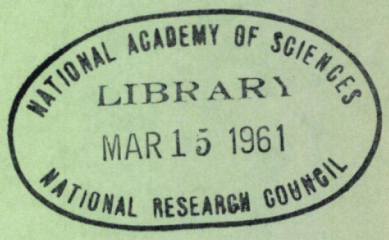
HIGHWAY RESEARCH BOARD

Bulletin 268

Some Evaluations of Highway Improvement Impacts



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Some Evaluations of Highway Improvement Impacts

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Freeway Impact on Municipal Land Planning Effort

EDGAR M. HORWOOD, University of Washington, Seattle

● A NOTEWORTHY concommitant of the current Interstate Highway Program has been the emergence of interest in urban planning and highway planning relationships. The literature has been replete with articles on this theme, (1 - 17) and the central statements of needs in this respect have now been presented. It remains to be seen whether or not these needs can be fulfilled.

The conceptualization of the state highway function is now actually in its fourth stage. The first stage, in the 1920's, was essentially the interconnection of urban places, without regard to continuity at the city line. The second stage, in the 1930's led to state highway continuity through urban areas, and more often than not became involved in a plethora of routes in the process. Thirdly, in the decade following World War II, the concept of limited access was evolved and perfected. And now the state highway role is being viewed in terms of an urban-area system, with its impact on land values, land use, and the dynamics of urbanization and city growth itself.

A completely new and rapidly changing arena of thought has come about. Highway and planning agencies are now facing the same degree of difficulty being experienced by the air-frame industry in meeting the demands of the space age.

This paper re-examines some of the factors which impose serious limitations upon the integration of the city planning and highway development processes, and is based on recent research undertaken by the highway research group at the University of Washington (18, 19), as well as visits to many urban areas by the author. It also presents some case studies taken from current research being undertaken at the same institution for the Bureau of Public Roads, a part of which work is oriented to a study of public policy as it has a bearing on highway development.

GENERAL EXPRESSIONS

Both professional and elected officialdoms concerned with highway and urban development are asserting themselves in favor of comprehensive outlooks, integrated points of view, and cooperative approaches among the various political elements of the urban order.

Typical of these assertions is the first formal finding of the much-publicized Sagamore Conference in October, 1958, which states:

> It is essential that all units of government cooperate fully in meeting the urgent needs for highway improvement involving the planning, designing, and operation of facilities, so as to provide optimum transportation service and accomplish the orderly and proper development of our urban communities (20).

Commissioner Ellis L. Armstrong, of the Bureau of Public Roads said, "The Conference stressed that all levels of government should strengthen their support of city and regional planning; that continuing consultation and cooperation are vital. It properly placed responsibility upon local government to prepare a comprehensive plan for the physical development of the community, embracing a land use plan, a transportation plan including public transit, and a program of land use controls. Similarly, it recommended that state highway departments, in cooperation with local governments, should develop a tentative program of urban highway improvement, at least five years in advance, as a basis for planning at the local level; and that this program should be in accordance with a jointly agreed-upon long range plan." (21)

These terms are probably as representative as any to set the stage for discussion. Everyone believes in these general expressions, but a real problem exists in translating them into meaning on the operational level. The first step in this process is to develop a framework for thought and for testing and interpreting real situations.

NEED FOR PROGRAM REVIEW AND ANALYSIS

The central thesis of this paper is that a large segment of top management of agency personnel in both the urban planning and highway development fields do not have, and are in need of, information by which to evaluate the success or failure of public policy relative to the solution of problems with which they are concerned. There is very little scientifically organized "feed-back" on the success or failure of programs and procedures for advancing the art of coordinated, urban area-wide planning (22). Although the study of economic determinants and economic impact, and the art of traffic projection in terms of land use have progressed rapidly, there has been virtually no advance in the administrative and management fields, and also in respect to coordinating highway and land-use policies.

This paper does not claim to present any solutions that have not yet been posed. It does, however, present some rudimentary suggestions as to ways and means of collecting information for feed-back purposes to aid both in the evaluation of policy and in the conceptualization of the problem. It is an important planning function for the staff or executive level of any planning or highway agency to undertake program review and analysis on a far greater scale than has been done in the past, so that evolving policy will be influenced positively and so that there can be a greater national exchange of information, which can be expected to raise the level of planning service to policy boards and legislative authorities. Without such organized review, only a few subjective viewpoints are exchanged at the national conferences.

THE FOUR CURRENT FACTORS

Four contemporary factors are presented here to assist in an understanding of highway and urban planning activity. These factors are not presented to critize any particular set of officials or professional groups. They are presented, rather in an effort to make thinking precise on four categories of the problem in order to understand the facts of the present situation. These factors are phrased as research problems, but they need far more refinement than either the length of this paper or the knowledge of the author permits.

Municipal Provincialism

The first factor deals with a new mode of local government which lies beyond rational integration into the regional land-use planning process. Specific reference is made to the "bedroom" or "dormitory" suburban city which has a unified land-use goal structure, consisting of no commerce, no highways and no industry except research and development corporations.

These cities are quick to assume the responsibility of preparing a comprehensive plan for their land-use development. In fact, many have incorporated for the primary purpose of local planning, which usually means having development standards of a more restrictive nature than those enjoyed by either residents of the county or central city. Others have more status in the time and place scale, being centered at older townsites in the suburban fringe. These, however, are in the process of rapid annexation to stop the spread of neighbors or preclude incorporations of adjacent areas.

Although the problems involved in a determination of the "area of appropriate inclusion" (23) for a unit of local government are apparent, nevertheless, there has been a rise of municipal provincialism which often makes for an impossible situation regarding acceptance of the planning efforts of agencies concerned with the solution of regional problems, such as developing a freeway network or mass rapid transit scheme.

There are both logical and absurd circumstances surrounding the formation of and changes in municipal boundaries. There is a need for an hierarchical ordering of the rights to be accorded to various units of local government by state agencies in the ful-

fillment of their area-wide responsibilities, and this can be done only by state legislatures. For example, there are the degrees of sovereignty held by a few hundred people who incorporate in the suburban fringe, with all the rights and privileges of municipal law, as contrasted with a residential neighborhood or precinct in which an equal population must have its goals tempered by city-wide needs.

There is every reason to believe that there has developed a double standard of municipal rights which must now be exposed, examined, and revised, if metropolitan planning problems are to be solved successfully. There is little question that the resident of these modern suburban pocket boroughs is not called upon to exercise full responsibilities of government. He surrounds himself in his state-franchised municipal isolationism and will not even admit of a remote concern with the nearby towns to which he sends his children to school, his wife to shop, or himself to work. It remains to be seen whether state government will confront this problem directly, or if it will continue its fifty-year trend.

State Limitations

The second restraint which conditions judgment of the qualities of highway planning in relation to urban planning deals with the ambiguous relationship which the state highway agency generally has with the cities within its jurisdiction regarding the development of a coordinated urban transportation network (24).

The first feature of the ambiguity is that on the operational level the state highway agency must accord a different status to different types of cities within the regional complex if it is to be even minimally successful in locating urban routes. However, there is generally no legal and administrative basis for exercising this kind of differentiation.

In most states there is also no legislative or other mandate that the state highway agency develop a coordinated system of limited-access highways and appurtenant traffic distributors within an urban area. Elements of state highway systems still tend to be added on a piecemeal basis by legislative action. With the exception of a few states, the status of urban highway planning as a state agency function is little further advanced than bringing a few specific state routes up to a fair degree of limited-access standard. The state highway agency is thus in the position of usually being only minimally responsible for a coordinated urban freeway system. On the other hand, under the typical system and extent of gas tax subventions by the state to the cities, most central metropolitan cities could build only a mile or so of a freeway-type facility each year, if that much.

Federal Indirectness

The third factor which has an important bearing on the evaluation of highway development in respect to urban planning relates to the tangential and non-uniform way in which federal interest is brought to bear on the solution of the urban transportation problem. Some major anomalies exist in respect to current federal highway policy in the metropolitan areas.

The urban segments of the Interstate System must actually be planned and designed with a view toward integration into an urban area-wide system of highways. Furthermore, highway officials on the federal level have frequently pointed out that the Interstate System is not designed to solve all urban transportation problems. Nevertheless, the degree of federal interest is so well developed in the major metropolitan areas that it is difficult to determine the opportunity areas left to local units of government in terms of broad transportation planning responsibilites.

This is not saying that federal interest is either too extensive or that general route selection in urban areas is basically faulty. But the limited responsibility of local governments to prepare the transportation elements of comprehensive plans must be acknowledged. In most metropolitan areas the federal interstate routes, either by themselves or in conjunction with state limited-access routes, have fairly well determined the basic framework of the entire urban road network well in advance of the burgeoning comprehensive plans or plan revisions (19). The federal government has entered the urban planning scene indirectly and sooner or later this reality must be recognized.

Privileged Position of Independent Authorities

Finally in this framework for judging the disposition of the highway and urban planning processes, there is the privileged position of the independent authority. Although the accomplishments of the authorities are impressive, (25) these agencies are usually beyond the limits of local, state or federal supervision once they are organized.

Although the increase of federal activity in the highway field since 1956 has undoubtedly cut down the growth of these quasi-public corporations, the next decade or so may see the emergence of the metropolitan transit authority, the metropolitan planning authority, and the metropolitan transportation authority.

In the operation of existing authorities, there are two primary problem areas to contend with. One is the strong partiality they have for administrative secrecy. Of course, all governmental agencies are faced with the need to get things done, but, when agencies are a part of the operating line or staff structure of general government itself, certain disciplines are imposed which require integration of plans and programs. Also, not being answerable to state government, authorities are usually politically insulated and economically self sufficient. The current public controversy between the Metropolitan Boston Planning Board and the Massachusetts Turnpike Authority exemplifies the problem.

The second problem area relates to the fragmentation of government which the independent authorities further, which in its own way is another form of the current movement curtailing the responsibility of central urban governments.

LACK OF UNIFORM CONCEPTS

A great deal of thinking is going on in planning and highway circles regarding both the types of land-use control devices which are being applied to freeway approaches and service roads and the determinants underlying these controls. A major portion of current highway economic research currently under way at the University of Washington is addressed to these questions, and several other such projects are being conducted in other portions of the country.

In correspondence and visits to local agencies it became apparent to those on the University of Washington project that government officials did not have any degree of unity of opinion on what the problem is. This observation prompted a somewhat random canvassing of planning and engineering officials throughout the country, with locations chosen to represent varying conditions of urbanization and land development problems.

Nearly 1,000 letters were sent out, including all state highway agencies, all regional and metropolitan area planning agencies, and selected city planning directors and county engineers. The letters were not all the same, but arranged broadly in three classes so that some degree of scientific content analysis could be made. All letters were designed to solicit expressions of opinion along certain lines and test the interest of the respondents.

The details of this survey are too lengthy to present here, but it is apparent that there is a distinct lack of uniformity of conceptualization of the problem even among the respondents from any particular group of professionals or according to the degree of urbanism.

Unlike some of the work done on aspects of the same research problem at Wisconsin recently (26), the University of Washington project was not as specifically interested in what the statutory police power controls were. Interest was in the operational approach to problems of land-use controls by local government. This survey is thought to have been helpful in detailing the dimensions of the problem, and it should be extended to the members of state and local legislative bodies, planning commissioners, highway commissioners, and a few other groups. The framework of police power controls is, after all, related to what legislators and their advisors feel is important, and the controls are only as strong as legislative opinion will support.

Two preliminary conclusions arising from this survey are mentioned here. First, practically everyone is waiting for more information to serve as a basis for land use

control policy. Aside from a handful of replies which treated the problem quite summarily and showed rather inflexible opinions there is a general feeling of concern by respondents from planning agencies that there is not enough data in general, or that local agencies are too harrassed with day-to-day problems to develop adequate criteria on which to build meaningful land-use policy.

Second, many respondents and interviewees from different functional agencies expressed concern over their ability to educate or convince policy-making boards of a course of action even if they did have answers themselves. Also, of particular concern to these officials is the timing of public policy development to meet or even reasonably approach the burgeoning developments imposed by the new urban highways.

To examine the matter more deeply a number of case studies are in preparation, some of which are reported here.

The Spokane Valley

The Spokane Valley comprises most of the urbanizing area outside of the city limits of Spokane on the eastern border of Washington State. It is a long rectangular area, approximately 3 by 12 miles, running from the easterly limits of the city of Spokane toward the Idaho state line. The area now has a population of 45, 000, and at the present rate of growth will double by 1980.

Before 1956 the major transportation route in the valley was US 10 (Sprague Avenue), running from Idaho westward through the city. Although Spokane County has had a planning commission since the late 1930's, and a staff since 1950, US 10 has become almost completely developed by commercial uses in a ribbon fashion. The east leg of the Spokane Freeway now supplants the Sprague Avenue route, in a parallel alignment approximately a mile northward. (Sprague Avenue still carries about the same volume of traffic as it did before the freeway was constructed, however.)

Through the cooperation of the Spokane County Planning Department all re-zoning applications which had relevancy to the new freeway were examined. All of these applications were found to involve one of the four access roads to the freeway, spaced at 2-mile intervals and intersecting the freeway at diamond intersections.

The results of this policy examination are shown in Table 1. Of the eighteen applications for various types of commercial use the planning commission denied only one, and this denial was based on other factors than the protection of transportation routes (Case 9, Table 2). The Board of County Commissioners also approved all actions of the County Planning Commission into the zoning law.

Significantly, in the absence of any frontage roads in the Spokane Valley freeway configuration all pressures for re-zoning were on the county arterials approaching the diamond intersections. These approaches are old local service roads remaining from the early development of the valley into tracts for irrigation farming. In some locations the right-of-way widths are as little as 30 ft.

Questions arose early in this fact finding as to why the official bodies (the county planning commission and board of county commissioners) were so completely permissive in their attitude. The Spokane County planning staff has had excellent direction since its commencement by Jonathan Cunningham, and there is a good spirit of cooperation between the county and state professionals concerned with the effects of land use. An interview with the planning director indicated that virtually all applications for land-use change had been either seriously questioned or advised against on the staff level. Furthermore, there is a substantial respect for the planning director by the board of county commissioners, as disclosed through interview of the board.

Subsequent analysis disclosed that several of the commercial uses approved were tied into general development as much as to orientation on the approach roads to the freeway, and in fact, the performance of the official bodies in approving applications for land-use change in the cases reported here did not significantly differ from their performance in general.

Although there is some slight evidence to the contrary, fragmentary data from many portions of the country clearly indicate the weakness of the county governmental structure in sustaining a long-range program of roadside protection through the use of the police powers, or any other means for that matter.

TABLE 1

LOCAL LAND USE POLICY, SPOKANE VALLEY

Case Number	Date of Filing Month-Year	Sites Size (acres)	Dist. From Freeway (feet)	Access Road: Argonne (A)	Access Road: Pines (B)	Access Road: Sullivan (C)	Access Road: Barker (D)	Exist Zone: Agriculture	Exist Zone: Agr. Suburban	Exist Zone: Mult-fam-Sub.
1	6/7	9.9	2,800	X				X		
2	8/7	4.8	350	X				X		
3	8/7	19.	1,300	X				X		
4	9/7	.11	1,600		X				X	
5	9/7	1.7	1,300	X				X		
6	10/7	33.	1,000			X		X		
7	10/7	7.	-0-	X				X		
8	2/8	1.6	4,800	X				X		
9	3/8	.4	4,750		X					X
10	6/8	10.2	200		X			X		
11	7/8	10.2	200		X					X
12	8/8	.7	5,200	X				X		
13	8/8	.3	2,600		X				X	
14	8/8	.6	200				X		X	
15	10/8	2.3	1,600	X				X		
16	4/9	.69	1,200				X		X	
17	4/9	170	1,000			X		X		
18	6/9	.26	1,400		X				X	

Case Number	Proposed Zoning: Residential	Local Bus.	Commercial	Agr. Suburban	Industry	Mult-fam-Sub.	Trailer Court	Agricultural	Gravel Pit	Existing Use: Sing-fam-Dwel.	Vacant	Office Bldg.	Apt. House	Cabinet Shop	Golf Range	Grocery Store
1	X									X						
2		X									X					
3			X								X					
4				X								X				
5			X										X			
6					X						X					
7						X					X					
8						X				X						
9						X								X		
10							X				X					
11						X					X					
12			X							X						
13		X								X						
14					X					X						
15								X							X	
16				X												X
17									X		X					
18		X														X

Case Number	Proposed Use: Sing-Fam-Dwel.	Shop-Center	Clean-Pick-up	Aplnce Store	Warehouse	Apartments	Cabinet Shop	Trailer Court	Office Bldg.	Unknown	Box Factory	Expand Site	Gravel Pit
1	X												
2		X											
3		X											
4			X										
5				X									
6					X								
7						X							
8						X							
9							X						
10								X					
11								X					
12									X				
13										X			
14											X		
15												X	
16												X	
17													X
18											X		

Case Number	Plan. Comm. Action Conditions: Approve	Approve condt.	Deny	Extra R/W	Define Access	Trailer Stand's.	Submit Plan	Const. Fence	No Freeway Adv.	Post Bond	Legis. Action: Upheld P.C. Action	Rejected P.C. Action	Status 1959: No Development	Plan not Submtd.	Const. started	Completed
1	X										X		X			
2		X		X							X		X			
3		X		X							X				X	
4		X			X						X		X			
5		X		X							X		X			
6	X										X		X			
7		X		X							X		X			
8	X										X					X
9			X								X		X			
10	X										X		X			
11		X				X					X			X		
12		X		X							X			X		
13		X					X				X			X		
14		X			X				X	X	X					X
15		X		X	X						X		X			
16	X										X		X			
17		X								X	X		X			
18		X		X							X		X			

TABLE 2

SPOKANE VALLEY REZONING APPLICATIONS

Case No.	Description
1	Zone change instituted by residents concerned with present classification. Zone upgraded to highest residential zone the county can give.
2	Expansion of existing zone. Decision of planning commission appealed to the board of county commissioners.
3	Across the street from the golf driving range.
4	Special permit was granted for a period of one year. No development has taken place by the applicant so the permit has expired.
5	Across the street from recently zoned shopping center.
6	None.
7	Proposed re-zoning took place March 13, 1958, the date the plat was recorded.
8	Convert several existing single family residences into apartment units.
9	The cabinet shop is a non-conforming use and under the zoning ordinance non-conforming use is permitted to expand under special permit. Planning commission did not feel the expansion of the non-conforming use should be permitted as the property in question is in a residential area.
10	Planning commission policy has been to require the multiple family suburban zone first, then have the applicant apply for a special permit so that the planning commission may control the type of development.
11	Trailer courts are allowed in the multiple family suburban zone by special permit.
12	Zone change essential expansion of existing commercial zone to the south.
13	The property in question is between two essentially commercial uses.
14	Essentially an expansion of existing restricted industrial zone to the east. Decision appealed.
15	Existing commercial use is non-conforming. Under zoning ordinance a non-conforming use is allowed to expand by special permit.
16	Grocery store and lunch room non-conforming uses. Permitted to expand by special permit.
17	None.
18	Property was presented as a preliminary subdivision. Policy is that all subdivisions which are not in a residential zone classification shall become zoned upon the filing of the final plat.

With the county unit of government of great significance in terms of its being the jurisdiction in which much suburban expansion is occurring, it becomes extremely important for highway officials and state legislative committees concerned with roads to understand the performance level of county government in respect to exercising police power control over roadside development. It is certainly insufficient merely to know the statutory provisions of local police powers, and to guess the degree of control which may be obtained by these measures in the future.

Unfortunately, the county level of government has never been a policy-making and programming unit in the American political structure, and there is no reason to believe that it will change radically now. Its traditional role has been administering house-keeping functions on behalf of the state, and governing under the impetus of petition form interested parties. Furthermore, in regards to the road function there has been a clearcut historical precedent of programming roads by local petition, and this tradition seems to have pervaded the county zoning and re-zoning function. In fact, decision-making on zoning cases is customarily conditioned by the views of surrounding land owners or their lack of objections, rather than by factors affecting the public welfare.

The Denver Valley

Observations in the Denver area will be described mainly in relation to shopping center development. The Denver Valley Freeway has been in operation for several years, being part of the major north-south trunk highway of Colorado just east of the Rockies. It connects to the Denver-Boulder Turnpike north of the city limits, and links with Colorado Springs and Pueblo to the south. Within the confines of Denver the highway constitutes two main radial elements of the urban area freeway system, with the southern leg serving the largest population center. Aside from an expressway-type facility linking the freeway with Golden to the west no other high-type urban highways have been constructed in the Denver urban area. The urban highway network is still in the planning stage in that region.

With water supply being a major problem in the Denver area the highway does not seem to have had a significant impact on either industrial or residential site location. It is fairly well confined to the industrial Platte River Valley over at least half of its length within the city limits.

Of major interest is the configuration of regional shopping center develpment in the Denver area. No centers have been developed adjacent to or near the freeway. This fact is contrary to the current belief that large, planned shopping centers must be either alongside a freeway or near a major interchange for best results. The two principal centers, Cherry Creek and University Heights, are discussed in this case study.

The Cherry Creek Center, the first outlying shopping center outside of the Denver central business district, is only three miles southeast of the CBD. About 1952 the Denver Drygoods Company established an outlying store of 40,000 sq ft sales area where an old strip commerical zone existed at the intersection of University Boulevard and E. First Street. Approximately 25 acres were developed at this time between E. First Street and Cherry Creek, featuring a mall design and the inclusion of specialty stores. A major zone change was required for this development.

Not long thereafter, Sears, Roebuck and Co. acquired possession of a tract of land immediately north of the Denver Dry Goods center and the city re-zoned land to the north of E. First Street, bringing the total area of the combined shopping center to 77 acres. Sears now has a large retail outlet on the site. (There is no grade separation for pedestrian traffic between the two shopping areas.)

The next stage of development of this dual shopping center has been the construction of nine moderate sized office buildings north and east of the Sears development, and there is further evidence from billboards that similar development will take place on vacant land just to the west of these buildings, across University Boulevard.

The University Heights Center evolved in a similar manner. Located approximately 6 miles from the CBD and at least a mile from the freeway, this center started as a community shopping center about 1950. The major store is an outlet of the D. F. May Co. The May Co. store covers about 60,000 sq ft of retail space on a site abutting Colorado Boulevard to the west, and about one mile from the nearest approach to the Denver Valley Freeway. It is part of a mall development surrounded by specialty retail outlets.

The initial development of this shopping center necessitated a change in zoning, as practically all integrally planned shopping centers do. In 1953, however, a second developer presented a plan for a second center immediately to the north of the first, on Colorado Boulevard and had some 20 additional acres zoned for this development. At the present time, in observing this joint entity one finds typical frame uses developing around the retail areas, enlarging the original concept of a planned retail center into a community shopping facility with appurtenant uses, such as auto row and clinics, more typical of those community shopping areas which just grow by accretion.

Several observations may be made about these two developments:

1. Regional shopping centers do not require locations adjacent to freeways or freeway interchanges for successful operation.
2. Regional shopping centers either cannot be handled effectively by the comprehensive plan, or require changes in public land-use policy for their inception.

3. Economic determinants seem to have outweighed conceptual viewpoints by either the planning professionals or advisory and action agencies of what the center should have been.

4. Highway planning and traffic agencies would have been led far astray in planning road facilities or improvements on existing arterials on the basis of either the scope of city planning before the centers were conceived, or the scope of planning early in the development of the centers.

Atlanta

Atlanta entered the freeway field before the evolution of standards of design characteristic of the freeways constructed since 1956. It has a well-defined system of radials and a circumferential on the Interstate System, although the industrial and railroad development to the immediate west of the CBD core has inhibited the development of an inner distributor. The elements of the system which are at present in use form a large Y, with CBD approximately 3 miles south of the junction of the oblique arms, and the stem extending southward through the city. The segment between the CBD and the intersection is called the North Trunk, and from there the system becomes the Northeast and Northwest Expressways (although they are full access control).

The system to the north of the CBD was consultant designed and financed by a municipal bond issue in the early 1950's. The major drawbacks of the elements in use to date are inadequate design standards on ramps (for example, no acceleration and deceleration lanes on the older segments), underdesigned lane capacity, and diamond connections with city streets of inadequate width and overdeveloped commercial use. This is perhaps one of the few major urban freeways where traffic is usually halted by police officers on the moving lanes of the facility to permit dissipation of off-moving traffic at diamond intersections (North Avenue, in particular).

It is worthy of note in regard to planning and land use developments in the Atlanta area that in practically every location, where topography and lack of housing developments permits, "window industries" are developing on the Northwest and Northeast Expressways.

Current work is now going on in Atlanta to shed some light on land planning problems, as part of the type of review or feed-back study which was mentioned earlier, It does not seem that the quality of planning is significantly different in Atlanta from that in other moderately large cities, and in fact there is a large and active body of planning professionals in the area as well as a leading center of planning study and research. The preliminary conclusions to be drawn so far, however, are that highway development efforts cannot place a great deal of faith on the quality, status, or outcome of public land-use policy.

Houston

The Houston area differs from most other cities of similar size in several respects.

1. It is the only major American city without a zoning ordinance.

2. Like most of the Texas cities but unlike most other cities there is a distinct lack of fringe municipal development as conditioned by the Texas annexation laws.

3. There has been an early development of rationale underlying a complete urban highway network in the Houston area resulting primarily from the requirement that Texas cities provide the rights-of-ways for state highways.

4. The highway classification philosophy in Texas has clearly given the state the responsibility of designing a complete system.

The lack of the authority to zone in Houston has not meant a lack of city planning. On the contrary, city planning effort in Houston has been able to concentrate on the phases of planning activated by eminent domain procedures rather than on those dependent on the police powers. City planning has had a long tenure in local government in Houston and seems to occupy a respected position in the hierarchy of local government. It has done an excellent job of establishing the basic framework of public facilities in a rational plan, which have in turn proved to be the determinants

for most of the private land development. These include the location of the major urban roads, schools, parks, etc., which provide the framework of the plan.

The freeway configuration for Houston, like that of Cleveland and a few other cities, was conceptualized by the municipal government through planning department assistance considerably before the completion of the O-D survey for the metropolitan area. Also, this configuration is very similar to those developed after the advent of the O-D surveys in many other cities.

Houston makes another interesting place of observation because there are exceptionally adequate standards of right-of-way widths for all categories of city streets and arterials. Most of the approach roads to the diamond interchanges of the Houston freeways are 80 ft in width, and many are wider.

In spite of the fact that only two of the seven radial routes are in use, resulting perhaps in a heavier concentration of traffic on these roads as compared to when the system is completed, there is virtually no congestion at intersections. No doubt the use of continuous collector-distributor (C-D) roads facilitates traffic movement in the urban areas of Texas, creating in effect a set of dual roadways, one set for express purposes and the other for local and access use.

