

Variables of Impact

In most studies the impact variables have been chosen on the basis of the availability or ease of collecting data. This varies substantially from state to state and area to area. For instance, in some states assessor's information is not available, even to state agencies for highway economic impact analysis. It is difficult, in fact, to find in any interstate comparison a fairly uniform list of variables. The issue underlying the study also determines what variables will be selected. For example, if real estate interest groups are concerned about land value this may be the prime variable, to the exclusion of others.

Techniques of Analysis

Sampling procedures vary from study to study and, in fact, scientific bases for sampling are absent in a large number of studies. Information sources range from essay-type questionnaires analyzed by consultants, with virtually no way of checking the validity of the data, to fairly rigorous methods based on analysis of documented public records. The adjustment of values, such as the correction of dollar values for inflation, is sporadic. The development of coefficients of change that normalize general population growth or other local factors is absent in many studies.

Control Area

A surprising number of studies do not make use of control areas and those researchers who do use control areas do not always select them on scientific premises. There is also the real and acknowledged problem of finding control areas similar to the area under study, as well as understanding the nature of control areas themselves.

Functional Change in Community Structure

Typically, when highway improvement is made there is a functional change in the community resulting from the improvement. An example in another form of transportation technology is found in the development of the gateway cities to the West. For instance, Chicago, Kansas City, and St. Louis owe their growth to the fact that they were railroad termini during the period of history when the West was developed, and these cities developed rather than the newer cities of the West (Denver, Salt Lake City, Santa Fe, etc.) Transportation improvement invari-

ably alters the central place relationship or the hierarchical structure among cities. This has been documented extensively by Garrison *et al.* in the Marysville study (*46*). In other words, the improvement of transportation, whether it be highway, rail, or air, changes the function of cities or places. There is a substantial impact on the nature of their economic activities and land uses based on their changes in the hierarchy. Referring again to the Marysville study, the Interstate highway bypass changed Marysville from a small agricultural trading center to a suburb of Everett, Wash.

Local Land Use Control

The nature and administration of local land use controls has rarely been studied in highway economic impact studies. This is of extreme importance, particularly where there are multi-jurisdictions in a study area. For example, in many small town bypasses where municipal zoning laws are more stringently administered than county ordinances, the connections between the cities bypassed and the limited-access highways become developed with commerce outside of the municipal boundaries. Under these circumstances there is a shift in impact from one municipality to another, which is not always taken care of in the selection of data.

Technological Change

With the passing of time there is continually a change in the relationship between the relative amounts of capital, materials, and labor to produce any particular commodity or service. Over the past ten years, for example, the labor input per car produced in Detroit has diminished by one-half. At the same time Detroit has been developing one of the most extensive urban freeway networks. Obviously, any analysis of highway economic impact on Detroit would have to recognize such technological changes as that referred to, or else conclude that highways have an adverse effect on employment. The same thing occurs, perhaps at a less dramatic scale, in almost every community. At times these changes are very rapid. To cite another example reflecting automation: when anticipating the building of an aluminum plant in 1950 at Malaga, Wash., 10 miles down the Columbia River from Wenatchee, the Aluminum Company of America anticipated 1,500 workers. The plant opened in 1953 with 900 workers and today has about 300 workers producing more output than originally scheduled. These are the kinds of events and changes that highway economic studies rarely probe, let alone investigate in depth.

Economic Change

Obviously, national, regional, and local economic changes due to a number of reasons, including large-scale trends in regional development and change, have an impact on what is happening in any particular area. The studies vary greatly in their capacity to analyze these trends. The growth of retail sales, for example, may be a function of changes in centrality or general economic conditions far more than changes in highway facilities.

CONCLUSION

The foregoing discussion recounts the great problem of comparability between studies, which precludes any rigorous statistical analysis comparing the results of one study with another or with others. Even simple statistical techniques could not be applied with confidence. As a result, three largest groups of studies for which data are available are comparatively analyzed with only simple statistical tools in the body of this report. The bypass studies, being quite extensive, are segregated in Chapter Two, and discussion of the urban radial and beltway studies considered to be of considerable importance for future analysis appear in Chapters Four and Three, respectively. The next largest category of studies (Table A-3) is the non-urban radial corridor studies, which are yet in the "before" stage. Of the remaining studies only a few are available for analysis in each category, and the results are handled in a general way in the total evaluation of the information available.

APPENDIX B

DEFINITIONS OF STUDY TYPES

The following are definitions of the study types contained in Table A-1, not elsewhere defined in the text:

Boulevard, shopping.—The only study of this type known (*47*) treats the commercial development which locates along major arterials and forms a "before" study of a boulevard to be paralleled by a freeway. The future "after" study will measure the impact on the shopping street of traffic transference to the freeway.

Bridges.—The bridge studies have provided information for economic justification, tax allocation, and toll determination. Property values and land development have been the major variables studied to determine the nonuser benefits of the improved access provided by the bridge.

Freeway, non-urban corridors.—Studies of Interstate routes, dealing with their overall social and economic impact over extensive inter-urban segments, are being made for the purpose of public information and regional transportation planning. They are designed to measure gross effects on farm production, bypassed town economies, reorganization effects on land use and population, etc. Of an "omnibus" nature, they usually cover a wide range of variables and extend over many years time. Most are still "in progress" with "before" data being gathered prior to the construction of the Interstate route.