Although under the Texas system of access control one finds much commercial development on the C-D roads near the intersecting arterials at the diamond intersections, there appears to be no evidence of problems associated with these uses from the standpoint of moving traffic. Furthermore, the Gulf Freeway, although having its C-D roads almost solidly developed in industrial uses, is exceptionally free flowing. One could almost come to the conclusion that the Houston freeway system, along with its unique philosophy of central distribution, represents the end point on the scale which tests transportation problems induced by land use.

Admittedly these observations on Houston are on the subjective side, but are presented as preliminary observations, and with a view toward designing more factual research along these lines.

SUMMARY

Much of this report has been aimed at trying to bring out the facts of highway development and urban planning relationships. It has been prompted by the feeling that those involved in economic impact research frequently lose sight of the level of acceptance of their work as related to policy development on either the state or local level.

There is no doubt that the market process will continue to be the strongest of the socio-political processes which will allocate uses to land in the vicinity of freeways and their approach roads, just as it continues to be the strongest determinant in almost all aspects of urban planning.

The only other approaches for action are hierarchy, polyarchy, and bargaining. In the hierarchal solution to the problem both appointed and elected officials must be convinced of the value of a proper course of action. The polyarchal solution would place a premium on an educated electorate to take leadership, both in the selection of the officials who will guide the course of action, and at the public hearing and public reaction levels. Finally, the bargaining solution will require the subjugation of one set of leaders by another, possibly involving different levels of government.

Probably all of these socio-political processes will be operative, just as they are in all other phases of public activity. The general conclusions following evolve not only from the specific investigations in present research, but from a synthesis of opinion and thinking about the problem over the past few years.

CONCLUSIONS

1. There has been insufficient feed-back review to analyze through careful research the consequences of either police power controls by local government or the process by which urban planning and highway development are integrated in a meaningful way.
2. There has been significantly more interest in what can be done under statutory planning provisions that what will be done in terms of public policy development.

3. The recognition of urban planning by state highway agencies is still in the lip-service stage because of complex framework of the urban municipal order, the area-wide and statewide responsibilities of these agencies, and the pressures of traffic.
4. There is not yet any evidence of local land-use control in respect to balancing the trip-generating characteristics of the use with the traffic capacity of nearby road facilities or interchanges.
5. Many state highway agency officials expect a far greater resolution of goals for city development and a more rational planning product in central metropolitan cities than is possible in a democratic governmental framework and in view of the complicated nature of city problems.
6. A small but vocal segment of the city planning profession tends to look upon highway programming as a means of altering the basic structure of land use in urban areas through limitation of access points, but fails to recognize the user sovereignty dictating state highway programs and the broader national policy implications required to reorganize the order of urban development.
7. Advocates of a local "workable program" as a prerequisite to federal financing of highways in the local jurisdiction (as is required for urban renewal under Section 101 C of the U.S. Housing Act) fail to recognize the multi-jurisdictional aspects of an urban areawide transportation and land-use plan.
8. In the absence of a unified urban government, the first step in working toward the integration of urban and highway planning is a workable program on the state level to initiate and support a permanent transportation planning effort to develop state policy in a framework which precludes veto by provincial municipal interests.
9. A municipal mapped streets act appears to be the most reasonable way of providing for uncluttered approaches to freeways by providing the machinery for the design of intersections which may not connect with existing arterials, but will no doubt require the earmarking of a portion of state gas tax returns to the municipalities for right of way acquisition.
10. Considerably more data on the demands for various types of traffic-intensive land use are needed before a strong, positive policy approach may be expected to evolve at the local level.

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Influence of Highways on Selection of Six Industrial Locations

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Extensive industrial development adjacent to new highway facilities stimulated this pilot inquiry regarding the priority placed on highways by industrial firms during plant location. A plant located adjacent to a major highway enjoys economical movement of raw materials and finished products, as well as the added convenience of increased labor mobility. In addition, there are indications that these firms may enjoy advertising and public relations benefits from selecting locations near heavily traveled traffic arteries.

Representatives of six industrial firms currently located adjacent to free access roads were interviewed regarding the importance placed upon general highway benefits, advertising benefits and public relations benefits when selecting new plant locations. With full realization that universal generalizations cannot be based on a sample of six firms, the following is a brief summary of conclusions.

The general influence of highways on the selection of plant sites is considered as important but not critical. The firms realized the need for highway facilities, but placed little priority on specific types of facilities during site selection. Little research was completed concerning potential economics from locating adjacent to highways offering specific services. If the road was paved and in good condition, it was judged adequate.

The advertising benefits resulting from location obtained little consideration. The factor was viewed as an extra benefit that could be realized at almost any location. Some difference in the value placed on the advertising factor was indicated between firms serving industrial and consumer markets.

The influence of public relations resulting from location adjacent to highway construction is vague. Considerable doubt was expressed concerning the value of attempting to locate in order to realize this benefit. Beyond doubt, this is not a factor in location. The benefits that can be realized appear to be independent of the type of road to which the plant is adjacent. The results of this pilot study indicate that the typical firm does not fully appreciate the total economic impact of modern highways on business operations.

●POST WORLD WAR II America has been characterized by industries forming, expanding, relocating and dying. New plants are constantly constructed or occupied by firms at "selected" locations in order to take advantage of radically shifting markets, lower processing costs, lower transit costs, or intangible factors offered by specific

locations. Experience has pointed out that plants can no longer be located by intuition. Selection of a location which offers the proper mix of cost, competitive, and intangible factors can often become the decisive factor between proliferation or failure of a firm. A large number of available vacant plants clearly points out that the days of making money "in spite of yourself" are at least temporarily a thing of the past. In Michigan alone, 292 plants were listed as vacant in early 1958 (1).

Critical among the factors which must be considered when selecting a plant site are the transportation facilities that are available at each location. The economic spectrum of manufacturing consists of raw materials on one hand, and the geographic locales of potential demand for finished products on the other (2). Plant location deals with this whole spectrum, whereas transportation consists of a system by which the two extremities of the spectrum can be united. There are five principal modes of transportation available to manufacturing firms—rail, water, air, highway, and pipeline. The broad subject under consideration in this pilot report is highway transportation. Specifically, the influence of highways on industrial location will be discussed.

During 1957-1958 the author conducted a study of plant location procedures used by six industrial firms located in Michigan. The objective of that study was to obtain some insight regarding the similarity of theoretical procedures suggested for solving plant location problems; and the actual procedures used by firms facing location choices. To ascertain a standard of comparison, locational theory was reviewed and reorganized into a procedural model which was in turn labeled "Applied Theory". An empirical inquiry was then completed to determine the degree of similarity between applied theory and the actual procedure practiced. During this study the primary emphasis was placed on procedure rather than individual locational factors determined critical by each firm.

One exception was made to the decision to concentrate strictly on procedure. As a secondary objective of the empirical investigation, each firm interviewed was asked several questions pertaining to the importance placed on potential highway benefits during the selection of plant sites. This secondary objective was intended to serve as a pilot inquiry into several relationships between highways and industrial location. This report presents a complete finding of these highway inquiries.

HIGHWAYS AND INDUSTRIAL LOCATION

Highways provide the basic facilities on which the majority of raw materials and finished products move to and from industry. In 1958, motor carriers provided 260 billion ton-miles of service. Between 1940 and 1958 truck ton-miles increased from 62 billion ton-miles to 260 billion. In 1958 this ton-mile figure represented 74.5 billion road miles (3). In addition, there is reason to believe that the completion of the integrated highway system now under construction will witness an increase in the annual use of truck transportation. For example, a survey of grocery wholesalers, concerning methods of receiving groceries at the warehouse, supports this assumption. This survey, completed in 1955, pointed out that shipments were equally divided between rail and motor truck, although the proportion of receipts by motor truck has been increasing substantially during the last two decades (4). This trend is further substantiated by interviews with traffic managers at several large food chain distirubtion centers. These managers report that currently over 70 percent of inbound freight is arriving by motor truck.

Finally, one merely has to look at the increase in total motor truck registrations from 1904 to 1958 to substantiate these trends. The truck increased in aggregate numbers from just over 6 thousand in 1904 to over 10.5 million in 1958 (3, p. 2).

Two basic considerations in plant location also support this trend toward increased use of truck transportation. First, markets have become a primary locational factor in most industries, generally overshadowing other influential factors. Increased freight rates since the end of World War II have forced firms to seek market orientated locations which offer a relatively short haul to the market. Two principles of rate structure support a market orientation: (a) transfer rates on finished products are normally higher than those of raw materials, and (b) generally, the greater the dis-

tance the higher the total transportation cost. At least one is safe in saying—other things being nearly equal—the normal preference will be to select a location in close proximity to the major sources of potential demand.

The second consideration is space. Space requirements as a prerequisite to efficient operation have stimulated a mass movement of industry to the suburban areas. Only where land is available at a "realistic" price can horizontal one-story factories, which offset the necessary economies of operation, be constructed.

Both of these considerations in turn mean that trucks can assume a greater role in the distribution of finished products to the market. In the first case, location in close proximity to the market means that trucks can satisfy most outbound transfer requirements. In the second, new plants are located at a point distant enough from thier market to require transportation services of a motor carrier on a regular basis. In both cases the services offered by motor truck transportation become desirable—the haul is relatively short and the convenience of speed and service is at a premium. And, of course, almost without saying—economical operation of trucking facilities depends on adequate highway access from plant to market. As will be elaborated on at a later point, the case studies presented in this report support these basic trends in plant location.

The influence of highways does not end with the transportation of materials and products. Along with the need for quick and economical transportation to the market, as well as a constant and economical flow of raw materials, the accessibility of labor is another reason for locating in close proximity to major roads. One California firm feels that location adjacent to a freeway had made selection of desirable personnel less difficult. Prior to freeway construction, prospective employees living some distance from the plant were reluctant to travel long distances to work (5).

Advertising and more desirable public relations are two additional benefits that some firms feel result from location near highways. The fact that some companies consider that highways possess immeasurable advertising value is pointed out by a plant survey conducted in California. That survey attempted to ascertain the benefits enjoyed by firms which had selected a location adjacent to a freeway. Six of the nine plants located on the Santa Ana Freeway reported such locations are an asset to business from an advertising standpoint (5, p. 6). Firms located adjacent to the Massachusetts Route 128 development also indicated an advertising and prestige value realized from their highway locations (6).

Desirable public relations resulting from a highway location have been pointed out by the observations of a chemical manufacturer. He reported a two-fold beneficial effect from his recent location on a major road: (a) the prestige of his company was increased by the image developed among the large number of people that pass his plant each day, and (b) securing employees became easier because people like to become identified with a well-known compay (7).

One writer ably summarizes the total relationship between plant locations and the benefits offered by good highways (8). "Industry spends millions for new plants, which have to be placed where they can easily be reached by workers and suppliers, and in addition will have ready access to the markets. It is only economically sound that industry desires to locate on the vast conveyor belt that lies before us." Previous research dictates that the major benefits of increased acreage, movement of raw materials and finished products, and convenience of labor mobility, resulting from location in close proximity to highways be accepted as relevant. Without question all locations offer some type of highway improvement, but not all highway improvements offer the same locational benefits. In this study the objective is to ascertain some insight into the consideration given to these highway benefits when selecting plant sites. Were these factors considered when selecting a location? In addition to general locational influences, some indication is desired regarding the importance placed on advertising and/or public relations benefits during site selection. If considered, what priority is placed on selecting a location which provides these benefits?

In the following several objectives are accomplished. First, a few examples of industrial development adjacent to new highway construction are reviewed. This discussion provides some insight regarding the way industry has been attracted to land

made available by new highway development. Second, the interview results are presented in case study form. Each case is introduced with a brief discussion of the firm under observation. This is designed to give the reader a feel for the firm considered. Next, a discussion of the influence attributed to highways when selecting plant sites is reported. Answers to specific questions regarding advertising and public relations are discussed. In the fourth part conclusions regarding all facets under consideration are presented. These conclusions do not take the form of verified generalizations but rather give some indication of relative value placed on highway factors by these six firms. All six firms currently operate plants located adjacent fo free access highways; all but one are adjacent to two- or three-lane roads open to traffic for a number of years. Last, a few suggestions for an additional inquiry resulting from this examination are presented for the reader's consideration. An appendix contains the methodology used. The firm selection procedure and the interview outline are presented in detail.

SOME EXAMPLES OF INDUSTRIAL DEVELOPMENT IN THE AREA OF NEW HIGHWAY CONSTRUCTION

Numerous examples can be found to support the statement—where major highways are constructed, industry often mushrooms. Such extensive industrial development indicates that land values increase and industry is attracted to new locations made available for plant sites. Whether land is provided in the form of an organized industrial park or merely large tracts of land on the fringe of the city, new industry will be attracted if other locational requirements can be reasonably met.

Route 128

The "magic semi-circle" is one good example of a highway improvement which has attracted extensive industrial development. Located near Boston, Mass., the land adjacent to Route 128 has experienced amazing industrial growth. Route 128 extends for about 60 mi on the easterly side of Boston. Highway construction is a combination of partial and limited-access facility. While parts of the "magic semi-circle" were completed as early as 1936, extensive industrial development did not take place until after World War II. From 1947 until 1955, 28 new plants owned by 25 different companies were constructed in the area (9). More than 100 million dollars has been invested in these new industrial plants (8). Land which at one time represented undeveloped suburban area now demands premium industrial prices.

The future of highway 128 appears to be one of continuous growth. Here we observe examples of firms which preferred locations in close proximity to a major road. The reader who is interested in obtaining additional information regarding Route 128 is referred to a number of publications reporting a large-scale study completed by representatives of the Massachusetts Institute of Technology (10). The objective of this study was to investigate all basic factors underlying social and economic changes that have taken place along the highway.

New York Thruway

The land recently made available by the New York Thruway has been used for similar industrial development. The first section of this highway was opened in 1954. Despite the short period of operation, major enterprises have earmarked some 150 million dollars for new or improved plants along the Thruway (11). These industries will have a 100 thousand dollar annual payroll and will employ 30 thousand persons (11). This basic industrial development has set off a beneficial stimulant to the construction of other businesses which will add prosperity to New York State for years to come. In New York, as in Massachusetts, land values have increased substantially since the new highway was completed. Recently 12½ acres of 21-acre parcel of land sold for 150 thousand dollars. In 1951, the total parcel was sold for 15 thousand dollars (11, p. 5).

East Shore Freeway

Another equally outstanding example of industrial development on land made avail-

able by new construction is reported in Alameda County, California (12). An area along the east shore freeway consisting of 7.5 mi was selected for intensive study. The objective of this study was to provide a testing ground to determine the economic effect of freeways on industry. This study pointed out that while only 9 percent of the total industrial acreage in Alameda County was included in the study area, 43.1 percent of the total expenditure for new industrial construction was invested in the study area (12, p. 2). Many additional comparisons are reported which clearly point out the manner in which industry was attracted to this area. Land values reported in this California study show an upward trend. Land selling at an average price of less than one thousand dollars per acre in 1941 was sold at plus 10 thousand in 1953 (12, p. 7).

Pennsylvania and Ohio Turnpikes

The areas adjacent to the well-established Pennsylvania Turnpike and the newer Ohio Turnpike have experienced this same phenomenal infiltration of industry. In Ohio, a 60 million dollar tractor plant was erected adjacent to the new road. This plant will eventually employ over 1,500 persons (8, p. 84).

These few examples of industrial development could easily be expanded to include a discussion of the Connecticut Turnpike, Massachusetts east-west toll road, and numerous other developments found in almost all states. Unquestionably construction of a new highway through undeveloped land provides additional area to be considered as plant sites. Current studies point out that this land is extensively used almost as soon as it becomes available.

EMPIRICAL CASE STUDIES

Information obtained during research is reported in this section. The objective is to relate the importance attributed to particular aspects of highways during industrial site selection. To present interview results in an unbiased manner, no attempt is made to generalize on the information reported at this point. Each of the six case studies is developed in two general parts.

The case is introduced with a brief discussion of general information regarding the firm under observation. Data concerning the product manufactured, size of firm, markets served, and other items peculiar to the individual firm are reported. This introduction is intended to give the reader a feel for the firm and an understanding of the events leading up to the locational problem.

In the second part of each case study, a discussion of the influence attributed to highways during site selection is presented. Answers to specific questions regarding advertising and public relations are also reported.

Two shortcomings of the empirical approach as used in this study warrant mention. With the exception of Firm C, during which interview two representatives were present, only one person was interviewed regarding each case. Use of this single interview approach allows inclusion of the biases of the individual interviewed. To some immeasurable extent, this shortcoming was minimized by interviewing the one person who was primarily responsible for selection of the site. In two cases a plant location consultant was interviewed. The untested assumption is made that the individual would be most likely to express the viewpoints of the firm.

The second shortcoming evolves from the elapsed time since a location decision was made. Depending on the retention abilities of particular individuals, as well as the resultant success of the decision, the factors leading to site selection may be distorted. Two checks were used to hold the second shortcoming to a minimum. First, only firms located subsequent to 1950 were selected for observation. This reduced the span of time between location and observation to a relatively short period. Second, the general validity of interview results was checked against information obtained from the Michigan Economic Development Department. This provided some standard by which to evaluate interview results. In all cases, the person interviewed readily recalled the location events and the general information checked with that obtained from the Department. The actual amount of intentional and unintentional bias presented in the case studies remains an unknown ingredient.

Each case study is labeled in reference to the size classification. (See Appendix for complete discussion of size classifications. Basically, firms are classified on the basis of number of location decisions rather than total dollar sales or number of employees.) This provides the reader with some insight regarding the frequency of location problems confronted by the various firms.

Firm A—Small-Size Firm

The first case is that of a small firm which owns and operates two plants. The firm manufactures delicate electronic instruments. At the present time the product is manually assembled; no automatic equipment has been developed which can meet the necessary product specifications. The firm normally experiences a high product rejection rate which is attributed to human error, component defects, and extreme vulnerability to dirt particles during product assembly.

All production undertaken is on a work order request to specifications established by the customer. The typical customer-manufactured consumer-branded items which use Firm A's product have a vital component in the finished product.

After three years of operation, increased business volume forced the owner to again expand manufacturing facilities. A branch plant was located 50 mi from the main operation. Both plants now employ a combined total of 150 full-time employees.

Highway Influence.—The owner of Firm A placed little emphasis on the influence of highways in selecting his plant sites. Although the plant is located on a major highway, this was not a prime locational requirement. The owner indicated that adequate roads were necessary to transfer workers, but other than satisfying transfer requirements, highways contributed little to the over-all specifications. He stated that his product is normally shipped by parcel post. If necessary, an entire week's production could readily fit in the trunk of an automobile. On the other hand, raw materials are all shipped in by truck. From this point of view, motor truck transportation does play a primary role in this firm's operation. Nevertheless, this factor was not considered when selecting a location.

Potential advertising which could result from location in close proximity to the highway was not considered. In discussion of the advertising influence, the owner felt it would benefit his particular firm very little. In selection of his location, no consideration was given to the public relations benefits. During the interview the owner of the firm expressed no opinion regarding public relations or community prestige resulting from location on a well-traveled road. In total, the owner of Firm A gave very little consideration to the highway factor in selecting the site for his new plant.

Firm B—Small-Size Firm

The second firm studied operates three plants. Two of the plants have been in operation for a number of years; the third plant is currently under construction. Although small in terms of number of plants, this company is considered as relatively large within the industry. The new plant under construction will employ 200 people when completed.

The product manufactured is a basic ingredient in the construction industry. Consumers vary from industrial firms to individual customers. All consumers purchase the finished product from retail stores or from wholesale construction suppliers. The market served covers a small geographical area, but has a very high population density per square mile. Within the market, sales are made to a variety of different customers.

Highway Influence.—In selection of the final site, location in close proximity to a major highway was considered as a primary prerequisite. The firm estimated that 75 percent of the finished product would be shipped to the market via truck. The site purchased is bound on one side by a major highway. The person interviewed stated that no consideration had been given to advantages gained by locating adjacent to the highway. Benefits of advertising and potential public relations were not considered when deciding where on the site the plant would be constructed. This lack of consideration is supported by the fact that the actual plant will be three-quarters of a mile from

the major highway and not visible to passing traffic. No opinion was voiced concerning the benefits of advertising or potential community prestige that could have resulted from construction adjacent to the highway.

Firm C—Medium-Size Firm

Firm C has participated in two recent plant locations. One plant represents an expansion of facilities. The other plant was constructed to modernize an outdated plant. In total, five plants are owned and operated by the corporation. The products manufactured are all in the electronics field. Firm C's finished product is a vital component of a variety of different products sold to industrial and consumer's markets. The product is purchased by customers located in extremely varied geographical areas. Major customers are appliance firms, power equipment manufacturers, and the government.

Highway Influence.—Location on a highway is one requirement the potential site must meet. Whereas rail is used to transport raw materials, trucking is a major method of moving the fabricated parts from the stamping plant to the final assembly plant. For potential use, rail facilities are required at all plant locations. At present, these facilities are not used at the assembly plant.

In reference to the advertising question, the executive interviewed replied that it was immaterial in site selection. His firm, serving an industrial market, would benefit very little from potential advertising. No consideration was given to resultant public relations received from highway proximity. The opinion was expressed that the local population will find you regardless of where you are located, and will measure the desirability of employment from labor relations and working conditions, rather than appearance. Location on a back road is satisfactory if it can meet all other tansportation requirements.

Firm D—Medium-Size Firm

Established shortly after 1910, this company has experienced steady growth at a moderate rate. Manufacturing capacity has steadily increased since the company was formed. At the present time, five plants are owned and operated by the firm.

The products manufactured by Firm D are primarily used for the packaging of customers' products. Firm D sells to a number of different customers. With the exception of a few standard items, products are manufactured to the consumer's specifications. At the present time, over 1,000 people are employed.

The five company plants are decentralized over a large geographical area. Each plant serves markets which are in close proximity to the plant. Both the weight of the raw materials and the finished product require that transportation costs be minimized.

Highway Influence.—The new finishing and assembly plant is located on a major highway. A direct route from the primary manufacturing operation facilitates movement of semi-finished products via truck to the assembly plant. One of the major advantages of the new location is the network of roads which provides ready access to the major markets. Location on a main highway was considered a prime requirement of the new site.

In selection of a plant, no consideration was given to increased advertising or beneficial public relations that could result from location in close proximity to a major highway. No opinion was voiced during the interview concerning these potential benefits.

Firm E—Large-Size Firm

The first large firm studied is one of the largest corporations in the United States. Corporation E has a staff department which is responsible for selecting the specific site at which the new plants will be located. This department has participated in the location of 33 major plants, in all parts of the United States, within the last 15 years.

Firm E treats the location of each plant as strictly a custom operation. This is necessary in order to assure proper consideration of all facets peculiar to each particular plant. Yet, in selection of each location, there are basic principles which are followed in obtaining the specific site. These principles serve as a guide to determine which department is responsible for each step in the selection procedure. One principle

of interest to this study is the general site specifications desired for each plant. The typical site must contain approximately 200 acres of land with a four-lane highway on one side, and a main line railroad on the other.

Highway Influence.—In the words of the executive interviewed, highway influence in location selection is becoming "bigger and bigger." As noted earlier, the typical site selected by the firm was a four-lane highway on one of the long sides of the site. If possible, the firm also desires to have secondary roads located at each end of the site. One major plant was located at a specific site because a promise was made to construct a major intersection at the corner of the lot, which would provide exceptionally good access to the plant.

The advertising potential of locating in close proximity to a major highway is considered as one of the reasons for the prerequisite of a four-lane highway. Considerable doubt was expressed concerning the direct value of such advertising. Indirectly, the firm feels their product image is increased by such locations.

Likewise, the public relations aspect of highway location is considered in determining the site specifications. The firm does not feel that such locations develop among the public the attitude of a good place to work. They do feel that over-all public relations are increased by construction of desirable plants.

Firm F—Large-Size Firm

The second example of a large firm involves a location problem that was stimulated by forces of expansion, modernization, and decentralization. Faced with the need for modernization, the firm decided to expand facilities used for the production of a relatively new product. The decision to decentralize resulted from the influence of a new managerial policy. As a first step in implementing this policy the decision was made to seek a location that was geographically separate from existing facilities, Firm F manufactures a series of parts which are basic components in the products of a number of different industries. With the exception of a few replacement parts, all production is sold to an industrial market. In total, twelve plants are owned and operated by Firm F. The plant relocation, studied in the case, specialized in the production of one product. This product has gained market acceptance rapidly. Increased production has made this item one of the major product lines of Firm F. This particular product is almost totally sold to the automotive industry. Other manufacturers of transportation equipment do use the product, but their orders represent a small percentage of total production. As a result of the concentration of the automotive industry in a few states more than 90 percent of this product line is sold in a small geographical area. Production is normally undertaken on a work order request. Although the basic product performs the same function for all customers, modifications are needed for each type of vehicle.

Highway Influence.—Firm F places substantial weight on the highway facilities available in each community. In evaluation of various sites, only those which had ready access to at least one major highway were considered. All shipments to and from the new plant used trucking facilities. Similar to the assembly plant located by Firm C, Firm F's new plant has rail facilities available which are not presently used. The person interviewed stated: "This was only smart business—future developments may make rail transportation a primary means of distribution."

Firm F did not consider the benefits of potential advertising when selecting their site. During discussion that followed the advertising question, the executive interviewed expressed the opinion that this is not influential to firms selling in an industrial market.

Consideration was given to public relations when planning how construction would be undertaken on the selected site. The plant is well landscaped and parking lots are placed close to employee entrances to increase the attractiveness of the new plant. Firm F did not feel that location had to be adjacent to the major highway. As a matter of fact, Firm F's new plant faces on a secondary road, one-fourth of a mile from the major highway.

OBSERVATIONS

General Highway Influence

1. With the exception of Firm A, all firms studied felt that location in close proximity to a major highway was necessary. These firms would not consider locations that did not offer adequate highway facilities.
2. Specific requirements concerning desired types of highway facilities were established by only one firm. Firm E stated in its specifications that it was necessary for a four-lane highway to border one side of any potential site.
3. Each plant studied is located on or near a major U.S. highway. Firms B and F are the only companies that are not directly adjacent to a major road.
4. Only Firm B cannot be seen by passing traffic.
5. With the exception of Firm A's finished product, truck transportation is one of the major means of distribution. Consensus of opinion was that this mode of transportation will increase in importance during future years.
6. All firms received some raw materials via truck.
7. Consideration given to highway influence and selection of sites did not vary according to the number of location problems confronted by the firm. No relationship was observed between the volume of business and the consideration given to highway influence.

Advertising and Public Relations Influence

1. Advertising benefits resulting from location in close proximity to a major highway were not considered by five of the six firms studied.
2. Firm E did consider advertising when establishing site specifications. Some doubt was expressed by this firm regarding the direct value of this type of advertising.
3. The two firms serving a consumer market reacted differently to the benefits of advertising. Firm E gave attention to this influence when establishing specifications; Firm B did not. When completed, Firm B's plant will not be visible to passing traffic.
4. Firms B and D expressed no opinion regarding possible advertising benefits that could have been realized.
5. Firms A, C, and F expressed the opinion that serving an industrial market made consideration of the advertising factor unnecessary.
6. Two firms gave consideration to the public relations aspects of location. Firm E considered this factor during establishment of specifications. Firm F gave some consideration during positioning of the plant on the selected site.
7. Three firms, A, B, and D, did not express opinions regarding public relation benefits.
8. Firms E and F felt that some desirable public relations result from location in close proximity to highways. Firm F indicated that this benefit could be realized without location on a major road.
9. Firm C feels that benefits from public relations result from factors other than location on a major road. If your firm offers a desirable place to work, people will find you regardless of your location.
10. Although the two firms considering public relations benefits happened to be the firms which participated in the largest number of location problems, no relationship between size and consideration can be inferred. Each gave the problem consideration from different viewpoints. Consequently, no relationship is observed between frequency and value placed upon advertising or public relation influence.

CONCLUSIONS

The influence of highway facilites on the selection of these six plant sites was considered as important but not critical. Each firm gave some consideration to selecting a location in close proximity to a major road. Motor transportation occupies a constantly increasing role in the economic activities of firms studied. As such, the person responsible for locating the plant realized the need for some adequate highway facility.

Regardless of this awareness, the firms studied did not place a high priority on selecting a site which rendered access to a specific type of highway facility. With the exception of one firm, highway prerequisites to guide site selection were not established. Little if any attention was given to potential benefits from location in close proximity to specific types of improvement. If the road was paved and in good condition, it was judged adequate. This is supported by the fact that none of the firms rejected a site because of an inadequacy of roads. If all other locational factors were determined satisfactory, the highway facility was always adequate.

Potential advertising benefits obtained from location adjacent to highways was not important in site selection. If considered, advertising was viewed as an extra benefit which could be realized at almost any location. There is some indication that firms serving an industrial market, place less value on advertising than firms serving a consumers market. Only one firm directly considered advertising prior to site selection. The remainder of firms placed no weight on advertising during the selection process. For the most part, the study indicates the firms were not aware of potential benefits, and even after consideration felt advertising was not a prime consideration.

The influence of public relations benefits resulting from location adjacent to a highway was not considered. During interviewing, considerable doubt was expressed concerning the value of attempting to locate in order to realize such benefits. Beyond doubt this was not a factor in location. Most firms felt that those benefits which can be realized are independent of the type of roads to which the plant is adjacent.

The results of this inquiry viewed in perspective of extensive industrial development adjacent to major roads, reported earlier, raises some interesting points. Numerous examples of firms attracted to the most modern of highway facilities were noted. In this study firms were observed that appeared indifferent to types of highway construction—firms which gave low priority to highways during site selection. Is it a fact that for "most" firms one type of road construction offers equal locational advantages as all other types of construction? Or, does this indicate the typical firm does not fully understand the impact that a proper highway can have on business activities?

This brief pilot study cannot answer these questions, but it does provide insights. Only one firm established prerequisites for highway facilities. During or prior to site selection, little attention was given to potential costs resulting from traffic flows, ease of access, seasonal weight restrictions, safety, etc. In addition, no studies were conducted concerning the advantages of locating near limited-access roads. None of the firms conducted studies to determine the economic feasibility of locating in order to make use of modern toll road facilities near the southern part of the state. In total, it appears little attention was directed toward analysis of highway benefits.

All of the foregoing factors indicate that the typical firm may not fully appreciate the impact of modern highways on business operations. As the integrated highway system now under construction is completed, the mass of location alternatives will increase. Although it is possible that inadequate roads will rarely cause a community to be rejected by a firm, it is a fact that highway facilities can render one location economic advantages over alternatives.

As business competition increases in the future, selecting the proper site which offers potential savings in daily operation may very possibly help determine firm longevity. In the past, the individual firm has historically been confronted with the problem of effecting closure between the point of manufacturing and the point of final product distribution. In other words, initially the problem of "getting the fruit to market" occupied the position of first concern to the individual firm. Faced with rising cost patterns, the firm of our future economy will constantly have to adjust marketing and distribution efforts to reduce costs and improve market flow efficiency. The profit potential of a specific operation is directly related to ascertaining if product distribution costs too much. The selection of a proper location establishes the environment from which the firm must meet competitive challenges. It is a decision which the firm must live with for a considerable period of time. With full realization of the potential dangers of a poor location decision—the executive finds in relocation a seldom veiled opportunity. In essence, it is an opportunity rarely available to most firms. It is an opportunity to gain an advantage over competitors. It is the opportu-

nity to place new life in the firm. Full realization of the impact of cost determinates, such as improper vs proper highways will determine the duration and extent of the competitive advantage obtained by relocation. The results of this pilot inquiry indicate that five of the six firms studied did not fully appreciate the impact of at least one cost determinate—highway facilities.

SUGGESTIONS FOR ADDITIONAL RESEARCH

In the spirit of a pilot inquiry, the final results can represent nothing more than insights into researchable problems. Thus, the final objective is to relate the findings of this pilot study with other research in order to suggest future research problems. This is accomplished for each of the areas considered in the pilot study—general highway influence, advertising, and public relations.

General Highway Influence

The basic necessity for locating in close proximity to a major highway is important for most firms. Additional study concerning the benefits that can be realized from location adjacent to different types of highway construction appears beneficial. As noted in this pilot study only one firm specified that a four-lane highway was desirable. Industrial development research reviewed earlier pointed out that substantial developments have taken place in close proximity to limited-access roads. Additional inquiry is necessary into "why" some firms attract to such locations while others do not. Where do firms which select locations adjacent to limited-access facilities obtain information concerning the availability of such sites? Did they consider alternative sites adjacent to other types of roads? On what quantitative factors did they base their decision to locate along limited-access facilities? And possibly more important, how substantial a geographical move did they make to enjoy these highway benefits?

The Massachusetts Route 128 study made considerable insight into the answers of the foregoing. It is interesting to note that companies representing 55 percent of the investment on Route 128 considered only a Route 128 location or another suburban Boston site (6, p. 36). Additionally, it is important that research and development firms, probably among the most "foot loose" in the American economy, considered the widest variety of sites when selecting a location (6, p. 36). These two conclusions when viewed in perspective of this pilot study indicate that the majority of firms may have one or two primary locational factors, such as labor, raw materials or markets, which limit their location alternatives to a very narrow geographical area. This fact is supported by the research of Greenhut and Smykay (13). Accepting this premise, the average firm is restricted to a few geographical alternatives in selecting a least-cost location and, consequently, the question of highway facilities may be a localized problem. Therefore, locating adjacent to a limited-access road or any other type of road may simply be dictated by the availability of such facilities in the specified area.

While the foregoing discussion will appear obvious to the spatial economist, the critical question remains to be answered. What are the variable costs related to these different highway facilities and to what extent do they justify an alteration of geographical location alternatives? Research designed to completely delineate the operational costs directly related to highway facilities must be accomplished to fully assess the location importance of specific types of roads.

Additionally, it must constantly be kept in mind that total least-cost concepts are only relevant within a framework of potential demand. One notes that in the Massachusetts study, commercial markets were listed as number twelve out of the fifteen locational factors influencing site selection along Route 128 (6, pp. 34-35). As early as Weber (14), later expanded by Hoover (15), and more recently substantiated by Greenhut (13), a market orientation was identified as one of the three potential location orientations available to a given firm. A complete review of the contributions of spatial economists and the impact of highways on each of these orientations appears worthwhile. Do production orientated firms view highway facilities differently than market oriented or foot-loose firms? Or to turn it around, are highways more or less important as cost determinates to firms falling within these different categories? The

hypothesis being: highways are greater cost determinates to market orientated firms. This is supported by the trends towards increased use of truck transportation by such firms, as noted previously.

Finally, the recent Third Progress Report of the Highway Cost Allocation Study (16) raises an interesting problem. It was concluded "there is little doubt that a single expressway in a fairly large metropolitan area could have a profound impact in creating new industrial sites." They then go on to indicate that this impact may have a diminishing quality. Unfortunately, this pilot study did not in any manner investigate the potentiality of a diminishing quality, but within this single observation lies the foundation for a far-reaching economic impact study.

Advertising

In the area of advertising benefits the results of this pilot study are contrary to those of other completed research. The most outstanding disagreement is with the California survey (5). Consideration of these opposing results suggest two areas for additional inquiry: (1) Study of the type of market (industrial or consumer) served may provide some insight into the value of locational advertising. No generalizations can be safely made concerning the markets served by the California firms. In this pilot study, four firms sold exclusively to an industrial market. The general hypothesis being: firms selling to a consumer market place more value on this type of locational benefit. (2) All California firms were located on limited-access roads. The Michigan firms were located on free access roads. Additional inquiry into advertising benefits resulting from location adjacent to different types of highway construction may provide some insight into the basic inconsistencies between these two studies. The studies completed thus far would support the hypothesis that: firms located adjacent to limited-access roads enjoy greater advertising benefits.

The results of the Massachusetts Route 128 study are interesting when compared to these pilot results. In Massachusetts, only a few firms anticipated the advertising benefits realized from locations adjacent to Route 128 (6, p. 38). This is in agreement with the pilot finding concerning firms in Michigan. Beyond this point, the similarity ends. The Massachusetts firms report a distinct advertising advantage while the Michigan firms do not. The reasons for this inconsistency raise some interesting research questions. Is this once again a basic difference between modern limited-access roads and older free access facilities? Do the firms adjacent to such modern facilities in fact experience such benefits or does the mass of promotional literature instill the representatives of such firms with a belief concerning such benefits. It is important to note that the majority of firms studied in Michigan didn't feel locational advertising was a benefit even after it was called to their attention. The reason given was "they served an industrial market," which leaves the question—do they really know or do they just "feel" that they receive no benefit? The modern use of roadside advertising of the sign and billboard variety would indicate that these firms do receive some type of benefit.

The fact remains that little reliable information is available concerning the advertising benefits received by firms with abutting locations. The problem of measuring advertising effectiveness is not new nor by any extent of imagination solved for advertising in general. One thing is apparent thus far—firms reporting advantages or no advantages do not have a reliable method of measuring the advertising impact; so consequently, they must generalize. It would be entirely too idealistic to simply say a measuring technique should be developed. On the other hand, the highway researcher interested in this problem can gain from the marketing and advertising research people. If substantial insights are to be accomplished, it appears the obvious place to turn is to the consumer who is supposedly influenced by such advertising, rather than to the executive for this opinion. In other words, here is one side of the picture; the challenge is now to verify these opinions.

Public Relations

Exactly what constitutes public relations benefits is somewhat nebulous. This pilot study indicates that public relations was not a locational factor for the six firms studied.

The other studies noted indicate that other firms have achieved some benefits by virtue of locations adjacent to modern facilities. Public relations as considered in the pilot study referred to something more than unrestricted access by employees. It was intended to represent a part of the corporate image as conceived by the firm's public in total and prospective employees individually. As such, segmenting the contributions of a specific location to the total community image developed may not be practical, given the costs of modern research methods, and possibly it may not be researchable. No specific suggestions regarding additional inquiry can be made from the results of the pilot study. With the benefits of hindsight, the separation of advertising and public relations from a locational viewpoint appears to be a mute question.

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Appendix

EMPIRICAL METHODOLOGY

There are at least two methods of obtaining information. The first, and possibly the least difficult method, is to review and interpret all available locational case studies. Although convenient, the shortcomings of this first alternative are many. Use of prepared materials limits observations to available case studies, avails only reported information, and requires interpretation and adaptation of materials to the task at hand. In light of these noted shortcomings, this first alternative was determined as inadequate for the purposes of this study.

The second method of obtaining desirable information was to conduct field studies. The primary advantage of this method stems from control over cases studied and materials analyzed. This empirical approach was determined as the best method of obtaining information consistent with the objectives of this study.

Geographical Study Area

The geographical area selected for consideration was the State of Michigan. Michigan was selected for two reasons: (1) close proximity to industrial firms, and (2) close proximity to necessary supporting information.

The nature of the problem under consideration is relatively independent of location advantages offered by any region, state, or community. The point is emphasized that this is not a study to measure the desirability of locating a plant in Michigan. The factors under consideration are immaterial to political boundaries.

Number of Firms Studied

A sample size of six firms was selected for analysis. Analysis of six locational procedures was arbitrarily determined sufficient for the primary objective of this pilot study. A limit was placed at six firms in order to use interviews rather than questionnaires in obtaining desired information. No attempt was made to obtain a statistically representative sample of industrial firms located in Michigan. No attempt is made to generalize universal conclusions concerning highway conclusions. Rather, this study is intended to give some indication of the relative value placed on highway influences by these six firms and to suggest topics worthy of additional inquiry.

Selection of Firms

Selection of the six industrial firms to study was made with the cooperation of the Michigan Economic Development Department. No restrictions concerning type of industry, location of industry, or prior location of industry were considered in the selection. Each of the firms selected had to meet the following requirements.

1. All shall have located subsequent to 1950.
2. All shall have selected sites distinct from the land on which prior facilities were located.
3. Each of the firms selected shall have different ownership.

Through the assitance of one of the Michigan Economic Development Department's industrial agents, a list of twelve potential study prospects was obtained. Selection was based on examination of firm files and on the judgment of the industrial agent. Only those firms with a past record of cooperation in research projects were selected. Special attempt was made to select firms of various sizes. Because of the consideration applied in selection of these potential firms, a list of twelve were determined satisfactory to obtain an acceptance rate of six firms for analysis.

From this list of twelve firms, the six most desirable firms were arbitrarily selected as prospects. Selection of prospects was made in a manner which presents an array of different size firms.

Classification of Sample

The six firms selected for analysis were classified into three groups for analytical purposes. The basis of classification was number of plants operated by each of the firms. Number of plants operated was selected in order to provide some insight into the frequency of locational problems confronted by the various firms. The limits of each group are as follows:

Category 1—Large-size firms—7 or more plants
Category 2—Medium-size firms—4 to 6 plants
Category 3—Small-size firms—1 to 3 plants

Each of the categories in the study contained two firms.

Method of Contact

Each of the six firms was sent a letter of introduction. The purpose of this letter was to provide information concerning the objective of the study and to solicit each firm's cooperation.

Five days after the letter had been mailed, each firm was contacted by phone to obtain their participation decision. At this time, additional information was provided as requested by the firm. Each of the firms consented to cooperate.

Interview Procedure

A personal interview was selected as a method of obtaining desired information. This decision was made primarily because the type of questions under consideration did not readily lend specific question structuring. Additional advantages of using the interviews are that the interviewer can obtain "feel" of the firm, all information can be classified on the spot, and perhaps more complete information can be obtained.

The objective of each interview was to encourage the person interviewed to express himself freely concerning general topics suggested by the interviewer. Extreme caution was exercised not to direct the interview by revealing any information aspects of the problem under consideration. Although complete conversational atmosphere was desired, some structuring of the interview was necessary to insure comparative interview results.

The actual interview used was structured on a stimulus response pattern. Each person interviewed was asked two general questions to guide the conversation. The first question stimulated the discussion concerning plant location procedure. As noted previously, the results concerning this first question were reported in an earlier study. The second question was directed at ascertaining the locational influence contributed to highway benefits. Each question was prefaced with a brief introduction to the reasons why the subject matter was being considered. Additional questions were asked if necessary to direct the progress of the interview. In all cases, these questions were structured as a request for clarification. With the help of these additional questions, all interviews remained channeled on the subject under consideration.

As a means of ascertaining the consideration given to advertising and public relations benefits, two direct question were asked during the interviews. During the general discussion concerning highway influence, no mention was made of an advertising or public relations benefit. Until directly asked the two specific questions, the person interviewed was not aware of the interviewer's interest in these factors. In evaluating all observation and conclusions regarding advertising and public relations benefits, the reader's attention is prematurely directed to the fact that only two firms studied, sell to a consumer's market.

The highway portion of the interview followed this pattern:

1. Second general lead question preceded by a general discussion of the reason why the subject matter was bing considered—in selection of the site what relevance did you place in locating in close proximity to a major highway?
2. Direction questions as needed.
3. Specific questions:

a. Advertising—In selecting your site did you consider that potential advertising might result from location on a major highway?

b. Public Relations—In selecting your site did you consider potential public relations that can result from a location adjacent to a major highway?

Highway Bypasses, Natural Barriers and Community Growth in Michigan

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● ACCELERATED highway construction activity around the country has spurred increased interest in the economic and social impacts of highway improvement. One area of interest which has undergone extensive investigation is the economic impacts of bypasses on business activity in bypassed communities. A sizeable body of evidence has been developed supporting the premise that business activity in such a community will generally not be adversely affected. This is a logical conclusion, and is consistent with present theories of community function. However, business activity is only one economic area, and bypasses have effects on other parts of the community economic structure. Many of these effects are equally important, although they are more difficult to measure. One such impact is the economic use of land as a result of the physical expansion of a community.

There is a current design cliche often used as a motto, "form follows function." It also applies to the physical form or patterns of a community. But as an artist or designer is limited to the forms attainable with his materials, so is a community limited by its physical and economic environment.

Numerous geographers and economists have developed economic models of community growth or design based on strict assumptions. Von Thünen (1) and Burgess et al. (2) worked with concentric zones of development although in different times and within distinctly different frameworks. Star patterns based on transportation were introduced as modifications of concentric patterns affected by differences in transportation. Other variations in form are the result of variations in terrain and the occurrence of other physical elements such as rivers and lakes.

Such physical barriers are important, and the frictions or obstacles they present modify simple models of form. Natural physical barriers are not the only barriers to community growth; constructed physical units may have many barrier-like qualities. Railroad rights-of-way and marshalling yards are examples. Highways, too, may act as physical barriers to growth, particularly for a small community because a small community is basically one operating unit. This does not imply that growth will be retarded in total, but that growth in a particular direction may be stymied.

If a bypass is constructed around a small community, a new and important physical element is introduced into the community's environment. If a relocated highway bypassing a community formerly traversed it, the relationship between the community and the highway is significantly altered.

The coincidence of natural physical barriers to growth and a highway bypass in the complex of a small community implies problems for the town; the observation of such instances provides useful insights into the problems.

METHODOLOGY AND SOURCES OF INFORMATION

An enumeration was made of small (that is, population under 3,000) communities in southern Michigan covered by geological survey information. Communities were rated as (a) having natural physical barriers to growth, (b) not having natural physical

barriers to growth, or (c) not having an important natural physical barrier to growth. The purpose of this approach was to isolate the effects of barriers and to evaluate the importance of community size as a mitigating factor. Where barriers are listed as "not important", the two following general classifications were developed: (a) the barrier was too small to be important or (b) the barrier has been crossed and development has occurred on the opposite side. Estimates of the presence or absence of barriers involved judgments based on the survey map's physical information and the growth patterns shown by cultural symbols. From this information an estimate was made of the importance and extent of natural physical barriers to community growth.

The interaction of highway bypasses and natural physical barriers is illustrated by reference to two small communities in Shiawassee County in south central Michigan. The discussion of the community growth of the two cases studies is based on geological survey data, agricultural land use determined by field survey, sequential community growth patterns as determined by field studies, and interpretation of aerial photographs.

EXTENT AND NATURE OF PHYSICAL BARRIERS IN MICHIGAN

The most common physical barriers in Michigan are lakes, river valleys, flood plains, swamps or marshes, and large areas of organic soil. Extreme slopes are also barriers, but are relatively less common. Mine tailings are quasi-natural barriers found primarily in the upper peninsula. But other associated pits commonly left by gravel quarries, limestone quarries, and strip mines are found scattered around the state. Rock outcroppings are relatively scarce. Areas of poorly-drained heavy soils are found in some areas of the southern peninsula.

The importance of barriers stems from two basic problems which are presented by them. The first problem is difficult or costly construction. This is true of extreme slopes, mine tailings, rock outcroppings, and swamps or marshes. Organic soils or poorly-drained heavy inorganic soils present problems in construction, as well as the additional problems of difficulty in disposing of septic effluent and providing a supply of safe water for domestic use.

The second major problem is one of physical or spatial isolation if development hurdles a barrier. River valleys, flood plains, marshes, lakes, and railroad rights-of-way all may be crossed and development can take place, but this development is spatially separated from the original growth.

It was possible to determine whether or not there were natural physical barriers to growth for 218 southern Michigan communities with population less than 3,000. Of the 218 communities, 123 were considered to have natural physical barriers to growth around them. In 31 cases it was determined that natural physical barriers were not important; that is, either they had been crossed (mainly by larger communities) or they were too small to be significant.

Of the 218 communities studied, 145 were located on a state or U.S. highway. Eighty-seven of these 145 communities were considered to have natural physical barriers to growth around them. Barriers were too small to be significant or had been crossed by 22 of the communities studied.

One significant point is that of the 123 communities having natural barriers all but five had barriers of water or were water-associated; for example, flood plains, river valleys, lakes or marshes.

The frequency of water or water-connected barriers is not surprising. Most of Michigan has interrupted drainage patterns due to glacial action, and streams, lakes, flood plains, swamps, and marshes are common. If communities were dropped at random in Michigan, we would probably expect one-half of them to land where water would in some way be a barrier to their growth. Inasmuch as Michigan communities were not dropped at random, of course, but to some degree purposefully located, their location near or on water is even less surprising.

The early importance of water as a means of transportation determined the location of many early settlements on streams that were more or less navigable. Prime locations were portages, fords, or river junctions. Another early use of water was for

motive power for sawmills and gristmills. Locations were thus selected also on smaller streams, and the conditions necessary for developing a mill race and a pond usually meant that natural physical barriers would be present.

How important the nature of physical barriers can be to community growth when decisions are made to locate bypasses can be discerned in Figure 1. The St. Joseph River has proved to be a definite barrier to Mendon's southward growth. Highway M-60 now goes through Mendon, constantly staying north of the St. Joseph River, and its wide valley and flood plain. If one were to plan a bypass around Mendon for M-60, it would be reasonable to assume that the bypass would lie north of the town. The St. Joseph River would be a handicap for highway construction as well as a barrier for the community's growth. This is an important point; in almost every situation where a bypass and natural barriers are found the bypass and the natural barrier will be on

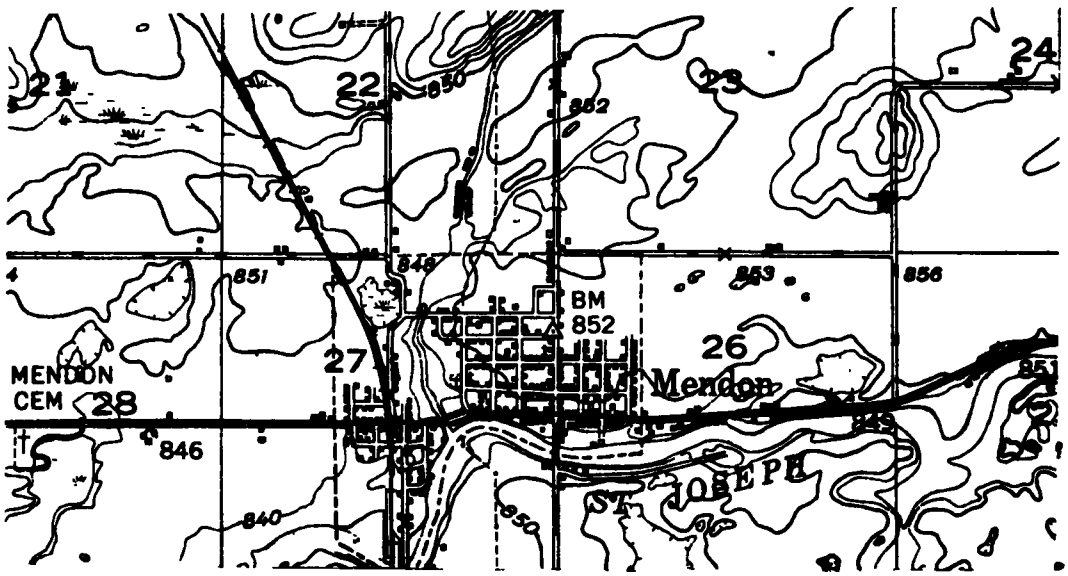


Figure 1. Village of Mendon, St. Joseph County, Mich.

opposite sides of the community. Constriction to some degree is almost a foregone conclusion. In the case of Mendon what type of growth could one expect?

If the highway were a controlled-access facility, Mendon would have two physical barriers to overcome. If the facility provided free access, development would eventually take place along the bypass and local traffic, turning movements, agitation for speed controls and traffic signals would soon negate many of the advantages provided to motorists by a bypass.

Growth also might, in either case, be forced across the St. Joseph River; this would increase the cost of community services and interrupt the continuity of community growth.

Effects such as these are not merely hypothetical. They are observable, tangible effects. Examples can be found and as more bypasses are completed, additional cases, unfortunately, will occur. Two such illustrations were found in central Michigan where sufficient time had passed since the construction of bypasses to allow a valid assessment of the effects of constriction between a bypass and a natural barrier.

TWO CASE STUDIES IN COMMUNITY GROWTH

Perry

The village of Perry is located in southwestern Shiawassee County, 25 mi northeast of Lansing, and 12 mi south of Owosso. The original location of the community was at the intersection of the Grand Trunk and Western Railroad and State Highway 47, an old state road first surveyed and constructed in the 1860's.

As a functioning rural service center, Perry has been active, and until the 1940's maintained stockyards adjacent to the railroad right-of-way. In the late 1800's and early 1900's, two small industries employing some home labor were located in the community, but the concentration of economic activity in larger population centers led to their decline and finally their demise.

Perry is now within driving distance of Lansing and is slowly becoming more of a satellite community than a rural service center. Much of village life remains, however, and many area residents work in service industries supplying the surrounding agricultural area.

Most of Perry's residential area as well as its commercial center lies south of the Grand Trunk railroad. Because growth here, however, is limited by heavy soils to the south and east, a second development area began north of the railroad.

In the mid 1930's, highway M-78 was constructed connecting Lansing and Flint to provide a good road link between these two industrial centers previously reached only by circuitous routes. This highway bypassed Perry as it did the other small communities between Lansing and Flint, with the exception of Swartz Creek.

The highway bypassed to Perry to the north, ¼ mi from the northern fringe, and only slightly over ½ mi from the commercial area. The original facility was a two-lane highway and one which carried a substantial amount of commercial traffic between Lansing and Owosso, Saginaw and Lansing, Lansing and Flint, and Lansing and Port Huron.

At the present time, only three businesses are located at the junction of M-47 and M-78, known locally as "Perry Corners." These three are of types normally considered attracted to transient trade, a restaurant, a tavern, and a restaurant-gasoline combination. As can be seen in Figure 2, only a few residences have been constructed directly fronting on M-78. Heavy traffic probably acted as a deterrent as did separation from the pulse of community activity. Some development has occurred across M-78, but in numbers this is small. Also being very recent, it probably reflects satellite development from Lansing and possibly should be disassociated from the community's trends.