Freeway, urban networks.—All-encompassing studies of nets or systems have been undertaken mainly for the purpose of determining regional or metropolitan effects of such system in regard to economic, land use, demographic, and social trends. These have implications for aiding in guiding regional planning, especially the area-wide transportation studies, through identification and prediction of gross effects.

Highways, forest and public lands.—Studies of forest and public lands highways have provided data for economic justification, future needs, and tax allocation purposes. Benefits of such highways have been determined by exploring the value of access to natural resources in terms of their development and economic impact.

Highways, primary and secondary.—These studies investigate the nonuser benefits, usually to land values, retail sales, farm, community and industrial development, income, tourism, etc., in order to demonstrate the economic justification of improvements to secondary and primary highways.

Interchange.—These studies were designed to show the impact of interchanges in encouraging more intense land uses at these access points. Anticipating that such uses might generate traffic in quantities sufficient to lower the efficiency of the interchange and hasten its obsolescence, the end result of these studies was to indicate the type of development occurring, its traffic generating potential, and the nature and extent of controls necessary to prevent its interference with interchange operation.

Median.—Undertaken as public relations and policy determination studies, median investigations look into the effect of median barriers on the sales of abutting retail establishments. Fear of sales losses has created business opposition to medians which, by preventing left turns, limit direct access to traffic traveling in only one direction.

Parkway.—Having been among the earliest manifestations of the limited access highway, parkways were the first highways studied for their nonuser effects and most studies have been done by nonhighway agencies. The parkway studies have examined such effects as land value, land use, and the opinion of abutting owners as to the desirability of living near such a facility. The studies have been accomplished mainly for the purpose of public information.

Frontage road.—These studies showed the substitutability of a frontage road location, for highway-serving retail businesses, for direct access with no loss and a likely gain in trade. As public information devices they were designed to quiet controversy from business interests over loss of direct highway access and show the benefits of accepting a frontage road location in lieu of the former.

Roads, rural.—The effect of rural road improvement (grading, converting from dirt to gravel, paving, etc.) on farm land values and operating economies has been the focus of these studies. They have been of interest primarily to highway departments and legislative committees in determining the cost/benefits of such improvements and for justifying the allocation of funds for this purpose.

Route location.—Predictive in nature, these studies attempt, through the use of economic indicators (*e.g.*, sales, land value, production, land use), to gauge the comparative economic impact of alternative route locations. These considerations are in addition to those of engineering design considerations, user cost-benefit analysis, and construction costs which generally guide such decisions.

Street, one-way.—Public relations/information oriented, these studies were designed to show whether retail businesses on streets converted to one-way suffered loss of trade due to deprivation of a lane of traffic traveling in the opposite direction. Claims to this effect had created conflict in the setting up of one-way systems.

APPENDIX C

SUMMARY OF VOLUMES NOT PUBLISHED*

Volume II—Studies, contains four case-study probes into the little-explored areas of spatially integrated and theoretically-oriented studies. Part 1 studies regional corridor impact in the Mohawk Valley (N.Y.) and Piedmont Crescent (N.C.) regions via economic base and employment analysis. Findings revealed that highways may have a significant influence on the employment mix and commuting patterns in communities within the commutershed of large urban nodes and having freeway connection to the nodes.

Part 2 is a theoretical examination of the settlement and density patterns of urban areas as they relate to the transportation network. Two models of population distribution and allocation are presented which will aid in estimating residential densities at particular locations and in estimating development according to differing plans, policies, and criteria.

Part 3 investigates, via computer graphing and mapping techniques, the distribution and change of land use and population density in the Los Angeles Urban Region during the period of its freeway development, 1940-1960. The findings identified three phases of regional growth linked to freeway development: (1) the substitution phase, wherein freeways serve existing demands from the present population created by auto-for-transit substitution; (2) the transition phase, wherein freeways follow induced demands caused by population spread into newly developed areas; and (3) the developmental or deterministic phase, wherein freeways traverse previously undeveloped areas and begin to determine the location and timing of land use change, thus creating demands. Also apparent was the tendency of the freeway network to decentralize work and residence, lower central residential densities, disperse population, and encourage industrial location and relocation near freeways.

Part 4 proves the visual analysis of highway development in two case studies, one of Los Angeles intersections, the other of Seattle highway corridors. The former developed a typology of visual intersection development phases related to increase in traffic intensity; the second provided indicators of the relationship of sign, open space, and building density to average daily traffic volumes and access control.

Volume III—Automated Indexing System, documents the methods and computer programs used to generate the automated bibliography and keyword-in-context indexes of highway nonuser impact studies. The system has utility to other aspects of highway research.

Volume IV—Automated Bibliography, presents a current comprehensive listing of documents relating to community consequences of highway improvement. It contains more than 600 annotated references, including studies, articles, commentaries, bibliographies, and general references.

Volume V—Automated Indexes, contains keyword-in-context and author indexes of all the works listed in Volume IV. Providing keywords in the context of their abstract or title adds precision to their meaning and facilitates literature search for documents dealing with a common topic.

* Loan copies may be obtained by writing to the Highway Research Board.

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* Highway Research Board Special Report 80.

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THE HIGHWAY RESEARCH BOARD, organized November 11, 1920, as an agency of the Division of Engineering and Industrial Research, 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.