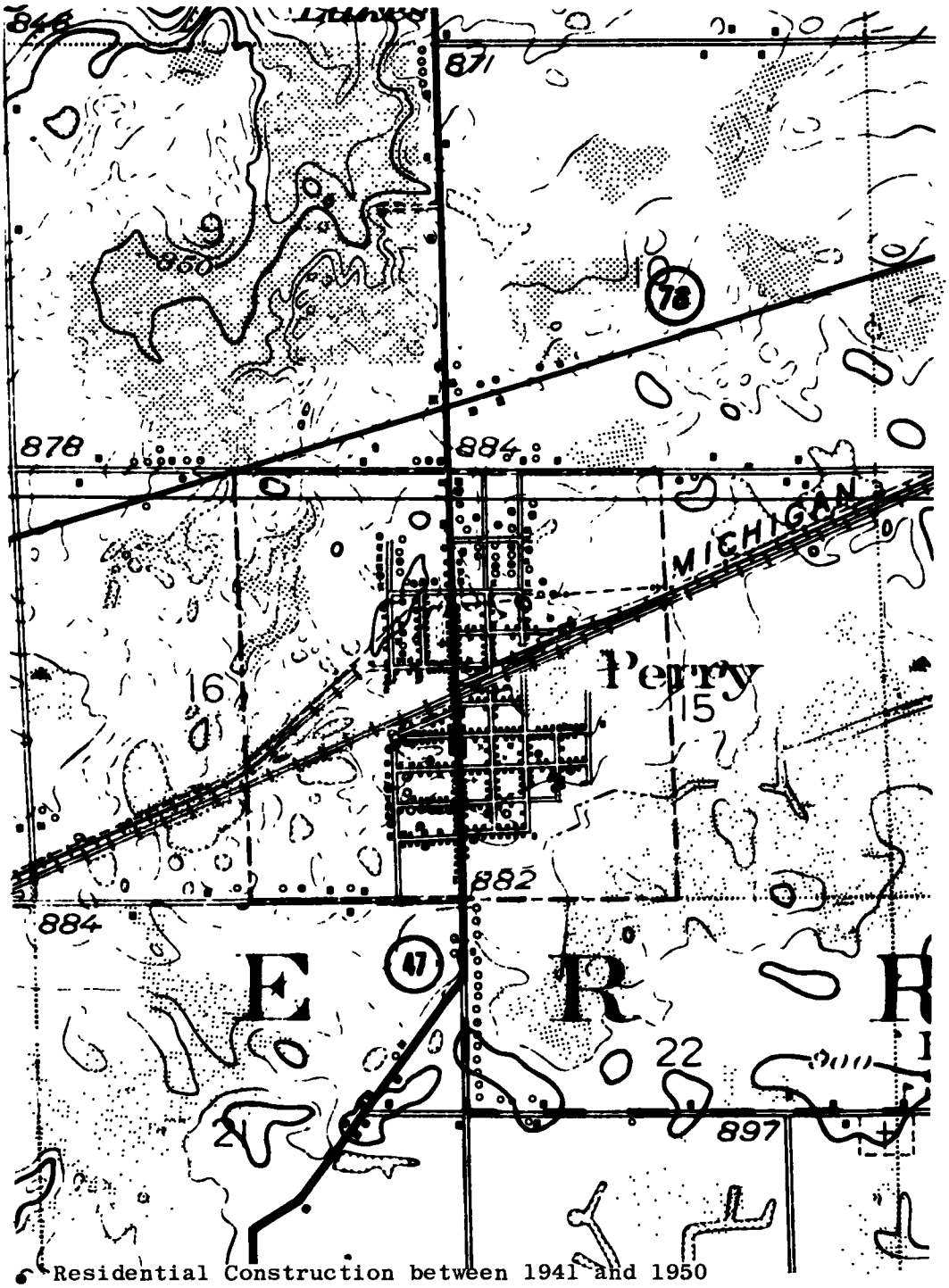
Basically Perry has continued to expand within its central area. Recently, however, the limiting conditions placed by nature around Perry's core have become actively important, and growth in the last three years has been restricted to the following alternatives: (a) locate on M-78, (b) locate across M-78, or (c) locate south of Perry across a belt of organic soil.

The choice apparently was to move south across the organic soil. Development here is separated from the community, but not as much as if it were on M-78 or across M-78. Some development fronts on M-47, but M-47 south of Perry is lightly traveled.

Development in this area is potentially limited due to soil conditions making construction difficult at any distance from the road. Also, interior land is being isolated by frontage development, making its future use difficult. Future development must be moved farther away from Perry, and the incomplete road system in the area will hinder other than further fragmentation and decentralization.

Growth concentrated in any one area would tend to be more orderly and efficient in the use of available land. Plats would be larger and would make use of interior lands also, instead of highway frontage alone.

Future service costs for the area will also be higher than for more compact and coordinated development. Visiting patterns and other social aspects of the community may also be disrupted and change (not necessarily equated with good) may prematurely come to the community.



• Residential Construction between 1941 and 1950

o Residential Construction between 1951 and 1958

Figure 2. Residential growth, Village of Perry, 1941-58. Shaded area indicates agricultural land removed from crop production due to physical limitations.

Decentralized and disorganized growth in many directions probably would not have occurred if the area north of Perry pre-empted by M-78 had been available for community development. Note the growth in the area south of the east-west road below M-78. It is reasonable to expect that expansion would have continued north with interior lands adjacent to the intersection being developed.

A real problem has developed for Perry because of constriction between a state highway and a series of extensive natural physical barriers. Movement of the highway further north when originally constructed would probably have aided both the town and the highway. The community's growth would have been more compact and orderly and less development would have occurred on the highway, decreasing turning movements and entrances and exits at slow speeds onto and from residential drives.

The problem is not that easily resolved, however, for in this case there are some difficulties involved in moving M-78 much further north, particularly west of M-47. These topographic problems mean, of course, increased cost. A policy problem now arises. What is more important, presenting the description of orderly community growth or preventing increased cost of construction? Increased costs of construction may at least be estimated. The social and economic costs of disorderly community growth, fringe distintegration, and the cost of reduced highway efficiency due to forced frontage residential development is another matter.

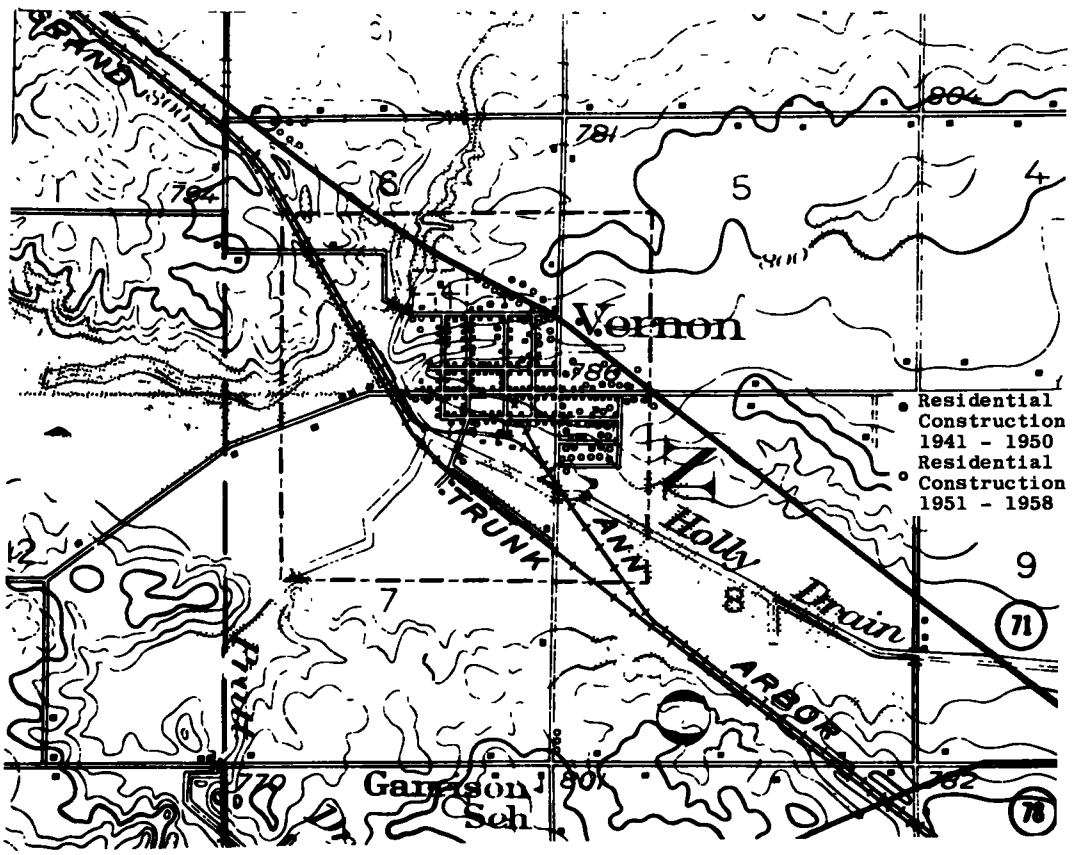


Figure 3. Residential development, Village of Vernon, 1941-58. Shaded area indicates agricultural land removed from crop production due to physical limitations.

Vernon

Vernon is located in eastern Shiawassee County between Owosso and Durand. A small rural service center, Vernon is located in a good agricultural area, and the community has enjoyed a steady growth.

In the middle thirties in conjunction with the construction of M-78, M-71 was constructed connecting M-78 west of Durand with M-21 and M-47 at Owosso. When this route was constructed, Vernon was bypassed to the northeast, and as is evident in Figure 3 the route passed very close to the fringe of Vernon's growth.

From the growth pattern (Fig. 3) it is evident that growth from Vernon has spilled onto frontage property abutting M-71. The reasons for this are fairly obvious.

As indicated in Figure 3, the Shiawassee River Valley and flood plain, tight contour, and railroad rights-of-way severely hinder growth to the west and northwest. Holly Drain, the railroads, and an extensive belt of heavy soils deter southward growth. After the available land suitable for development within the bounds of these barriers is used, only the northeast is left for growth.

As shown, a high proportion of recent development is on or across M-71. In 1957 the daily average twenty-four hour traffic flow on M-71 was between 3,600 to 3,800 vehicles department estimates according to Michigan State Highway. It would seem a safe assumption that development on the highway at this point has not increased the efficiency of the bypass. Further, there has been agitation for speed limits in this area and for a traffic signal at the intersection on M-71 and Vernon's main street. Future development in the area can reasonably be expected to intensify this need, and to further reduce the efficiency of traffic flow in this area.

In all probability, this difficulty could have been avoided by selecting a route skirting Vernon at a greater distance than that at which M-71 presently does. This need not be, as it is in this case, a matter of hindsight. Growth could feasibly take place in only one direction, and if this fact had been considered in the 1930's, the present situation in all probability would be much different.

A further factor which will influence Vernon's growth is the relocation of M-78, due to be constructed as a controlled access highway. The new route will be located north of the present M-78 and logically will be south of Vernon and the Shiawassee River. This will reinforce the factors causing north-eastward expansion.

SUMMARY AND CONCLUSIONS

In the portion of southern Michigan covered by the study, natural physical barriers to community growth were found to be widely distributed and significant determinants of community growth patterns. Over 56 percent of the small communities studied were considered to have natural physical barriers adjacent to them. Of the communities on state or U.S. highways, 60 percent had natural physical barriers. Water and/or a water associated form constituted 96 percent of the natural barriers to growth.

The difficulty of bridging such barriers and the barrier-like effects of bypasses upon small communities indicated a need for careful selection of bypass routes. If communities are to grow in an orderly manner and not obviate the advantages of highway bypasses, bypass routes should be located at a considerable distance from the core of a community's primary growth. This is necessary since development on a bypass may be more easily accomplished than the crossing of most natural barriers.

It was determined that most small communities bridge natural barriers when their population has exceeded 1,200 depending on the extent of the natural barrier. This crossing or bridging apparently can be traced to two causes. They are the following: (1) In this population range, the community normally splits into two or more neighborhoods which downgrades the importance of spatial contiguity in the selection of building sites, and (2) Directional growth away from a physical barrier will become extensive enough that building sites at the fringe or across a natural barrier are equally isolated from the primary focus of the community, and an indifference point is reached with respect to the two locations.

Some evidence of (the size necessary for bridging barriers) can be gained from an examination of the data concerning barriers which were considered to be important.

In seventeen cases, this classification was selected since community growth had bridged the barrier and continued on the other side. In only two instances had barriers been bridged by communities of less than 1,000 population. In three cases, the communities had between 1,000 and 1,200 population. It is, of course, impossible to pinpoint exactly when these barriers were crossed or bridged; however, the preponderance of communities with population less than 1,200 have not bridged natural barriers. And since the majority of communities having bridged natural barriers are larger than 1,200, it seems reasonable to infer that the break normally would occur when the population has reached a number between 1,200 and 2,000.

The need for bridging varies, of course; the physical conditions vary considerably and thus one would expect considerable individual variability.

Although barriers are common, their effects in conjection with bypasses should be considered, only if a community is growing steadily. Particularly is this true if the effective life of a non-controlled access bypass is of concern.

Some small communities in Michigan are growing, others are static, some are declining, and others are being obliterated or swallowed as functioning units by metropolitan sprawl. Michigan Department of Health population statistics provide a basis for assuming that small communities in southern Michigan probably are continuing to grow steadily, much as they did between 1940 and 1950. Population decreases in the Upper Peninsula have tapered off as a balance is reached between economic opportunities and population. In the Detroit metropolitan area, small communities are disappearing as they are engulfed by urban expansion, but as mentioned above, in most of the state, small communities are still very much alive.

The following recommendation is based upon the above deduction, and the analysis of growth data included in the study.

Bypass routes should be located at a distance from the community's fringe which will be sufficient to allow enough normal growth at existing density patterns that a population of between 1,200 and 2,000 can be accommodated. For as mentioned before, when a community reaches this size usually natural barriers no longer effectively block growth. Necessarily, each case must be determined indepently as physical conditions vary greatly. Such routes would allow small communities to expand in an orderly manner and eliminate almost all community growth on a bypass.

ACKNOWLEDGMENTS

The research on which this paper is based is part of a project on economic and social effects of highway improvements conducted by Michigan State University under contract with the Michigan State Highway Department with the participation of the U. S. Bureau of Public Roads.

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Measuring the Economic Impact of a Limited-Access Highway on Communities, Land Use, and Land Value

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Research in the field of highway economics has long been recognized as an essential part of the highway planning task. One branch of this research is of comparatively recent origin; namely, that specifically concerned with the economic impact of various forms of highway improvement. This new research emphasis stems from: (a) an urgent need for information which can be used in the appraisal aspects of right-of-way acquisition programs of highway departments; and (b) the fact that data are needed for predicting what a proposed change in the routing of a highway, such as bypass which sends traffic around rather than through a town, may do to the economic health of a community.

In November 1957, the Bureau of Business and Social Research of the University of Denver undertook a study—sponsored by the Colorado Department of Highways in cooperation with the U. S. Bureau of Public Roads—of the economic impact of segments of limited-access highways (U. S. 85 and 87) on business activity of bypassed communities, and on land value and land use. These highways were appropriate subjects for study because of the variety of uses of the land abutting them and because they are representative of other highway projects planned for the state.

The primary aim of this paper is to discuss the techniques developed in the Bureau study to measure the economic impact of the highway on bypassed communities and on land value and land use. A collateral aim is to present some findings from the Colorado study which illustrate applications of the technique.

The first part of this paper deals with the influence of US 85 and US 87 on business activity of certain bypassed Colorado communities. The second part discusses the subject of impact of segments of various highways in the 85-87 complex on land value and land use.

The findings of both phases of the study are preliminary in nature. The influence of the subject highways cannot be fully measured until sometime after the links through Denver, Colorado Springs, and Pueblo are finished, and more time following completion of certain portions has elapsed. Similarly, with respect to methodology, some of the techniques employed must be regarded as tentative in their applicability to studies of this kind. Being conscious of the need for methods which provide, not only indications of what impact the highways have had, but also methods which might have predictive value, considerable effort was devoted to finding ways to explaining why certain types of impact have taken place.

● THE BIRTH of a community is brought about in many ways: as a trading center for a large agricultural region, historically important as a rendezvous for Indian fighters,

and as the hub of extensive mining activity. Whatever the size of a community, it has had a hand in shaping the economic and political development of the state of which it is a part. Seven communities—Brighton, Sedalia, Castle Rock, Larkspur, Palmer Lake, Monument, and Fountain—were selected for the Colorado study because each, within the past 10 years, has been bypassed by north-south US 87 running through the state (Fig. 1).

Each of these communities has had rail service since early days of the state. With the advent of the automobile, the need for good roads became apparent. As the highway network began to develop, these communities became junction points and centers of

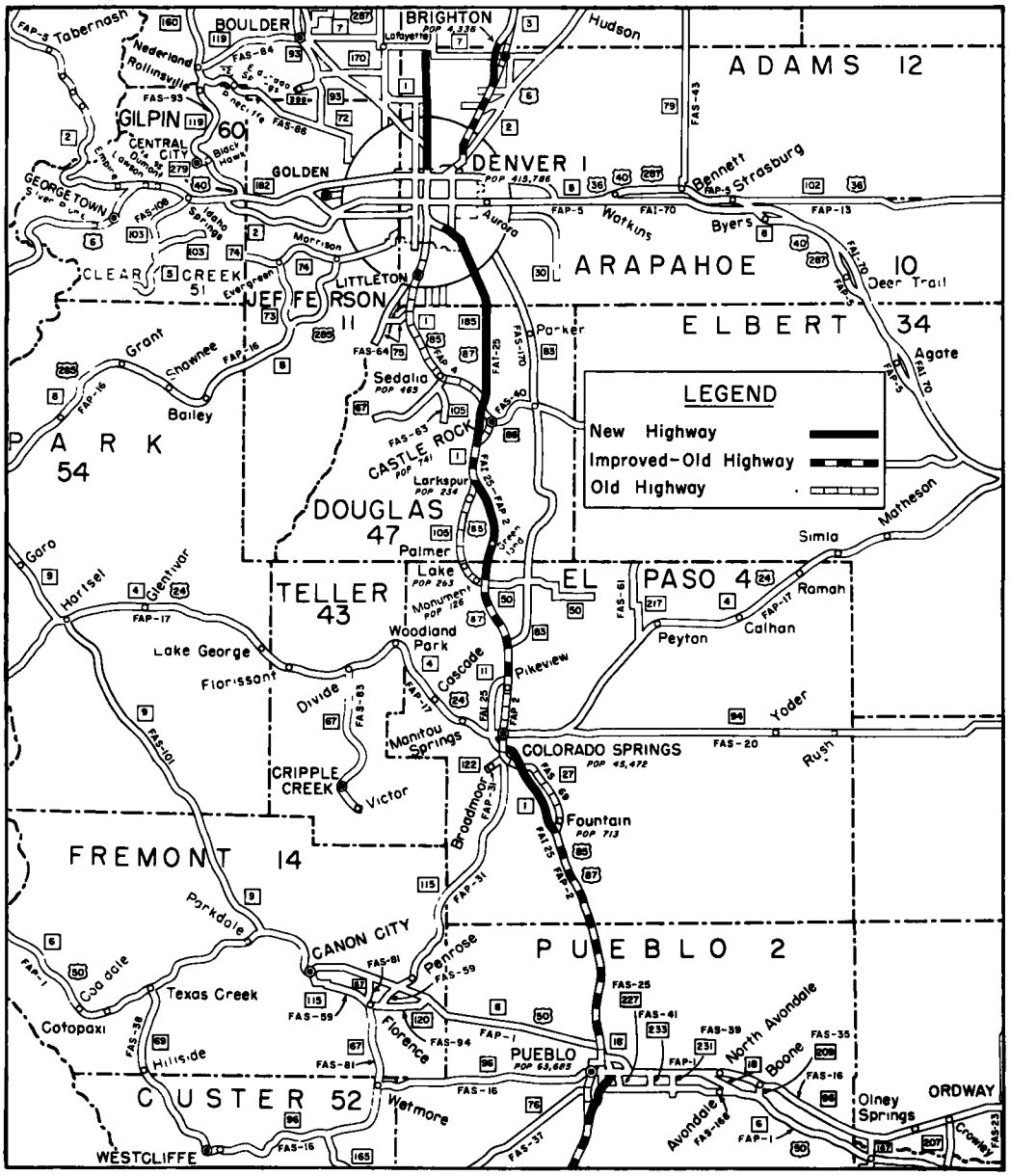

Figure 1. Subject highway network showing bypassed communities and their 1950 populations.

business activity on the principle north-south route through the state. Pressures of population growth and business expansion in the past two decades created demands on the highway network to eliminate points of congestion so that larger traffic volumes and increased speed could be accommodated. In December 1949, US 85 was changed and rerouted from north of Larkspur to Monument resulting in Larkspur, Palmer Lake, and Monument being removed from the main stream of traffic on one of Colorado's busiest thoroughfares. During the period 1952-1956, Brighton, Sedalia, Castle Rock, and Fountain were bypassed by new 4-lane limited-access highways.

In 1954, an area east of Colorado Springs was selected as the site for the United States Air Force Academy. This event has exerted, and will continue to exert, further changes on the economic development of the surrounding areas.

The economic motivations which explain the existence of these communities are a matter of history and bear little or no relation to the sustenance on which they now depend for their livelihood. The economic origins of these communities were completely divorced from any business activity to be generated by the modern highway; but to an unknown extent they have come to depend on it. A community suddenly cut-off from sources which contribute to its normal growth does not perish immediately. It is difficult to predict what the ultimate outcome will be. It does seem clear, however, that when a major disruption of this flow of activity occurs it will result almost immediately in changes in the normal level of business activity. The extent of this disruption may be interpreted as a reflection of the community's dependence on the affected activities as economic assets.

People of a community become deeply concerned about the possible effect that a bypass might have on their economic well-being when the bypass is first proposed; likewise, planners of highways. No objective information is available which can be used can be used to justify or to relieve this concern.

To what extent is the nature and volume of business activity affected when these communities are passed by the major stream of traffic which formerly went through them? How can this effect be measured? The methods employed in the Colorado study to answer these questions are examined in the following sections. Based on this methodology some of the findings with respect to Brighton are reported.

MEASUREMENT OF IMPACT ON BYPASSED COMMUNITIES

The study rests almost entirely on an analysis of sales tax collections as a measure of business activity for each of the seven communities over the years 1946 to 1957. Such data provide not only measures of the amount of business activity year-by-year, but give insight into changes in the composition of this activity if sales tax collections are analyzed according to type of business.

If changes in the level and composition of business activity are to be related to the highway, then some guide or standard of comparison is needed against which the significance of the changes can be evaluated. Sales tax collections covering the entire state would seem to provide an appropriate base for comparison. These data would be almost entirely independent of any effects brought about by the bypass highway, but they still would be sensitive to statewide economic changes which would be felt by the communities as well.

Gathering of information necessary for such a program entailed dealing with month-by-month reports of sales tax collections from individual businesses in each of the communities studied.

Since the second quarter of 1954, sales tax statistics collected by the Colorado Department of Revenue for the state as a whole have not been kept by individual business classes (for example, drugstores, filling stations, motels, etc.). To make comparisons between the state and the community, estimates of sales tax collections had to be derived for each business class by quarter for the years 1954 to 1957. Details of this step are given in the Appendix.

Business Classes Studied

By agreement with the Colorado Department of Revenue, no data are reported which

would tend to reveal the sales of an individual business. The agreement of non-disclosure was met in two ways: (a) if the number of firms in a given business category was less than four in any year, no analysis was made for this category; and (b) by not reporting sales tax figures for any category of business. As a consequence, the relative importance of each business class in a community over the years 1946 to 1957 is not given. Such an analysis would be valuable because it would reveal more definitely what changes take place in the composition of business activity of a community due to the bypass. Nevertheless, reference will be made in the discussion to statistics compiled for this purpose, even though no specific identifying figures will accompany the reference.

An analysis of at least the total sales tax collections for every community was possible, because the number of businesses in operation in each of the communities was four or more in each of the years 1946 through 1957. It was possible in certain instances, using this "rule of four", to single out certain business classes for special study. The following groups were chosen because they include firms associated with the kind of business that is generated by highway traffic:

1. Apparel group—including boot and shoe stores, clothing stores, and dry cleaners and laundries.
2. Automotive group—including stores selling automobiles, bicycles, and automotive accessories; filling and service stations; garage and repair shops.
3. Food group—including grocery stores, motor stores, meat markets, bakeries, poultry stores, restaurants, taverns, cafeterias, hotels, cottage camps and resorts.
4. Furniture group—including appliance stores, furniture stores, radio sales and service shops, and upholsterers.
5. General merchandise group—including department, drug, hardware, jewelry and sporting goods stores.

Separate tabulations were also prepared, when there was no danger of disclosure, for certain businesses within each of these groups. Such tabulations permit tracing the impact of the highway bypass directly to the businesses affected.

Only in the case of Brighton was a detailed program of analysis possible for a variety of business groups. Accordingly, the approach used in assessing the effects of the highway bypass for this community is quite representative of the approach used for the other communities. This does not imply that the findings for Brighton are typical of those for the other communities.

Graphs Showing Business Activity

Some discussion is in order as to the construction of the graphs shown in Figures 2-10. The dashed lines shown for Colorado and Brighton connect the plots of actual sales tax collections from one quarter to the next. The heavy solid line running through the dashed lines is a "centered four-quarter moving average." This moving average represents the general pattern of tax collections when cyclical variations from quarter-to-quarter and other random fluctuations are ironed out. Based on the moving average, it is possible to examine more easily the main effects that have taken place in the movement of business activity in a given community. This concept is explored further in the Appendix.

The scale chosen for the figures is a semi-logarithmic one. This scale allows direct comparison of the moving average of Colorado sales tax collections with that of the given community in terms of percentage changes over a period of years. If, for example, the general movement of the moving average for Colorado, as approximated by a straight line, were parallel to a line drawn similarly through the moving average for a community, then the rate of change in business activity year-to-year for the state and the community would be identical. In other words, the community would be keeping pace percentage wise with the state. A good example of this relationship is shown in Figure 5, for 1949-1954, where total sales tax collections from filling and service stations in Brighton are compared to those of the state.

On the other hand, if the slopes of these lines are somewhat different, then it can

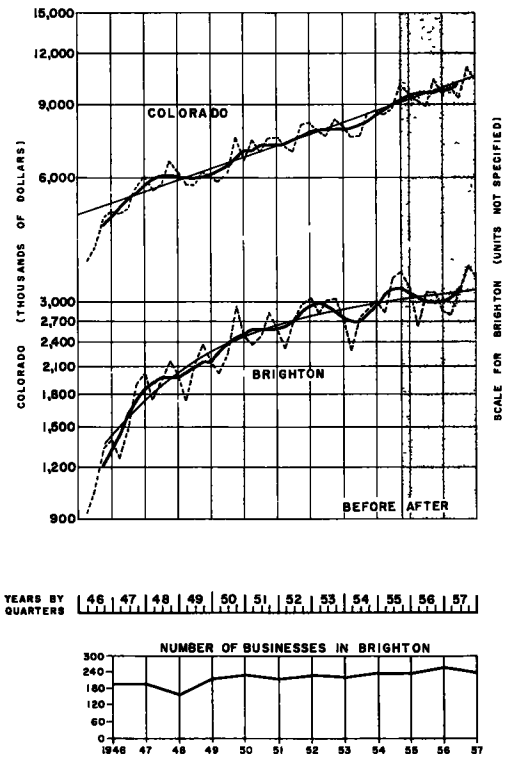

Figure 2. All business groups: comparison of Brighton and Colorado (ratio scale).

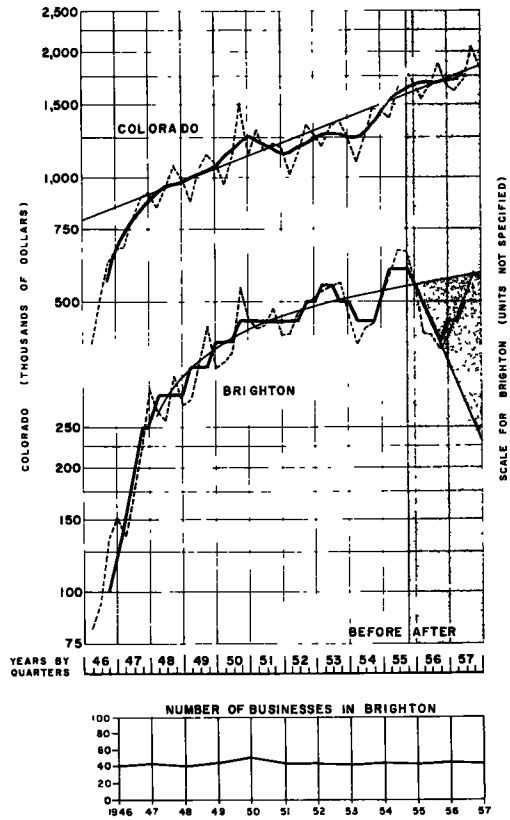

Figure 3. Automotive group: comparison of Brighton and Colorado (ratio scale).

be said that the rate of increase of the series represented by that line with the steepest slope is greater than the rate of increase of the other series. A good example of this situation is shown in Figure 6. Here, the rate of increase in sales tax collections from the food group for Brighton is somewhat less over the period than that for Colorado. The important characteristic of these charts, then, is not a comparison of magnitude of the changes that take place but, rather, rates of change. This characteristic property of semi-logarithmic charts applies equally well to comparisons that might be drawn between periods of years for a given series. For instance, from the middle of 1950 to the middle of 1953, Colorado's total sales tax collections increased from about $6,600,000 to $7,970,000, or $1,370,000, approximately 21 percent. From the middle of 1953 to the middle of 1956, the change is from $7,970,000 to $9,700,000, or $1,730,000, a 22 percent increase. Here, there is a large dollar difference between the two periods, but the percent changes are almost identical. These two periods would straddle the same straight line passed through the moving average curve.

Each chart is shaded so that the post-bypass period may be compared easily with the pre-bypass period. Dates used for this purpose are those on which traffic first flowed around the community in question. Thus, this date might be the opening to traffic of the bypass with only two lanes in operation instead of the ultimate four-lane divided highway. The bypass around Brighton was opened to traffic in July 1955. (Dates on which the bypass was first opened to traffic for the other six communities are as follows: Larkspur, Monument, and Palmer Lake—December 1949; Sedalia—August 1952; Castle Rock—December 1955; and Fountain—November 1956.)

No numbers are shown on the scale for Brighton because, under certain circumstances,

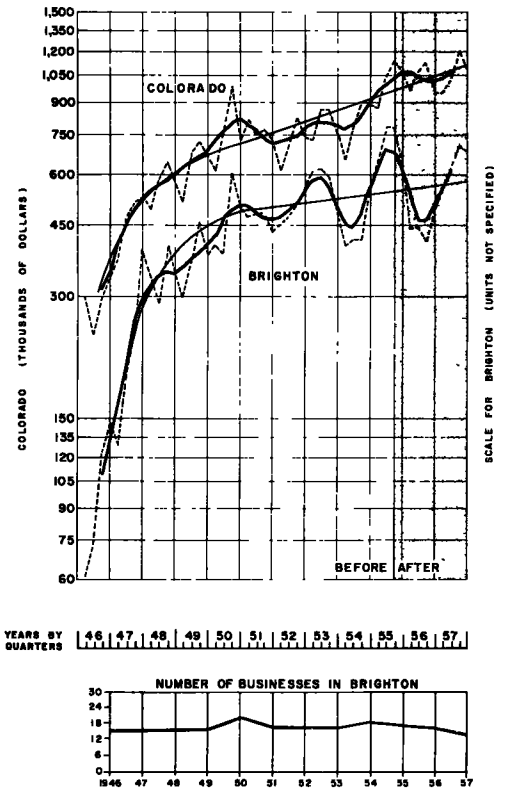

Figure 4. Automobiles and bicycles: comparison of Brighton and Colorado (ratio scale).

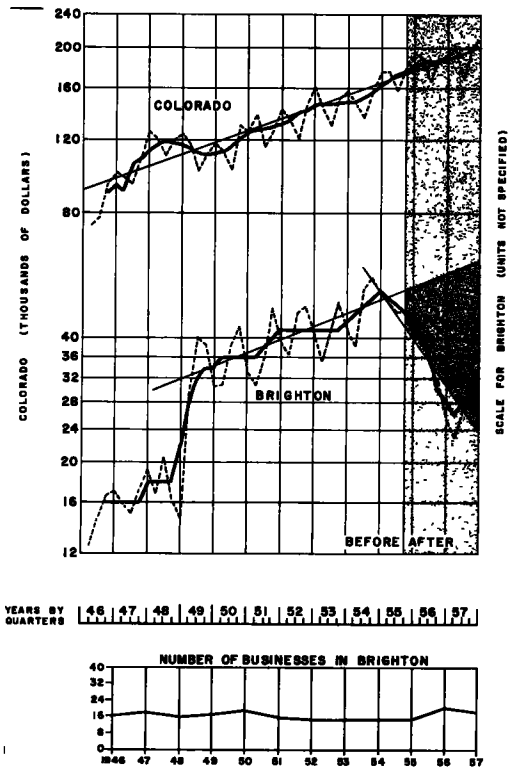

Figure 5. Filling and service stations: comparison of Brighton and Colorado (ratio scale).

to do so would allow comparisons to be made between individual businesses. This is particularly true in view of the fact that the number of businesses over the period 1946-1957 is shown at the bottom of each figure. The chart, showing number of businesses, gives the maximum number of stores doing business in any quarter of a given year.

Adjustment of Data for Price Changes

No adjustments have been made in sales tax collections to take account of price changes that have occurred over the years 1946-1957. Such adjustment would, indeed, be necessary for meaningful comparisons if it could be shown that price changes that occurred in Brighton were materially different from those which occurred statewide. It is unlikely that changes in the price level of purchased items in Brighton are very different from those which occurred statewide, because any statewide index of price changes would be dominated by price changes which occur in the metropolitan area of Denver. For all practical purposes, Brighton is a part of this area. At any rate, no satisfactory measures are available. It will be assumed throughout that even if sales tax collections had been adjusted for price changes, the same relationships between Brighton and the state, as shown in Figures 2-10, would prevail.

FINDINGS IN THE CASE OF BRIGHTON

Of the communities studied in this report, Brighton is probably the one which has been least affected by unusual business and industrial expansion, or other exceptional developments, over the period of the study. This is evident from Figures 2-10

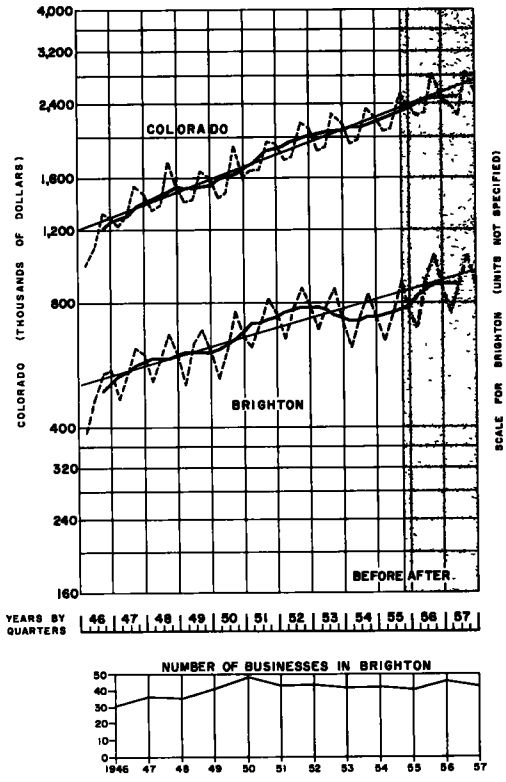

Figure 6. Food group: comparison of Brighton and Colorado (ratio scale).

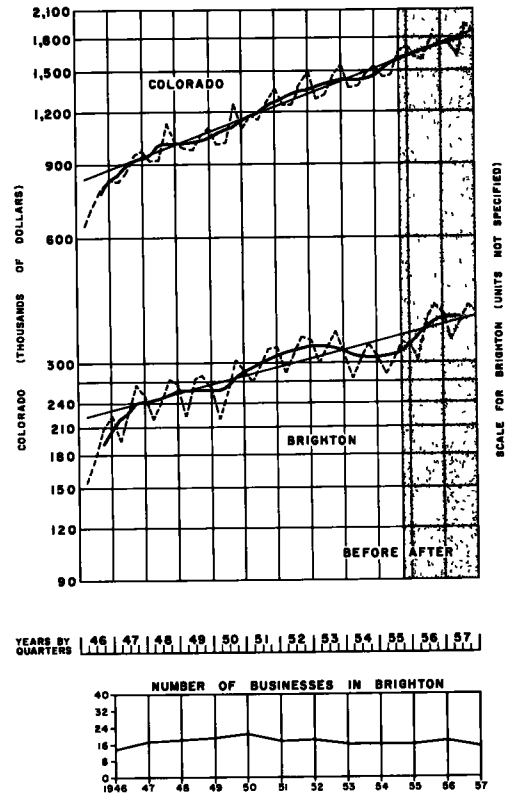

Figure 7. Grocery stores, motor stores, and meat markets: comparison of Brighton and Colorado (ratio scale).

showing sales tax collections from the various businesses in Brighton. Total business activity in Brighton (Fig. 2) follows very closely the pattern of business activity statewide, though the over-all rate of change in Brighton is somewaht less than that for the state. Fluctuations in the "moving average" for Colorado are almost exactly duplicated by those for Brighton. As is to be expected, however, fluctuations in the moving average for Brighton are more pronounced than those in the curve for the state. This basic characteristic is exhibited, also, in the case of the automotive group prior to the bypass date, July 1955 (Fig. 3). It is also true, though in varying degrees, for businesses selling automobiles and bicycles (Fig. 4); the food group (Fig. 6); the grocery and meat market trade (Fig. 7); and the furniture and general merchandise groups (Figs. 9 and 10).

The growth in population in Brighton, as indicated in the table on page 46, declined percentagewise in the period 1940-1950, as compared to that of the previous decade, whereas the percentage increase in population for the state was larger in the decade 1940-1950 than in the period 1930-1940. This would account, in part, for the smaller rate of growth in business activity in Brighton, as compared to the state (Fig. 2).

In a striking way, the moving average of quarterly sales tax collections for Brighton has paralleled that of the state for the period preceding the opening of the bypass highway. A reasonable assumption is that this related movement should continue following the opening of the bypass if business activity is indifferent to it. Employing this line of reasoning, it would appear from Figures 2 through 10 that:

1. The bypass has not affected the general level of business activity in Brighton.
2. The immediate effect of the bypass on the automotive group (Fig. 3) has been to

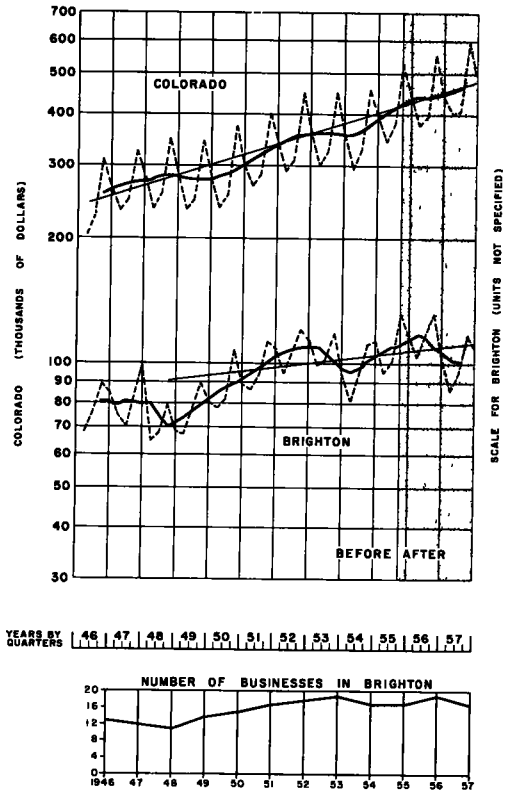

Figure 8. Restaurants, taverns and cafeterias: comparison of Brighton and Colorado (ratio scale).

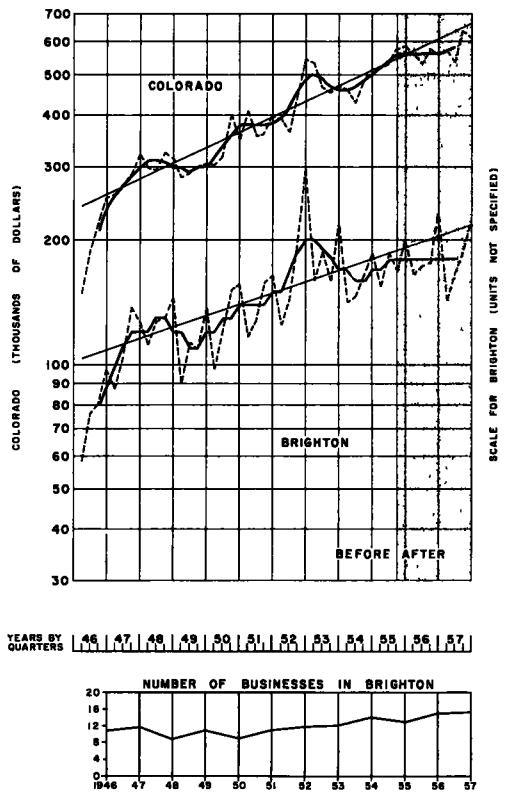

Figure 9. Furniture group: comparison of Brighton and Colorado (ratio scale).

decrease gross sales by about 13 percent per quarter for a period of about 1 year. Indications are that a substantial improvement in this activity is taking place and that perhaps a level which existed before the bypass might be achieved. This effect on business activity for the automotive group arrears to be due largely to a deterioration in service and filling station sales (Fig. 5). No concomitant effect is noticeable in the sales of automobiles and bicycles (Fig. 4) although the number of businesses has declined from 1954 to 1957. In the case of filling and service stations, the rate of increase in sales from 1948 to 1954 was at a level close to that established by the state as a whole. The effect of the bypass on total sales of this group is clearly shown in Figure 5 though no accompanying change occurs in the number of businesses.

3. The level of business activity of the food group as a whole (Fig. 6) is indifferent to the opening of the bypass. Variations in business activity appear to be completely consistent with the pattern established between Brighton and the state as a whole in the years preceding the bypass. This situation prevails with regard to grocery stores and meat markets (Fig. 7), as well as to restaurants and taverns (Fig. 8).

4. Sales tax collections from businesses in the furniture class (Fig. 9) vary in a manner that would be expected had there been no bypass highway. The usefulness of patterns of variations established between the community and the state for analysis of the economic impact of the bypass is borne out in Figure 9. The sales picture for Brighton alone from the middle of 1955 to 1957 infers that the bypass had some detrimental effect on this group in businesses. However, when comparisons are made with the state such variations seem quite consistent with what might be expected had attention not been given to the bypass date at all.

5. Sales of the general merchandise group of businesses (Fig. 10) also appear to be unaffected by the opening of the by-pass highway.

Discussion of the Findings

The economic profile of a community is composed of many components, each of which is important in the total picture. The manner in which these components depend on one another is largely unknown, and to measure their relative importance is difficult. The components are put together in a way which achieves, at any given time, a general state of balance which is likely to be unique to that community. It is reasonable to suppose that the dislocation of one of these components will produce change in the economic profile, in proportion to the severity of the dislocation. Moreover, such dislocation ought to be revealing of the role played by the component in the profile. Thus, in the case of the present study, if a highway passing through a community has the effect of contributing to the economic well-being of that community, the movement of traffic around instead of through it will alter the economic profile according to the net effect produced by the change in location of the highway.

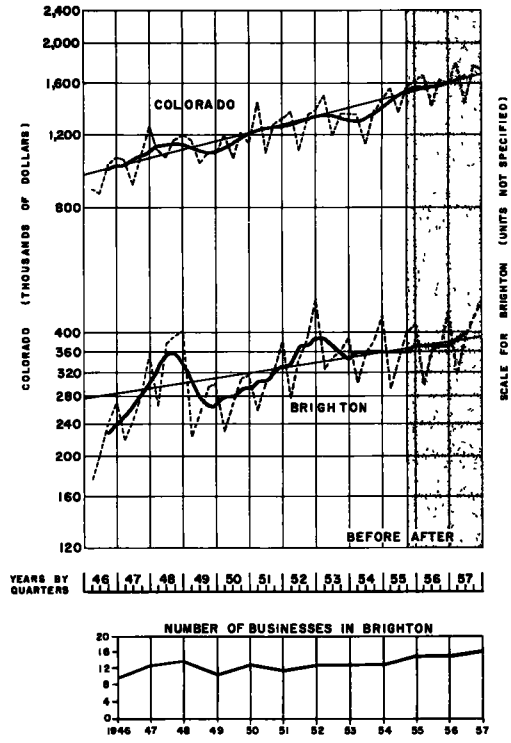

Figure 10. General merchandise group: comparison of Brighton and Colorado (ratio scale).

This conceptual framework is a simple one. The major difficulty facing the investigator who attempts to work within this framework is one of finding tools of analysis capable of measuring realistically the changes in the economic profile brought about by dislocation of one of its components. The temptation is always present to assume away much of that which is probably present and to claim for the tools the capacity of measuring exactly changes whose identity can be known only roughly.

However, if the pattern of change can be understood and is predictable, tools of analysis can be built which stand a reasonable chance of performing the required task.

It is common for economic changes which take place at the community level to be in concert with similar changes at the state level. Moreover, this relationship is likely to persist over long periods of time imbuing the relationship with a predictive quality which is valuable in assessing the nature and extent of dislocation when it occurs. There is evidence of this relationship in the graphs depicting business activity for Brighton and the state. The possibility exists that the predictive relationship which has been established between the community and the state by this analysis will fail at the precise moment when the effect of the dislocation (the highway bypass) on the economic profile of the community is being judged, thereby rendering practically worthless any results that rest upon an interpretation of this relationship. Perhaps the only safeguard here is the precaution of the investigator. The associated risks are no different from the risks inherent in other decisions that the community and highway planner must make completely apart from the problem of the highway bypass. Justification for studies in this area of highway economic research lies in reducing the uncertainties concerning the impact of a proposed bypass on the well-being of the community.

POPULATION OF BRIGHTON AND COLORADO—1930, 1940 AND 1950

	1930	1940	1950	Percent Changes 1930-40	Percent Changes 1940-50
Brighton	3,394	4,029	4,336	+18.7	+ 7.6
Colorado	1,035,791	1,123,296	1,325,089	+ 8.4	+18.0

Source: U.S. Bureau of the Census, Census of Population, 1950.

IMPACT ON LAND VALUE AND USE

The subsequent portion of this paper deals with the impact, if any, that new and improved US 85 and US 87 have had on land value and land use in certain areas of Colorado where these highways are located. This study was based on the assumption that these highways, by virtue of their character and location, have affected the values and uses of land along their routes, and further that if such effects could be isolated and measured, a rational basis for estimating effects of similar, future highway improvements in Colorado might be provided.

Scope of the Study

The Colorado study is concerned with an examination of parcels of land located along US 85 and US 87 which are the principal north-south travel routes of Colorado and connecting links between the state's three largest cities, Denver, Colorado Springs, and Pueblo. Of the two, US 85 is the older—having been built several decades ago. With the building of US 87 since the end of World War II and with extensive improvements to portions of old US 85, an integrated network of divided-lane, limited-access highways has been provided. (Certain portions of old US 85 serve also as the route of new US 87 and therefore, carry the designation of US 85-87. The connecting links through Denver, Colorado Springs and Pueblo were still under construction at the time of the study.) Stages in the development of these highways over the period 1946 through 1958, are depicted in Figures 11-14. In this highway network, there are essentially three classes of road:

1. New highways—those constructed over new routes (US 87).
2. Old highways—those in existence before the study period (US 105 and 27, which were formerly US 85).
3. Improved old highways—where an additional lane has been built parallel to an old lane (US 85-87).

As will be noted later, this three-fold designation of highways serves an important role in the analysis.

Because some segments of the highway are not yet complete, and others not sufficiently complete to make meaningful before-and-after comparisons, it is clearly impossible to subject the entire network to examination. Moreover, certain areas are so bound up with influences other than the location of the highway that meaningful measurements of impact on land value and land use cannot be made. This applies particularly to a large portion of El Paso County north of Colorado Springs, which is greatly influenced by the Air Force Academy installation.

There is the methodological problem of choosing those parcels of land which provide the greatest opportunity for detection of impact of the highway. The decision was made to study those parcels which would certainly reflect the effect, if any existed, of the highway on the value and use of said parcels. Parcels abutting or virtually abutting the highway provide opportunity for fairly clearcut measurement of impact of the highway, though it is certain that some parcels not abutting the highway and, hence, not included, might also be affected by it. (For comments regarding the meaning of virtual abutment, see Appendix.)

Pertinent also to the concept of the present study is the variety of types of land over which the highways extend (Fig. 15). (In the rural area north of Denver in Adams

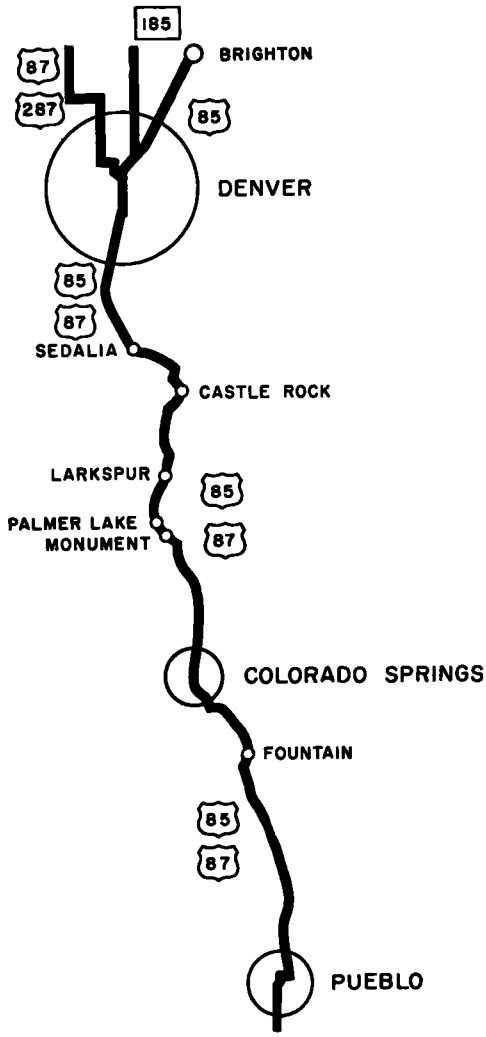

Figure 11. Main highway network in 1946.

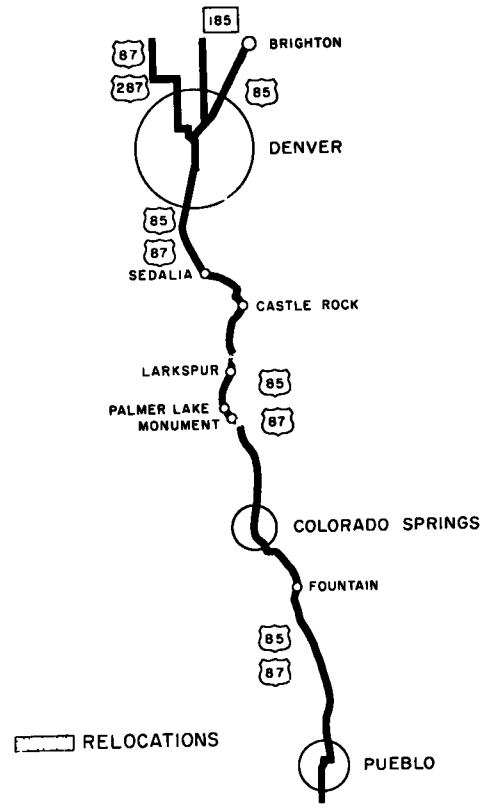

Figure 12. Main highway network in 1950.

County along US 85, irrigated vegetable farm land is the predominant type. Dry farm land, excellent for the growing of wheat, rye and other grains, is the prime type of land in Adams County along US 87, and in Arapahoe County south of Denver. Farther south in Douglas, El Paso and Pueblo Counties, grazing land perdominates, though occasional parcels are under limited cultivation. The terrain throughout the length of the subject highway network is level to rolling, but not mountainous.) Type of land as well as type of highway plays a major role in the analysis. Effort is made to find out if given types of highway improvements exert different degrees and kinds of impact on four classes of land; namely, grazing, dry farm, irrigated and rural-urban land.

Concepts Important to the Study

Land Value.—It is important in a study which seeks to measure impact of a highway on land value, that a defensible and easy to apply definition of land value be established. There are a variety of meanings given to the word "value" in relation to land, depending on one's point of view. The most appropriate definition of value for purposes of this study is the amount of money (per some common unit) that given types of parcels of land command in the market place; for example, sales price per acre.

Land Use.—The concepts of land value and land use are intrinsically related. Land has value in terms of the use to which it is put, or in terms of its intended use. The

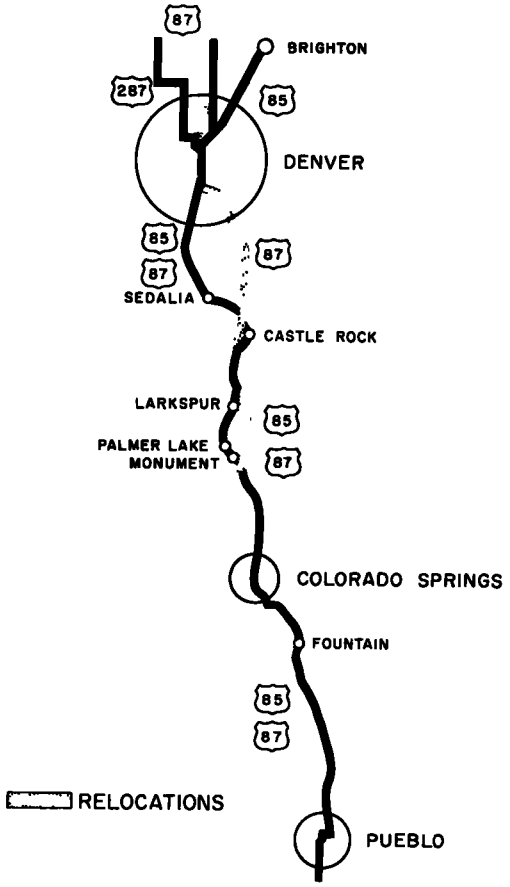

Figure 13. Main highway network in 1954.

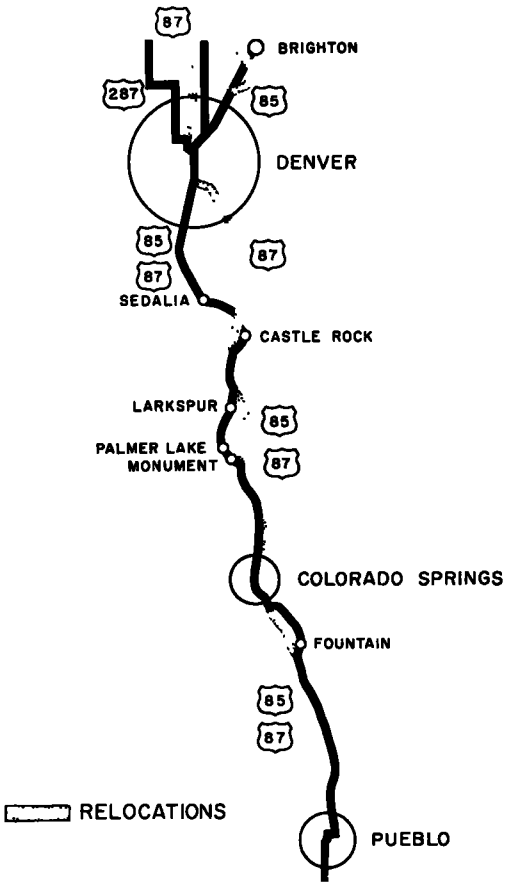

Figure 14. Main highway network in 1958.

assumption is made in this study that land is in its "highest and best" use position at the time of sale, but that conditions may occur (for example, an impending highway) which may cause it to fall below its "highest and best" use position. As the findings will indicate, such influences are present in the case of some parcels as a result of the location of the highways.

Assignment of Parcels to "Before" and "After" Periods.—Equally difficult to define as land value is the date on which the landowner or potential purchaser of land located in the path of a proposed highway becomes "aware" of the impending development. This date is important. To a very great extent, this study is concerned with measuring what effect this "awareness" has on the price the buyer and seller of land will agree upon for a given parcel, and the use of which it is likely to be put. There will be varying degrees of awareness among different buyers and sellers: therefore, any date that might be used has its limitations. The date which has most to recommend it, however, is the approval date of the highway project; that is, that date on which agreement is reached by state and Federal highway planners regarding financial and construction arrangements for the proposed projects. It is this date which is assumed to mark the beginning of public awareness of the proposed highway. Sales of land occurring before the approval date for given segments of highway are designated "before"; and those occurring after this date are denoted "after".

Data Collection Methods

To carry out the program of analysis previously indicated, requires the identification of parcels of land which abut the highway and have been sold during the period 1946-1957. The cash consideration in the sales price of a parcel was established from the value of revenue stamps affixed to the warrranty deed. To arrive at an estimate of the full sales price, the amount of mortgages outstanding were noted in deeds of trust at the time of sale. Records kept by the county assessor in the various counties provided data on assessed valuations of land and improvements. Other data kept by the assessor as well as abstract companies, were necessary in identifying and determining the sizes of parcels. Such records were also useful in tracing successive sales of a given parcel, portions of an original parcel, or combinations of several parcels.

Illustrations of how the information was collected and recorded are shown in Figures 16 and 17. The sale of a parcel of rural land which changed hands only once during the period 1946-1957, is shown in Figure 16. Figure 17 illustrates a situation with regard to a fairly active parcel of land denoted as "rurban" because, in spite of its proximity to an urban community, it also evidences some of the characteristics of rural land. Further discussion of procedures employed in developing data on land transactions is contained in the Appendix.

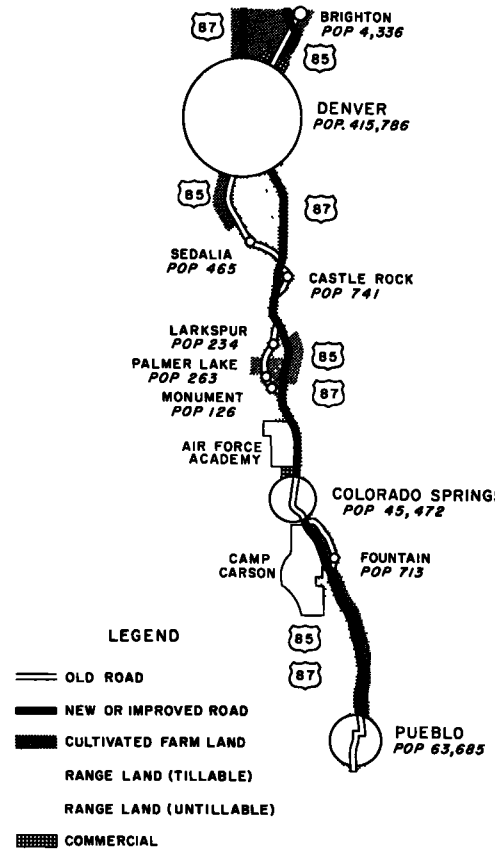

Figure 15. Main highway network in subject area and abutting culture (1958). (Size of circle is proportional to the population of community, 1950.)

An important consideration in the selection of areas for study was the tremendous task of developing information over many miles of road. Although some scheme of sampling might appear to be a feasible way of reducing the quantity of work involved, such was clearly impracticable because of the great variations in the essential characteristics of one transaction as compared with another. In addition, the magnitude of the task could not be completely known from the outset and could be fully realized only when the job of abstracting data was well under way. The data used are the result of efforts to achieve complete coverage of all property transfers within the period 1946-1957, over the segments of highway indicated.

The real property sales schedules were edited for completeness and evidence of reliability of data. With respect to the latter, there were numerous transactions which were omitted because of the strong possibilty that they were not "bona fide" negotiated sales between earnest buyers and sellers; for example, a sale from John Smith to John Smith, Inc.; a sale in settlement of an estate, etc.

Limitations of these data are presented in the Appendix.

Analysis Methods

A meaningful basis for classifying parcels had to be found before any analysis of the data could be undertaken. Experimentation with various bases led to the selection of the following:

REAL PROPERTY SALES SCHEDULE

Description:

COUNTY Douglas PHASE: Rural DATES OF R.O.W. ACQUISITION

4/1/50

RANGE: 95 TWP: 47 TAX DISTRICT: 5 BEFORE AFTER

SECTION(S): 26, 27 PLAT NO: 32 T. NO. 1

DATE OF TRANSFER: 7/6/53 BOOK: 1101 PAGE 243

BUYER: Jones, A. B. SELLER: Smith, C.D.

DESCRIPTION: Sec. 26: S½ NW¼, NE¼ NW¼ NW¼ NE¼, Tract (55A) in NE¼, Sec. 27: Tract (37.37 A) in NE¼ SE¼

WARRANTY DEED REV. STPS.: 9 10 DEED OF TRUST STATED ON W. D. No

TERMS OF DEED OF TRUST: — BOOK: — PAGE: —

Computations:

SALES PRICE: 9000 00 IMPROVEMENT: YES (NO)

ACRES: 252.37 (TIME OF SALE) BASE REP. COST: — (1941)

PRICE PER ACRE W/IMP.: # 36 00 IMPROVEMENT ASSESSMENT —

PRICE PER ACRE LAND ONLY: # 36 00 CONST. COST INDEX: — (DATE OF SALE)

LAND ASSESSMENT: 1310 REPROD.COST AT TIME OF SALE: —

ASSESSMENT PER ACRE: 5.19 DISTANCE INDEX: 4.08 mi.

CLASSIF. OF LAND: HIGHWAY FRONTAGE: 2.12 mi.

CENTER OF GRAVITY: 3.88 X 4.29 Y

REFERENCE POINT: 12 E 20 N

TYPE	ACRES	ASSESSMENT
G-6	111.37	45 50 500 00
G-7	100	3 20 320 00
DF-4	41	12 00 490 00
TOTAL	252.37	1310 00

(910)(x) = (3.5)(40) + (4.5)(80) + (6)(320) + (3)(320) + (1.5)(80) + (0.5)(70)

$x = \frac{3535}{910} = 3.88$

910(y) = (0.5)(120) + (2)(160) + (3.5)(160) + (6)(320) + (6.5)(80) + (7.5)(70)

$y = \frac{3905}{910} = 4.29$

Figure 16.

(a) whether the parcel was sold "before" or "after" the program date of the highway; (b) whether the parcel was improved or unimproved; (c) whether the land was grazing, dry farm, irrigated or rurban-suburban, each as determined by assessed valuation per acre; and (d) whether subject land abutted a "new" highway, an "improved-old" highway or an "old" highway.

This plan of classification provides opportunity for generalizing about the impact of various kinds of highway improvements on the several kinds of land which were identified.

REAL PROPERTY SALES SCHEDULE

Description:

COUNTY El Paso PHASE: Rurban DATES OF R.O.W. ACQUISITION

BEFORE AFTER

RANGE: 98 TWP: 25 TAX DISTRICT: 41

SECTION(S): 36 PLAT NO: 46 T. NO. 4 - (1a-2+1f)-1

DATE OF TRANSFER: 2/11/53 BOOK: 1234 PAGE 567

BUYER: Saban, V. SELLER: Henning, R.

DESCRIPTION: Sale of Tracts # 4A & 4G

WARRANTY DEED REV. STPS.: 13 20 DEED OF TRUST STATED ON W. D. Yes

TERMS OF DEED OF TRUST: Saban assumes DOT BOOK: 1098 PAGE: 991
of 7/2/51 for use of Tesanovic. $50,000 note @ 6% p. a.; payments of $1,500/mo (inc. int) begin. 8/2/51'

Computations:

SALES PRICE: 48,450 / 12,000 } 60,450 IMPROVEMENT: (YES) NO

ACRES: 1.69 (TIME OF SALE) BASE REP. COST: 30,500 (1941)

PRICE PER ACRE W/IMP.: 35,769 IMPROVEMENT ASSESSMENT 14,500

PRICE PER ACRE LAND ONLY: 12,593 CONST. COST INDEX: 131.6 (DATE OF SALE)

LAND ASSESSMENT: 450 REPROD.COST AT TIME OF SALE: 23,176

ASSESSMENT PER ACRE: 266 DISTANCE INDEX: 303'

CLASSIF. OF LAND: HIGHWAY FRONTAGE: 100'

TYPE ACRES ASSESSMENT CENTER OF GRAVITY: 215' X 120' Y
SW COR. 46

REFERENCE POINT: E. N

$(1)(109) + (0.69)(368) = 1.69x$

$109 + 253.9 = 1.69x$

$x = \frac{362.9}{1.69} = 214.7'$

TOTAL

$(1)(100) + (0.69)(150) = 1.69y$

$100 + 103.5 = 1.69y$

$y = \frac{203.5}{1.69} = 120.4'$

Figure 17.

A list of factors was devised which would relate sales price per acre of a given parcel to the possible impact of the highway on its value and use. Only a few of the factors explored proved productive under the criteria that reasonableness and consistency of relationships of impact should be obtainable. The factors which "held up" best under these criteria were:

1. Sales price per acre (adjusted for change in value of the dollar) for improved as well as unimproved parcels.

2. Distance of parcel in miles from an urban community.
3. Size of parcel in acres.
4. Assessed valuation as a basis for classifying land of given types and extent of improvement. For rural land, the following classifications were employed:
   (a) Grazing land—assessed valuation per acre under $10.
   (b) Dry-farm land—assessed valuation per acre, $10 and under $40.
   (c) Irrigated land—assessed valuation per acre, $40 and under $135.

"Rurban"-suburban properties were assumed to be characterized by land valuations which exceed $135 per acre.

Some of the factors which did not prove productive were: highway frontage, distance between the highway and the center of gravity of the parcel, average elapsed time between sales of a given parcel related to the approval date, extent of land improvements and reproduction costs of improvements adjusted by cost indexes.

The relationship which was found to be most revealing of impact was that between adjusted sales price per acre, and the size (in acres) multiplied by distance of the parcel from an urban community.

These relationships, as they refer to various types of land and various types of highway improvements, are presented in a series of scatter diagrams as a part of the findings. These diagrams, plotted on a log-log paper because of the range of values existing in the acre-distance measurement, are intended to serve as a schematic representation of relationships revealing of the impact of the highway on land value and land use. Moreover, they are suggestive of approaches to the important task of predicting the character of impact which occur as a result of highway improvements.

Findings of the Study

Some of the findings of the study relate to the effect of the highway on land value and land use; and others refer to the possibility that there are predictive qualities in certain relationships established in the study.

1. Of significance, first, is the fact that the value of nearly all types of rural land (whether improved or unimproved), as measured by sales price per acre, was greater in the "after" period than in the "before" period. This observation applies to the two forms of highway improvement in which before and after comparisons could be made namely, new highways and improved old highways (Columns 5-10, Table 1). (An old highway would naturally have no "before" and "after" time period within the present study. Data presented in Table 1, on real property transactions along the route of "old" highways allow comparisons between improved and unimproved properties only.) Undoubtedly, some part of such increase in value is attributable to factors other than the existence or impending existence of the highway. The fairly consistent increase in value, however, over most all types of land strongly suggests that the highway has given location value to properties adjacent to it.

2. There are wide differences in the extent of impact on various classes of land according to type of highway improvement adjacent to the highway. A few classifications of land display little or no increase in value, and in one instance, there is a decline in value in the after period, as compared with the before period. These observations suggest that land value is at least partly a function of the type of highway as well as the type of land within the zone of influence of the highway. This contention is further supported by evidence that unimproved parcels, in the case of all classes of land, show a greater relative increase in value than improved properties; and also by evidence that irrigated land parcels, upon which there were improvements at the time of sale, show substantially less appreciation in sales price per acre in the after period than do improved grazing or dry farm land parcels (Table 1). It appears that there is greater appreciation in sales price per acre of parcels located along new highways than alongside improved old highways. This is particularly true in the case of grazing land and "rurban" land whose parcels along improved old highways show virtually no appreciation at all, while substantial increases are noted to have occurred alongside new highways.

3. Indications of impact of the highway on land use are reflected in the differences in number of transactions, size of parcels sold, and distance of parcels from a metro-

politan community for the before period as contrasted to the after period. It seems noteworthy that the number of transactions, particularly of unimproved properties, is substantially greater alongside of new highways than alongside of improved-old highways. The average size of parcels of land sold in the after period was generally less than in the before period. The average distance from a metropolitan community was greater for parcels sold in the after period than in the before period. This fact is consistent with what is already obvious—that expansion of a community occurs in areas made accessible by improved highways and that as land becomes scarce, the parcels available for purchase become farther removed from the community.

4. If it is true that land available for purchase becomes increasingly scarce as one approaches a metropolitan community (for example, Denver, Colorado Springs, or Pueblo) it follows that such scarcity causes land to be more valuable, and hence capable of commanding a higher market price. Also because of the scarcity of available land, it is reasonable that the size of parcels available for purchase are smaller, on the average, the closer said parcels are to a metropolitan community, and that value as reflected by sales price per acre is greater (Columns 19-22, Table 1). In short, then, if what has been said is true, the interrelationship of these two factors—distance from a community and size of parcel—should bear a joint relationship to the value of said parcel.

The tenability of this hypothesis was tested through use of "scatter diagrams" in which a dot "before" the highway and an (x) "after" the highway was plotted for each parcel sold according to the product of the size of the parcel and its distance from Denver, Colorado Springs, or Pueblo (Figs. 18-23). (See the Appendix for a discussion of the rationale behind the determination of which city, Denver, Colorado Springs, or Pueblo, should be used in making the distance measurement.)

The results shown in Figure 8 and 19, for "new" highways, are interesting. In the case of grazing land, transactions in the "before" period take no discernible pattern; that is, sales price per acre and size-distance (measured by acre-miles) appear to be randomly distributed (Fig. 18). This is the pattern which one might expect because the highway is not in existence, and hence, can not give location value to parcels which are sold. In the "after" period, however, the data tend to show an inverse relationship between sales price per acre and acre-miles of parcels sold; that is, the smaller the acre-miles factor, the larger the sales price per acre, and conversely. This result makes tenable the hypothesis proposed earlier; namely, that a highway reflects location value on abutting land by making it more accessible, and hence, more desirable for purchase. The more desirable land is for purchase, the more scare it becomes and the higher its price. The results for "rurban"-suburban land (Fig. 19), are similar to those for grazing land, though they are not quite so sharp. Nonetheless, "before" period transactions appear to be randomly distributed, while "after" period transactions display the expected inverse relationship between sales price per acre and acre-miles.

Further evidence of the reasonableness of this notion is found in the relationships in the case of parcels which abut "improved-old" highways (Fig. 20) and parcels which abut "old" highways (Figs. 21, 22, and 23). While the relationship between sales price per acre and acre-miles is more evident in some instances than in others, it is apparent that, in general, it is upheld. An "improved-old" highway, for which there is a "before" and "after" period to which transactions can be assigned, should reflect such relationship in both periods simply because of impact of the accessibility provided by the "old" highway before it was improved (that is, before another lane was added). The same line of reasoning applies to the several parcels adjacent to "old" highways.

In the case of dry farm land and irrigated land parcels the hoped for relationships were obscured by the fact that a particular segment of "new" highway which was involved was very close to an "old" highway. The implication is that subject parcels would reflect a relationship between sales price per acre and acre-miles in both the "before" and "after" periods simply because they were influenced by the long existing accessibility of the "old" highway nearby (Figs. 11-15).

TAB

CHARACTERISTICS OF REAL PRO
BY TYPE OF PAR

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
	Number of Transactions				Adjusted Sales Price Per Acre				Change in Adj Sales Price Pe	
	Improved Parcels		Unimproved Parcels		Improved Parcels		Unimproved Parcels		Improved Parcels	Uni Pa
	Before	After	Before	After	Before	After	Before	After		
					(In Dollars)				(In Percen	
New Highways										
Grazing Land	10	16	7	16	15.14	48.35	12.56	151.15	+219.4	+
Dry Farm Land	22	12	22	34	99.83	318.29	56.34	288.94	+218.8	+
Irrigated Land	22	15	6	18	314.89	614.54	148.95	1465.07	+ 95.2	+
Total or Average	54	43	35	68	50.49	72.69	34.99	235.53	+ 44.0	+
Improved-Old Highways										
Grazing Land	45	13	12	14	39.65	36.64	8.89	9.82	- 7.6	+
Dry Farm Land	16	22	13	9	81.75	308.29	89.85	381.46	+277.1	+
Irrigated Land	4	--	2	--	907.50	--	309.00	--	--	
Total or Average	65	35	27	23	441.41	81.38	9.92	12.73	--	
Old Highways										
Grazing Land	9		4		24.96		159.82			--
Dry Farm Land	29		6		194.13		61.57			--
Irrigated Land	16		3		355.82		465.78			--
Total or Average	50		13		129.23		112.22			--
Grazing Land										
New Highways	10	16	7	16	15.14	48.35	12.56	151.15	+219.4	+
Improved-Old Highways	45	13	12	14	39.65	36.64	8.89	9.82	- 7.6	+
Total or Average	55	29	19	30	34.33	45.36	9.48	19.88	+ 32.1	+
Dry Farm Land										
New Highways	22	12	22	34	99.83	318.29	56.34	288.94	+218.8	+
Improved-Old Highways	16	22	13	9	81.75	308.29	89.85	381.46	+277.1	+
Total or Average	38	34	35	43	88.49	311.72	60.24	299.60	+252.3	+
Irrigated Land										
New Highways	22	15	6	18	314.89	614.54	148.95	1465.07	+ 95.2	+
Improved-Old Highways	4	--	2	--	907.50	--	309.00	--	--	
Total or Average	26	15	8	18	318.71	614.54	149.92	1465.07	+ 92.8	+
Rurban-Suburban Land										
New Highways	8	40	7	32	13746.00	12057.00	1989.00	8292.00	- 12.3	+
Improved-Old Highways	5	5	4	3	20042.00	9344.00	6455.00	774.00	- 53.4	-
Total or Average	13	45	11	35	16168.00	11756.00	3974.00	7645.00	- 27.3	+

1. Transaction classified "before" if sale took place on or before approval date of construction of highway in question. "After" refers to sale after approval date.
2. Average Distance of Parcel to City: See "Location and Identification of Abutting Parcels" (Appendix).
3. Adjusted Sales Price Per Acre is sales price per acre adjusted for price changes by applying price indexes corresponding to type of land sold, i.e., Grazing, Dry Farm, or Irrigated.

LE 1

PERTY TRANSACTIONS CLASSIFIED
CEL AND HIGHWAY

(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
sted Acre	Average Size of Parcels Sold				Average Distance of Parcel to City				Average Acre-Miles			
proved cels	Improved Parcels		Unimproved Parcels		Improved Parcels		Unimproved Parcels		Improved Parcels		Unimproved Parcels	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
		(In Acres)				(In Miles)				(Acres X Miles)		
103.4	691.00	487.00	455.00	164.00	27.30	29.30	10.30	19.40	12842.00	17379.00	4357.00	1680.00
412.8	75.00	23.00	72.00	61.00	8.00	5.50	6.30	18.40	832.00	201.00	698.00	200.00
889.0	28.00	15.00	55.00	5.00	4.00	4 00	4.90	3.80	158.00	36.00	104.00	26.00
573.1	170.00	188.00	146.00	70.00	9.90	11.20	6.90	14.80	2781.00	6535.00	1328.00	502.00
10.5	553.00	206.00	1386.00	2446.00	15.10	10.90	9.00	12.20	968.00	270.00	549.00	2628.00
326.5	180.00	24.00	16.00	30.00	8.90	6.80	6.60	4.10	3122.00	322.00	218.00	361.00
--	1.00	--	1.00	--	8.00	--	7.90	--	8.00	--	8.00	--
--	427.00	92.00	624.00	1501.00	13.10	8.30	7.80	9.00	1439.00	303.00	350.00	1741.00
	371.00		79.00		24.50		16.70		11944.00		1557.00	
	52.00		82.00		11.30		9.60		610.00		807.00	
	69.00		9.00		8.60		6.90		521.00		65.00	
	119.00		64.00		13.70		11.20		2670.00		867.00	
103.4	691.00	487.00	455.00	164.00	27.30	29 30	10.30	19.40	12842.00	17379.00	4357.00	1680.00
10.5	553.00	206.00	1386.00	2446.00	15.10	10 90	9.00	12.20	968.00	270.00	549.00	2628.00
109.7	578.00	361.00	1043.00	1229.00	17.30	21 10	9.50	16.00	3127.00	9709.00	1952.00	2122.00
412.8	75.00	23.00	72.00	61.00	8.00	5.50	6.30	18.40	832.00	201.00	698.00	200.00
326.5	180.00	24.00	16.00	30.00	8.90	6.80	6.80	4.10	3122.00	322.00	218.00	361.00
397.3	119.00	24.00	51.00	55.00	8.40	6.30	6.50	15.40	1796.00	279.00	520.00	234.00
889.0	28.00	15.00	55.00	5.00	4.00	4.00	4.90	3.80	158.00	36.00	104.00	26.00
--	1.00	--	1.00	--	8.00	--	7.90	--	8.00	--	8.00	--
877.2	24.00	15.00	42.00	5.00	4.60	4.00	5.60	3.80	135.00	36.00	80.00	26.00
316.9	0.58	0.90	2.80	0.80	0.46	7.33	1.30	1.10	0.28	8.20	14.40	1.40
88.0	2.63	1.78	1.67	6.67	1.12	0.60	1.18	3.03	3.20	1.30	1.95	22.87
92.4	1.37	1.00	2.39	1.30	0.71	6.58	1.26	1.27	1.40	7.43	9.87	3.24

4. Grazing Land classified as land assessed at less than $10 per acre at time of sale.
5. Dry Farm Land classified as land assessed at $10 and under $40 per acre at time of sale.
6. Irrigated Land classified as land assessed at $40 and under $135 per acre at time of sale.
7. Rurban-Suburban Land classified as land assessed at $135 or over per acre at time of sale.

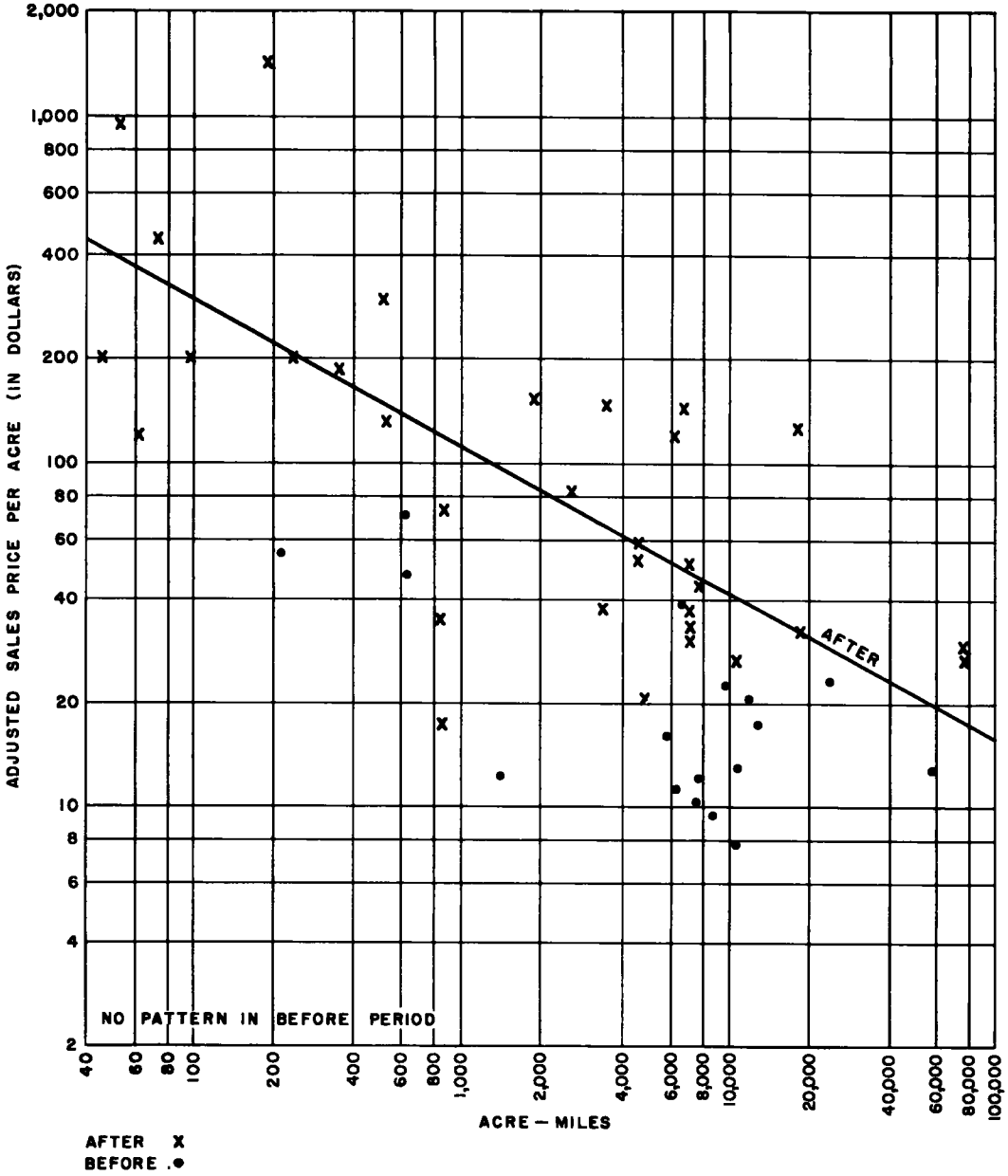

Figure 18. Relationship of sales price per acre and acre-miles:grazing land parcels before and after new highways.

Implications of the Findings

The supposition that a highway gives location value to abutting land seems to be fairly clear from the evidence derived in the study. Such location value is simply a manifestation of the fact that land made accessible by an improved road will become more valuable land. When an existing road is improved, some enhancement in value in abutting land should be expected but, as shown in the present study, the relative increase in value is not as great as in the case of a new highway improvement. This may

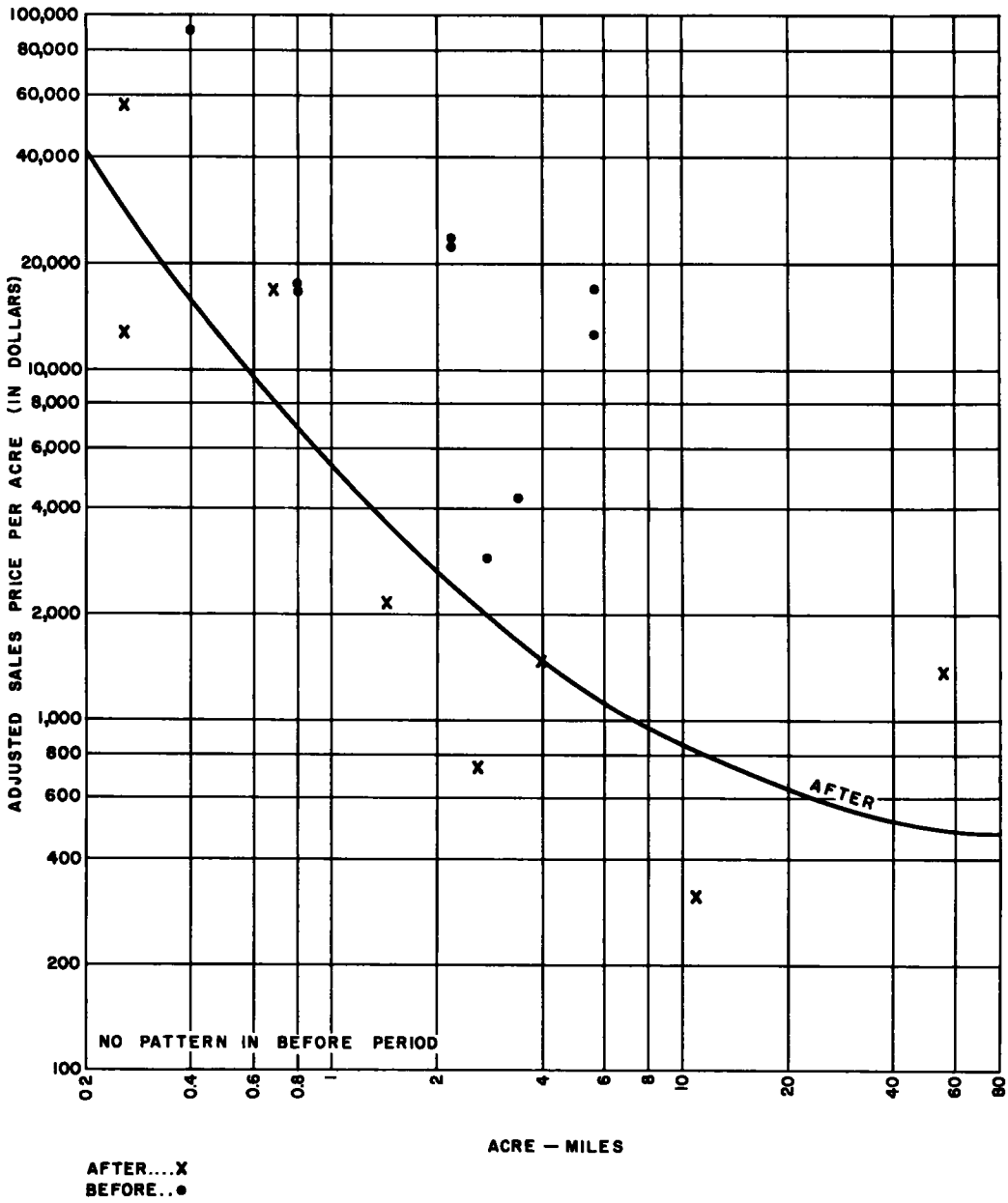

Figure 19. Relationship of sales price per acre and acre-miles: suburban-rurban land parcels before and after new highways.

be explainable by the fact that land adjacent to an "improved-old" highway has simply been made more accessible by virtue of the improvement made to it. The tentacles of urban expansion into suburban and rurban areas are inclined to follow the lines of least resistance, in proximity to major access routes. Such forces of expansion have been present in Denver, Colorado Springs and Pueblo for at least 10 years. Because of the scarcity of land it is reasonable to assume that land values and the land use

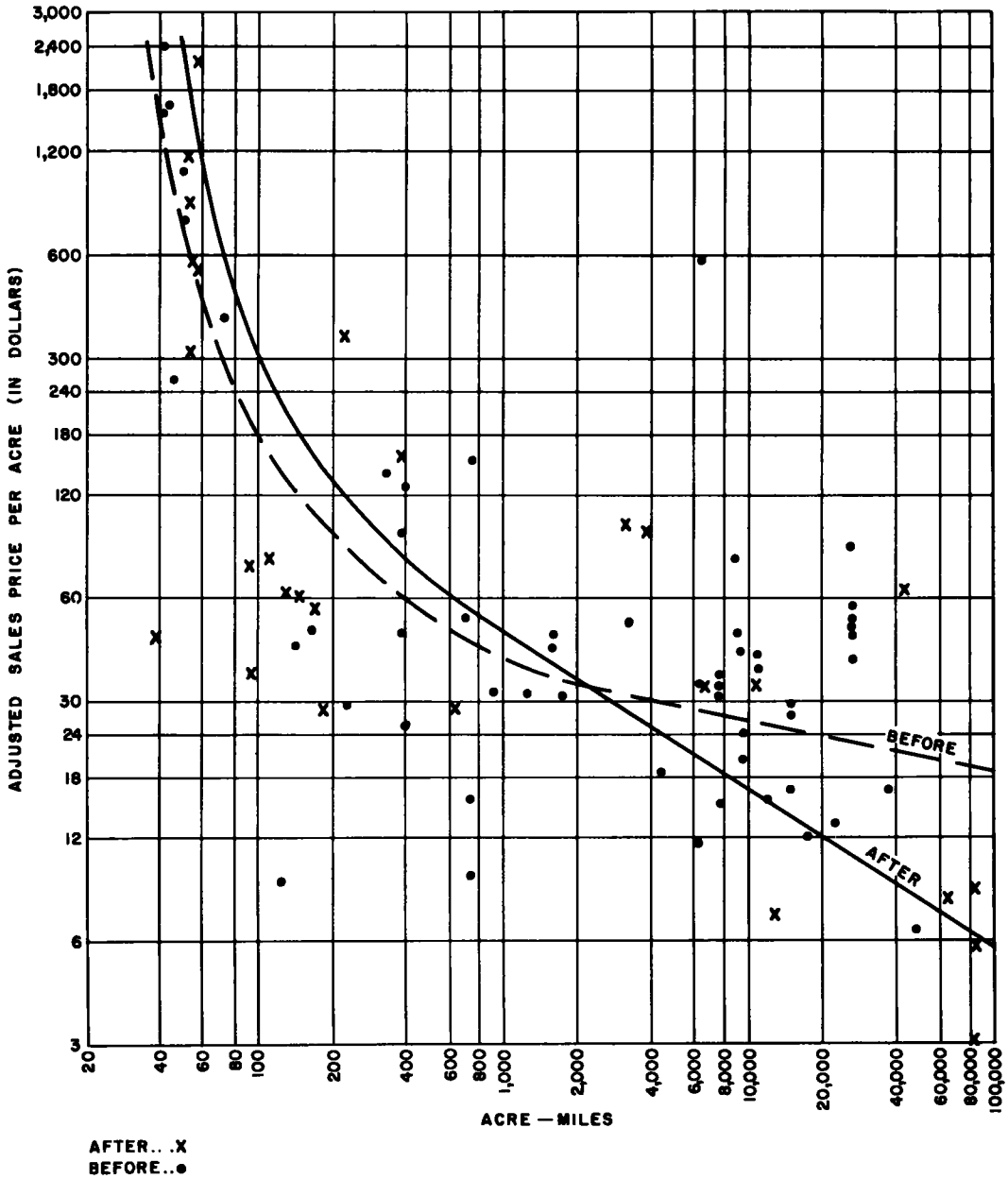

Figure 20. Relationship of sales price per acre and acre-miles:grazing land parcels before and after improved-old highways.

structure along an established, though improved, highway would not be affected as much by the improvement as land "opened up" by a "new" highway.

Inasmuch as land has value in terms of the use to which it is put, it would seem reasonable, also, that an improved parcel, particularly one which is intensively improved and comparatively small in size, would be less susceptible to forces which might tend to alter its present use. This reasoning is supported by the fact that, generally speaking, improved properties reflect less impact from highway location than do unimproved properties.

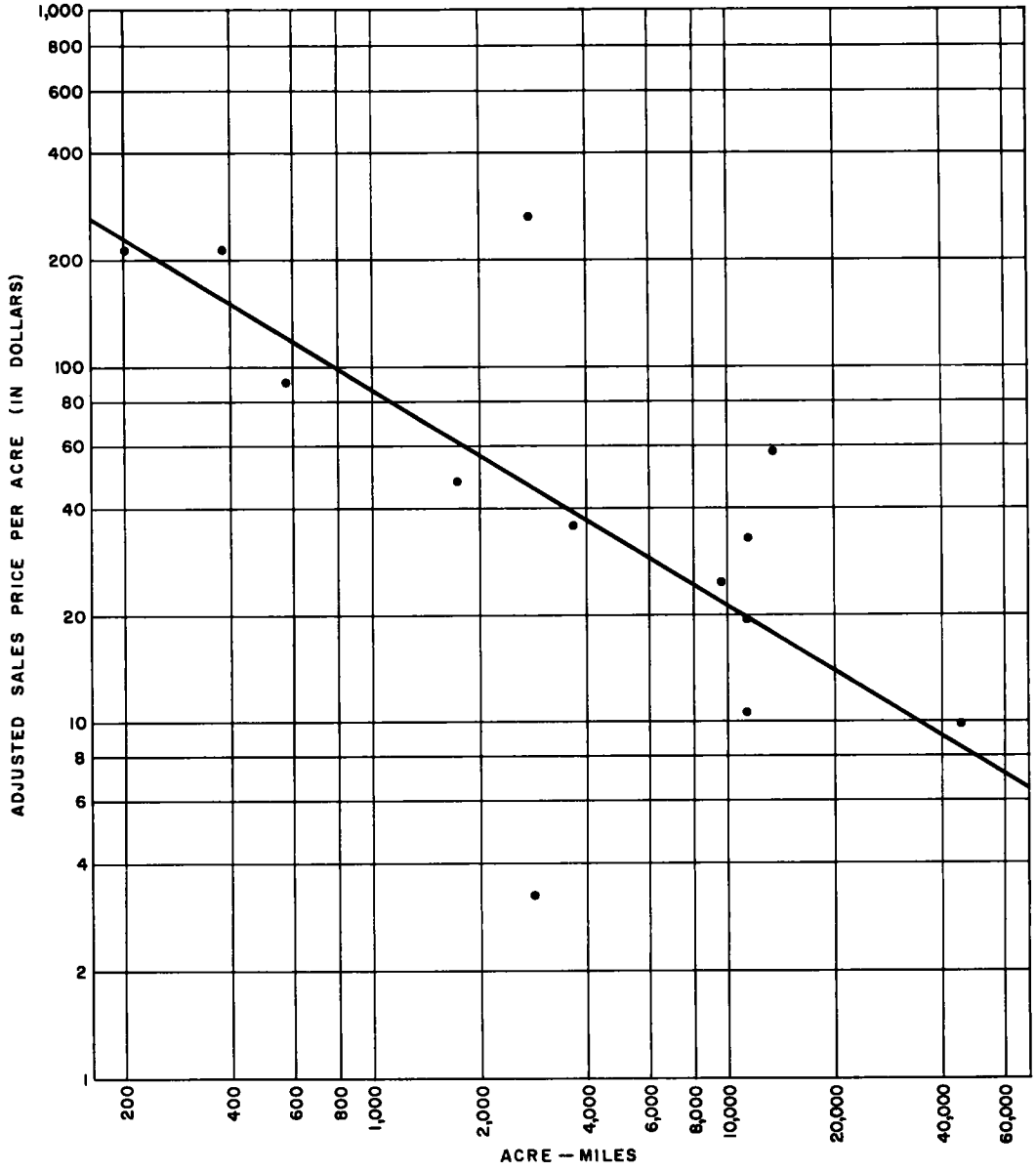

Figure 21. Relationship of sales price per acre and acre-miles: grazing land parcels, old highway, 1946-57.

This same line of reasoning applies to differences in impact noted between types of land sold in the "before" period as compared with the "after" period. Improved grazing land which has the lowest use value per acre (in terms of assessed valuation), reflects the greatest relative amount of impact from the highway, while rurban-suburban land, which has the highest use value per acre, reflects the least relative amount of impact from the highway. These observations indicate that the more valuable the land is in its present use, the less will be the influence of a highway improvement adjacent to it.

The notion that the size of the parcel and its distance from a metropolitan community

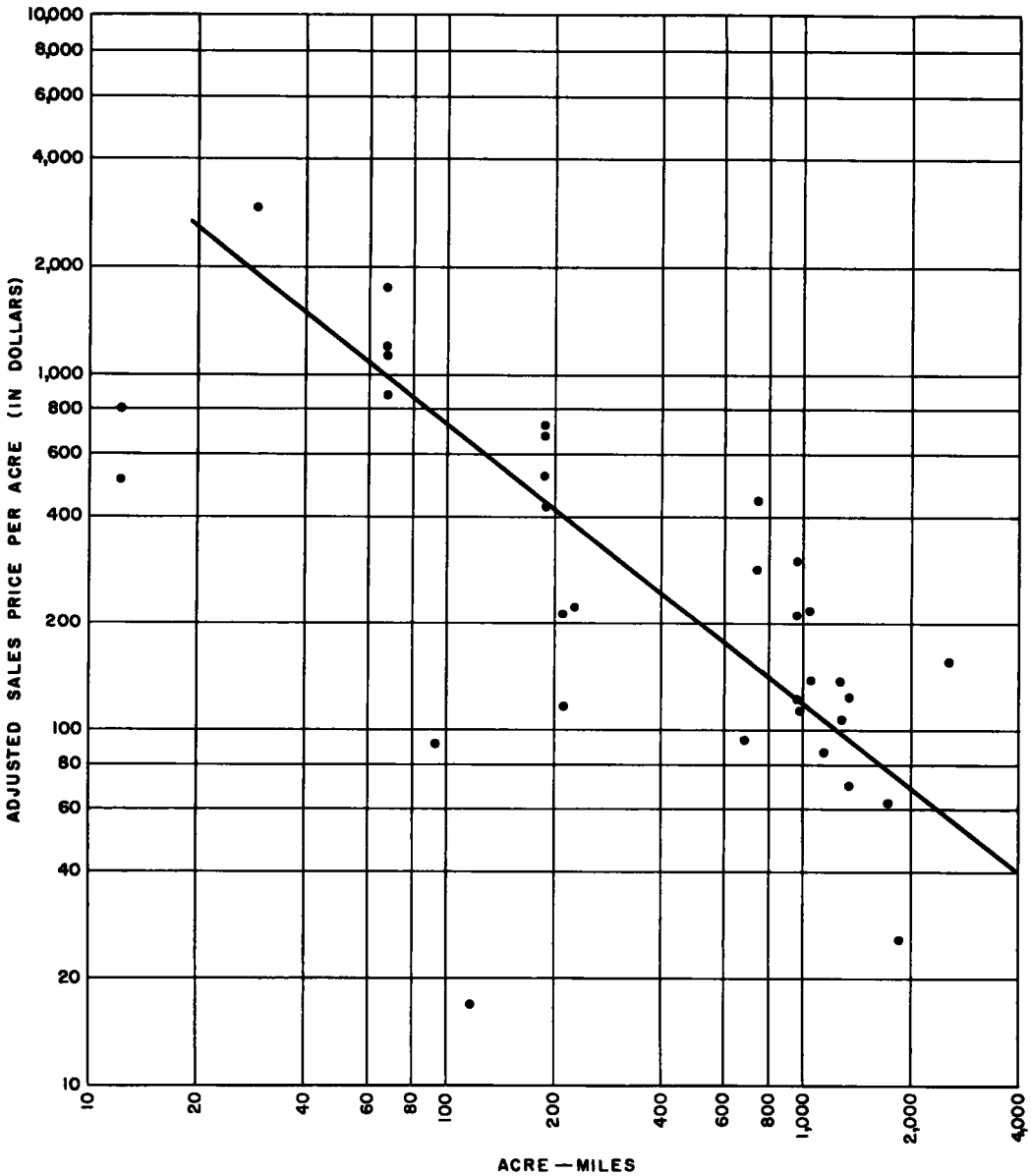

Figure 22. Relationship of sales price per acre and acre-miles: dry farm land parcels, old highway, 1946-57.

are jointly related to the value of said parcel has been examined in this paper. It was believed that some predictive qualities of land value relative to highway location might be provided if a relationship could be established for parcels included in the study. Because highways make land accessible to a community and because accessibility is a prime contributor to the value of land, then it follows that the relationship of size-distance to sales price per acre shows to what extent a given parcel of land is made accessible by a given highway. For example, one might expect to find no discernible relationship between size-distance and sales price per acre in the case of parcels sold "before" the program date of a "new" highway; but "after" said program date, such relationship should appear.

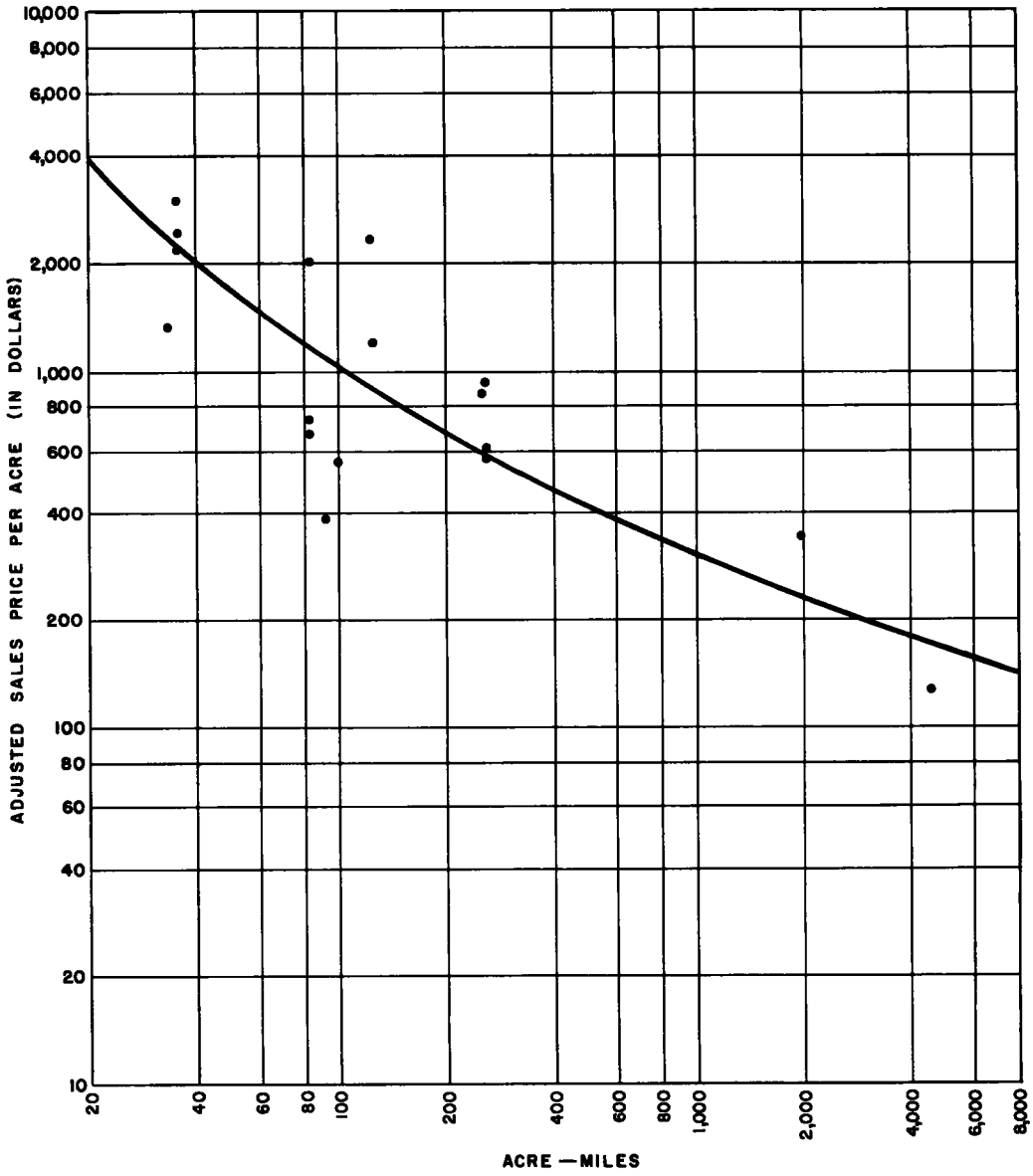

Figure 23. Relationship of sales price per acre and acre-miles: irrigated land parcels, old highway, 1946-57.

If these relationships do have predictive qualities, it would seem that they are in terms of providing the highway planner with some yardsticks as to what impact might be expected for given types of parcels in relation to the given kind of highway improvement whose location make such land more or less accessible.

The findings of this phase of the study, as well as the methodology employed, are regarded as somewhat tentative in nature. Not only is it probably too early to tell what the ultimate impact of the highway network will have on land value and land use; but in important respects there has been set forth in Colorado some rather fundamental

generalizations and a new slant on methods of analysis of impact which, of course, must stand the tests of further studies.

ACKNOWLEDGMENT

Acknowledgment is made to the Planning and Research Division, Colorado Department of Highways, for use of the data and the careful preparation of the Figures, and tables in this paper.

Appendix

COLLECTION OF SALES TAX DATA

The analysis of business activity in this study requires quarterly sales tax collections by various business groups over the period 1946-1957. Information covering these business classes had to build up from reports of sales tax collections from individual businesses. A complete search of the records month by month was necessary to develop a 12-yr business history of the individual store. Identity of the business had to be established; in addition, change in ownership, temporary closing of the store and conversion in type of business had to be recognized and dealt with. For the years 1956 to 1957, such information was more handily acquired than for the years 1946 to 1955, because the records for these later years were kept on electrically operated rotary filing drums. Data for the earlier years, 1946 to 1956, were compiled from microfilms.

The form used in the compilation of sales tax data is shown in Figure 24, on which have been recorded examples of the entries made. The top part of the form was cut off after the entries were made in order to conceal the identity of the business.

COMPUTATIONS FOR THE CENTERED 4-QUARTER MOVING AVERAGES

Data of the sort shown in Figure 24, were summarized by quarters for the years 1946 to 1957 for each business group having four or more stores doing business in each of the years 1946 to 1957. Data were rounded to the nearest dollar.

Figure 25 shows a summary of total sales tax collections for Brighton, Colorado. The circled figures are the number of firms from which sales taxes were collected.

Centered 4-quarter moving averages were obtained by averaging together successive quarterly totals and "centering" the averages so that each average could be referred to a given quarter. This procedure is illustrated step by step, taking the first few years of sales tax collections for Brighton from Figure 25.

1. Total collections for the four quarters, 1946, is $78,746. Dividing by four gives $19,686, the average quarterly collection for these four quarters.
2. "Moving" now to the total collections for the 2nd, 3rd, and 4th quarters of 1946, and 1st quarter, 1947, gives $84,336. Dividing by four gives $21,084, the average quarterly collections for the second successive group of four quarters. In the next step, the 3rd and 4th quarters of 1946, and the 1st and 2nd quarters of 1947, are added together and the result divided by four, which gives an average per quarter of $22,837.
3. Each of these averages is logically not related to any given quarter. For example, the average $19,686, obtained from the four quarters of 1946, would pertain to a time halfway between the end of the 2nd quarter and end of the 3rd quarter. This difficulty is remedied by "centering" the moving averages. For instance, the average of $19,686 and $21,084, or $20,385, can be referred to the 3rd quarter of 1946. This figure is the "4-quarter centered moving average" for the 3rd quarter, 1946.

This process is represented schematically in table on page 63.

Figure 26 shows the 4-quarter centered moving averages of total sales tax collections in Brighton over the period 1946-1957. Note that there are no centered moving averages for the first two quarters of 1946, nor the last two quarters of 1957. Information for these four quarters has been sacrificed in order to obtain a description of the general movement of the data over the years.

Year	Quarter	Collections	Moving Total	Moving Average	4-Quarter Centered Moving Average
1946	1	15,459			
	2	17,766			
	3	22,272	78,746	19,686	20,385
	4	23,249	84,336	21,084	22,248
1947	1	21,049	93,803	23,451	
	2	24,777			
	3	31,739			

QUARTERLY ESTIMATES OF TOTAL COLORADO SALES TAX COLLECTIONS FOR VARIOUS BUSINESS GROUPS 2ND QUARTER, 1954 TO 4TH QUARTER, 1957

Statistics of sales tax collections for various business groups have been available from the Colorado Department of Revenue for many years. Because of pressing demands of other work made on the Department and because of temporary disruption in the production of statistical data during the installation of data processing equipment, these data have not been available since the 3rd quarter of 1954. The analysis conceived for this study calls for the construction of a time series of sales tax data for individual business groups statewide so that comparisons can be made to companion sales tax data for selected communities. Such a program requires estimates of statewide sales tax collections classified by business group for the period from the 3rd quarter, 1954 to the 4th quarter, 1957.

Present Owner A Shapin — Name of Business Shapin's Bicycle Shop — Owner No 3-61
Previous Owner G Bradwell — Previous Name G & V. Market — " " 3-42
Next Prev " D Merry — Next Prev Name Merry's Inn — " " 3-22
Third Prev " S. Teglovic — Third Prev Name 310 Restaurant — " " 3-20
Fourth Prev " M. Predovich — Fourth Prev Name 310 Restaurant — " " 3-17

CUT HERE AND DESTROY TOP PART

	Tax Ser #	Location	Bur Class	Tax	Ownership	Beg Date	Close Date	Owner No
47-649C		Castle Rock 310 So. Main	2-2	Q		7/11/56	/ /	
47-410B		"	3-4	M		4/30/55	10/15/55	" "
47-375D		"	3-6	Q		8/3/53	3/22/55	" "
47-710A		"	3-6	Q		11/1/51	6/29/53	" "
47-620A		"	3-6	M		3/4/46	6/13/48	" "

SALES TAXES PAID (Includes refunds and assessments)

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC.	TOTAL
1957			19 21			35 61			72 12			40 21	
1956									3 11			7.15	
1955			12 01	72.91	83.90	59 96	63.91	42 59	30 02	110 97			
1954			30 62			37.11			44 22			10 40	
1953			1 11			14			7 77			29.31	
1952			3 72			5.21			8 61			4 19	
1951												03	
1950													
1949													
1948	5 11	5 43	6 13	2.55	1 13	12							
1947	5 17	6 32	5.18	8.84	9 18	10 41	15 26	11.23	10 36	14 55	9 47	10 01	
1946			10	1.20	2 40	3 16	4.18	6.20	5 30	14.76	8 29	9 39	
TOTAL													

Figure 24.

The procedures used in making these estimates follow closely one of the more classical, empirical methods for dealing with time series data. This method would suppose in the present case that a time series of sales tax collections is composed of four components: (1) trend (T) which characterizes the long-term, inherent growth forces in the series; (2) cyclical fluctuation (C) which denotes the long-term, somewhat cyclical, variations which occur in varying degrees in all series; (3) seasonal variation (S) which denotes the periodic fluctuation which occurs from quarter to quarter within the span of a year; and (4) residual variation (R) which denotes that which is left over when T, C, and S are filtered out.

It is supposed, also, that each of these components enters into the original series (O) in such a way that one may symbolically represent the original series as the product of the four components; that is, $O = T \times S \times C \times R$. Because each of these components tends to behave in a manner which is predictable, estimates for the missing quarters are made by dismembering the original series into its components according to the formulation $O = T \times S \times C \times R$.

Procedures used to isolate each of the individual factors often involve several steps, the result of each step yielding a combination of components. A practical procedure for developing estimates of the values of T x C is by the method of "4-quarter centered moving averages" explained earlier. Values of T are then derived by "fitting" or approximating the movement of these 4-quarter centered moving averages by selecting from a number of possible mathematical curves one which appears to describe the series fairly well. On the other hand, the fitting might be done freehand.

Cyclical variation is not so conveniently projected mathematically as are the values of T, and freehand projections are often used. For short periods of time, freehand projections appear to give results that are usually quite as good as those obtained using mathematical formulations.

Present Owner _____ Name of Business _____ Owner No ___
Previous Owner _____ Previous Name _____ " " ___
Next Prev. " _____ Next Prev. Name _____ " " ___
Third Prev." _____ Third Prev. Name _____ " " ___
Fourth Prev. " _____ Fourth Prev. Name _____ " " ___

CUT HERE AND DESTROY TOP PART

Tax Ser # | Location: Beichroa | Bus. Class: Totals All Groups | Tax | Ownership | Beg. Date | Close Date | Owner No.

SALES TAXES PAID (Includes refunds and assessments)

YEAR	Jan	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1957		(225)	16527	.	(227)	53704	.	(237)	61582		(237)	57014	.
1956	.	(234)	13856	.	(249)	54389	.	(248)	52530	.	(259)	47990	.
1955		(224)	17234	.	(219)	57088	.	(230)	57652	.	(231)	54240	.
1954		(212)	38718	.	(219)	46068	.	(230)	48072	.	(228)	50239	.
1953		(217)	46710	.	(219)	50436	.	(223)	51790	.	(217)	47967	.
1952		(219)	38746	.	(215)	45203	.	(229)	47266	.	(226)	50857	.
1951	.	(215)	39530		(218)	41539		(216)	46638	.	(218)	43756	
1950		(224)	32646		(224)	37124	.	(231)	48361	.	(221)	41789	.
1949		(207)	29000	.	(210)	35532		(211)	39793		(212)	35864	.
1948		(141)	29144	.	(162)	32348	.	(157)	36075		(160)	33467	
1947		(175)	21049	.	(179)	24771		(181)	31739		(188)	33726	
1946		(119)	15459		(177)	17766	.	(189)	22278		(186)	23299	
TOTAL	.				.								

Figure 25.

Values of S resulting in an index of seasonal variation are obtained by dividing the values of T x C for each quarter into the corresponding quarterly values of the original series. Symbolically the result of this division is S x R, since T x C is divided into T x C x S x R. The effect of R is then removed from S x R by simply taking a median of all the first quarter values of S x R, all second quarter values of S x R, etc. The hoped-for result is an index which typifies the variation in sales tax collections from one quarter to the next for any year.

The step-by-step procedure actually employed to obtain quarterly estimates of Colorado sales tax collections for various business groups is outlined:

1. Tax figures for each of the quarters in the years 1946-1953, and the first two quarters of 1954, were obtained from the Colorado Department of Revenue covering each of the business groups listed in step 4.
2. Tax collections for a given business group were expressed as proportions of total statewide tax collections quarter by quarter. Proportions were used in preparing estimates, rather than the actual collections. Because proportions tend to be less variable than actual collections, estimates based on their use are more reliable.
3. The method of "4-quarter centered moving averages" was applied to the figures derived from step 2, and the results were placed on graphs to facilitate the selection of the appropriate curve for deriving trend.
4. Values of T were developed for each business group according to the following
   a. Apparel group—mathematical fit given by the equation, $y = 0.0556 + 0.013(0.8976)^x$ where y is the value of T corresponding to x quarters from 3rd quarter, 1946, when x = 0. For the 4th quarter, 1946, x = 1, etc.
   b. Automobile group—freehand fit.
   c. Automobiles and bicycles—freehand fit.

Present Owner _____ Name of Business _____ Owner No ___
Previous Owner _____ Previous Name _____ " " ___
Next Prev " _____ Next Prev Name _____ " " ___
Third Prev " _____ Third Prev Name _____ " " ___
Fourth Prev " _____ Fourth Prev. Name _____ " " ___

CUT HERE AND DESTROY TOP PART

Tax Ser # ___ Location Brighton Bus. Class Total All Groups Tax ___ Ownership ___ Beg. Date / / Close Date / / Owner No ___

4-QUARTER CENTERED MOVING AVERAGE (000's)

SALES TAXES PAID (Includes refunds and assessments)

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT	OCT	NOV	DEC	TOTAL
1957			51.			54.		.		.			
1956			52	.		50			50.	.	.	50.	
1955			52.			54.			54.		.	53	
1954			45	.		46		.	47.			49	
1953	.	.	50			49.			48.	.		46	
1952			44			45	.		47		.	49	
1951			43	.		42.		.	43.	.		43.	
1950			38			40	.		41			42	
1949			34			35	.	.	36	.		36	
1948			32			33			33			34	
1947			24		.	27			29	.		31	
1946									20			22	
TOTAL						.	.	.					

Figure 26.

d. Filling and service stations—horizontal line at the mean of the series.
e. Food group—least squares linear fit given by the equation, y = 0.25180 + 0.00006x where x and y have the same meaning as in a.
f. Grocery stores, motor stores, and meat markets—least squares linear fit given by the equation, y = 0.1661 + 0.00021x where x and y have the same meaning as in a.
g. Restaurants, taverns, cafeterias, etc.—horizontal trend at y = 0.045.
h. Hotels, cottage camps, resorts, etc.—horizontal trend at y = 0.008.
i. Furniture group—least squares linear fit given by the equation y = 0.05309 + 0.00018x where x and y have the same meaning as in a.
j. Merchandise group—freehand fit.
k. Drug stores—horizontal trend at y = 0.030.

5. Estimates of the values of T for the missing quarters were prepared for each business group by extrapolating the series obtained in step 4. An example of this analysis is shown in Figure 27 for the apparel group of businesses.

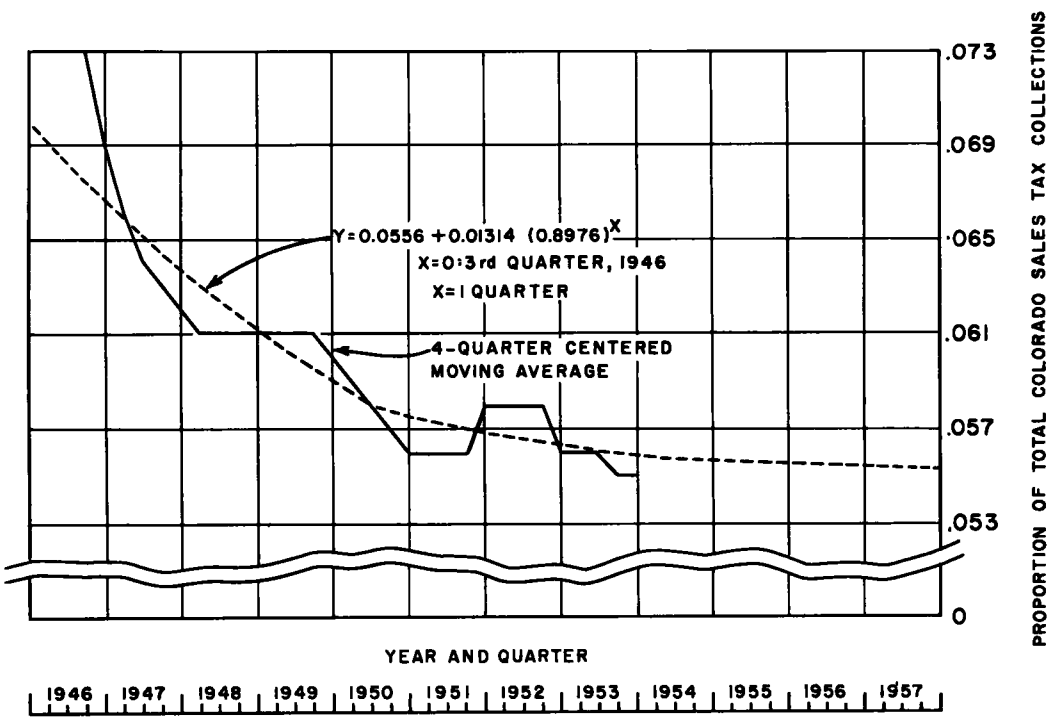

Figure 27. Four-quarter centered moving average of quarterly sales tax returns for the apparel business group as a proportion of total Colorado quarterly tax returns, June 1946- December 1953, fitted mathematically and projected to 4th quarter 1957.

6. The cyclical component, C, was estimated freehand by noting the historical relationship between the cyclical pattern of the series under study and the total sales tax collections statewide. This estimate was then superimposed upon the estimates of T obtained from step 5. Figure 28 shows the estimates of C superimposed upon values of T for grocery stores, motor stores, and meat markets.

7. Seasonal indexes were computed for each of the business groups in step 4. The seasonal indexes found were compared to the seasonal variations revealed by figures for the West Region in the Monthly Report of Retail Trade, Bureau of the Census for the same business groups in the period 1954-1957. No significant departures from the normal seasonal pattern were observed for the Western Region during this period, thereby giving some assurance that no radical departures from the general seasonal pattern for the various business groups had occurred in Colorado during this period.

8. Estimates obtained from step 6. were then adjusted for seasonal variation; that is, seasonal variation, S, was combined with T x C to give estimates of T x C x S.

9. Minor adjustments were made in the estimates of quarterly values obtained from step 8. The sum of the estimates of proportions for the individual business groups for each quarter was forced to equal quarterly estimates of composite series

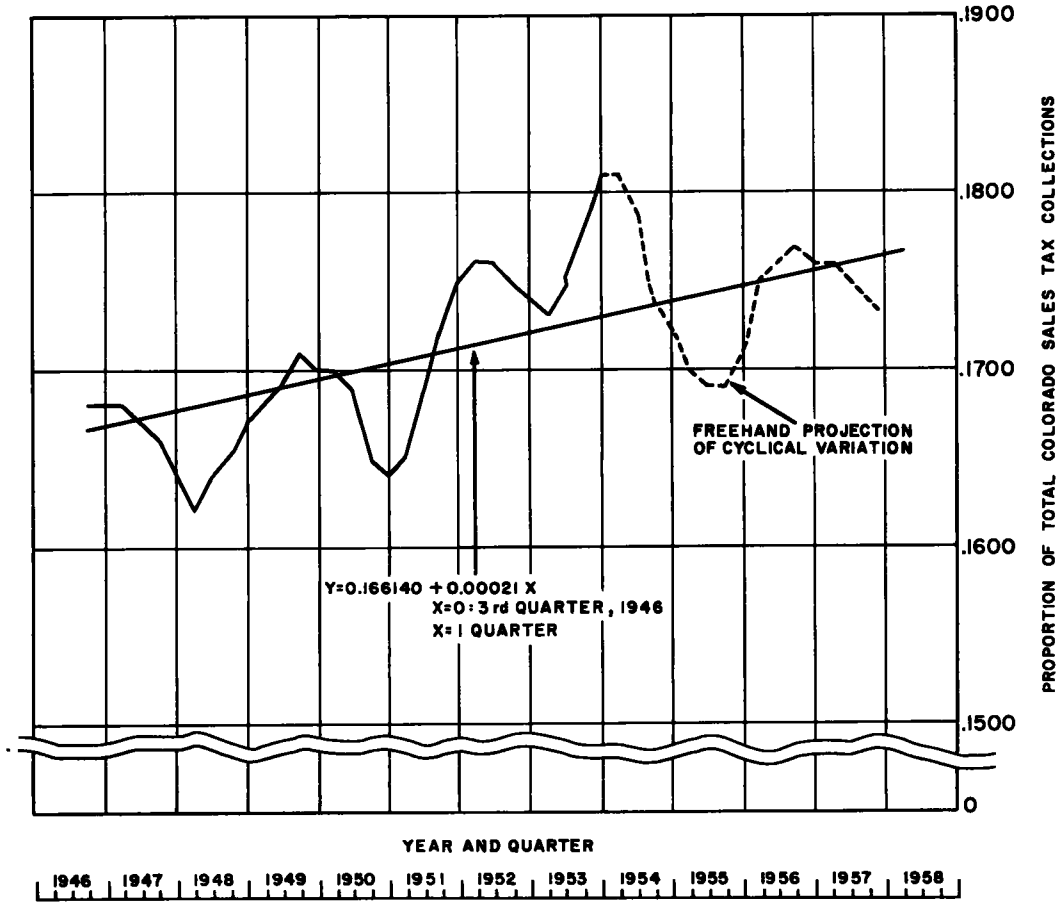

Figure 28. Centered moving average of sales tax collections from grocery stores, motor stores and meatmarkets in Colorado fitted by least squares straight line and freehand projection of cyclical variation, 1946-1957.

prepared specifically for this purpose. That is, the combined quarterly estimates of the apparel group, automobile group, food group, furniture group, and general merchandise group were compared to quarterly estimates of the sum of these groups and appropriate adjustments made.

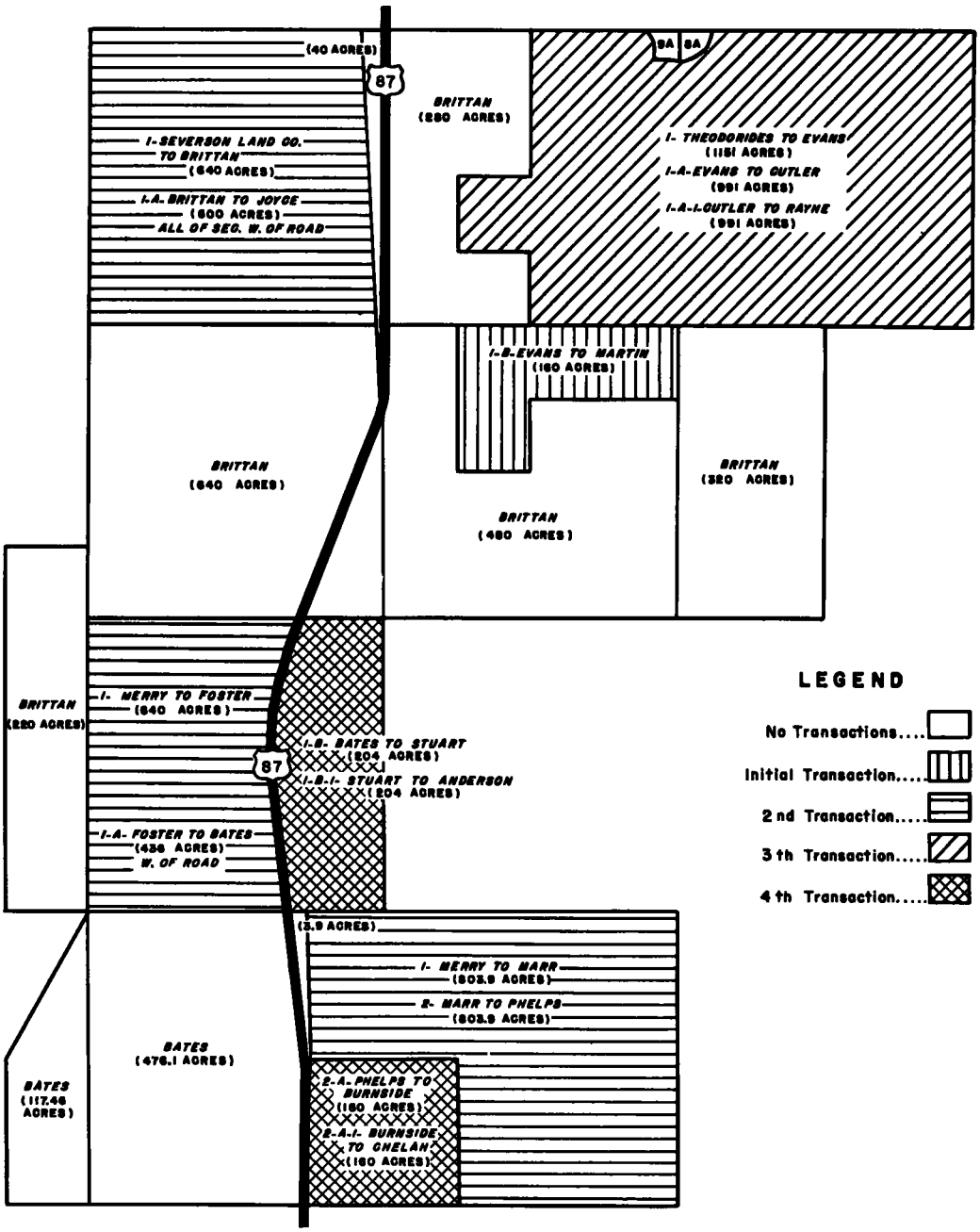

Figure 29. Example of technique to trace land transfers in rural areas (Jan. 1, 1946 to May 1, 1958).

TABLE 2

QUARTERLY SALES TAX COLLECTIONS FOR SELECTED BUSINESS GROUPS COLORADO, 1946-1957[1] (DOLLARS)

Year	Quarter	Total Colorado	Apparel Group Total I	Automotive Group Total[2] II	Automobiles & Bicycles[3] II_2	Filling & Service Stations[3] II_3	Food Group Total III	Grocery Stores & Meat Markets Motor Stores[4] III_4	Restaurants, Taverns & Cafeterias[4] III_6	Hotels, Cottage Camps, Resorts, Boarding Houses[4] III_8	Furniture Group Total IV	General Merchandise Group Total V	Drug Stores[5] V_2
1946	1	3792199	314886	399489	297254	76509	992442	646839	204341	26709	148130	894878	144450
	2	4087823	313279	503304	242870	78953	1082534	704472	223642	27889	187112	879276	152305
	3	4811195	329394	613260	300046	95513	1320610	793122	307901	55637	221436	1033449	168388
	4	4978092	359035	666602	342181	101849	1293525	834246	266663	38140	251259	1066554	153177
1947	1	4920186	326736	675786	378406	97174	1228987	819879	232130	31560	256998	1047941	165449
	2	5067133	322791	789494	472737	95531	1301173	865584	246706	34721	271502	903626	154958
	3	5729801	331054	882848	514294	109830	1533297	958275	327264	67695	288996	1074050	171768
	4	6051034	389777	920468	538425	126885	1463106	970356	284226	43723	319986	1261970	165665
1948	1	5640951	374758	849696	499516	120877	1338206	919526	235510	32927	299235	1098186	176825
	2	5818974	342067	948210	589390	109190	1370973	926416	253715	35626	295370	1057477	163164
	3	6572949	354016	1064025	646512	120791	1741734	1121517	350553	74459	326331	1176475	186159
	4	6234511	399783	981342	584959	124943	1527360	1021587	289333	46330	313683	1200166	170814
1949	1	5792996	382572	862593	518100	117018	1408926	982885	234101	34812	282416	1164334	180182
	2	5802243	349777	1034787	680564	100443	1423156	973502	248942	38917	289989	1016173	172134
	3	6285163	343470	1135050	726358	111131	1673436	1052393	342842	78345	301194	1084535	190945
	4	6183208	388114	1082719	677378	118014	1605808	1107391	279130	47134	305381	1085563	176035
1950	1	5927093	383623	960038	613647	113332	1431228	1000898	236005	34402	302074	1203757	197237
	2	6142799	347061	1118511	761906	101661	1474242	1019736	254330	36475	318800	1047463	183095
	3	7482765	374717	1481865	995466	131636	1914264	1254093	373652	79252	400110	1210961	202041
	4	6594888	388920	1134180	714668	125345	1602209	1079834	296346	46193	350676	1154907	189459
1951	1	7453926	445191	1283858	828160	138340	1678399	1180880	269117	39100	410723	1430375	227189
	2	6828657	367270	1165396	753585	115368	1673872	1158749	287636	40976	358497	1075784	204375
	3	7472239	388422	1203862	770456	126274	1980583	1269723	401553	84106	360595	1276516	224653
	4	7498775	417824	1184106	730242	142281	1971876	1362107	344391	54697	398177	1336905	212846
1952	1	7217456	484380	1022576	612634	136671	1784264	1256320	290900	40222	391388	1361639	241975
	2	6959869	395491	1132717	719835	121880	1798142	1245860	309751	42727	364901	1093098	216409
	3	8115017	416447	1328053	829317	144322	2188431	1381830	449632	99540	454537	1340015	239031
	4	8177332	480160	1257334	748275	161590	2136545	1489999	355019	56382	540773	1386569	226775
1953	1	7786082	478355	1182910	737983	142975	1853973	1291930	300036	40103	536022	1493421	256041
	2	7678300	405076	1318960	868616	130569	1904599	1321567	323383	41995	467837	1190094	231280
	3	8351880	429121	1369274	862985	152688	2286222	1469373	456395	96206	450774	1354378	247165
	4	8068632	449819	1256766	763015	157084	2193771	1550654	356464	55926	469905	1357249	228981
1954	1	7618677	463858	1085997	657604	146259	1919577	1368469	295819	39204	462157	1351939	252139
	2	7620564	398002	1246532	798992	134920	1968726	1383966	325330	42454	430855	1149279	230825
	3	8594905	438300	1461100	902500	154700	2346400	1478300	455500	103100	481300	1358000	257800
	4	8681080	503500	1449700	894200	173600	2231000	1536600	390600	60800	512200	1458400	243100
1955	1	8649329	519000	1392500	873600	173000	2049900	1453100	346000	51900	519000	1556900	276800
	2	8795622	475000	1592000	1046700	158300	2093400	1468900	378200	52800	527700	1345700	263900
	3	9970011	508500	1794600	1146600	179500	2532400	1665000	528400	119600	578300	1565300	299100
	4	9743567	565100	1695400	1062000	194900	2396900	1714900	438500	68200	584600	1627200	272800
1956	1	9372169	562300	1537000	965300	187400	2239900	1621400	374900	56200	562300	1677600	299900
	2	9185690	496000	1671800	1065500	165300	2287200	1598300	395000	55100	532800	1396200	275600
	3	10436979	532300	1868200	1127200	187900	2807500	1826500	553200	125200	574000	1628200	313100
	4	9634258	558800	1657100	953800	192700	2476000	1743800	433500	67400	558800	1599300	269800
1957	1	10005248	600300	1620900	950500	200100	2391300	1740900	400200	60000	570300	1780900	320200
	2	9367262	505800	1704800	1030400	168600	2248100	1620500	402800	56200	533900	1423800	281000
	3	11271938	574900	2040200	1217400	202900	2863100	1938800	597400	135300	631200	1758400	338200
	4	10472439	607400	1822200	1078700	209400	2565700	1874600	471300	73300	617900	1738400	293200

1/ Except for total Colorado collections shown in the first column, all figures after 2nd Quarter, 1954, have been estimated. Figures not estimated were obtained from various Annual Reports, Colorado State Department of Revenue.

2/ Less occasional auto sales. 3/ Included in Automotive group total. 4/ Included in Food group total. 5/ Included in General Merchandise group total.

10. Finally, the proportions resulting from step 9. were multiplied by total sales tax collections statewide for corresponding quarters giving estimates of quarterly sales tax collections for the various business groups. These estimates are given in Table 2.

LOCATION AND IDENTIFICATION OF ABUTTING PARCELS

It was found necessary in the course of abstracting information on real property sales to keep track of the location and identity of parcels through the use of work maps. The criterion of virtual abutment referred to in the body of the report means that parcels included in the study had to abut the existing subject highway, as in the class of "old" and "improved-old" highways, or would abut the highway at a later date, as in the case of "new" highways.

Ownership of selected parcels was established for 1957 from records kept by the assessor in the various counties or by use of the facilities of abstracting companies; the stages in the development of a given parcel were then recreated year by year back to the year 1946. For example, a given parcel in 1957 might have been but a small part of a transaction in 1946, involving large tracts of land situated some distance from the highway in question. On the other hand, though less likely, the parcel selected in 1957 might have been formed by the banding together of a number of smaller parcels, each of which might have been sold and resold many times during the period, 1946-1957. An illustration of the work involved in tracing the history of a given parcel in the rural areas is shown in Figure 29. Figures 30 and 31 show the method of identifying parcels in tracted areas.

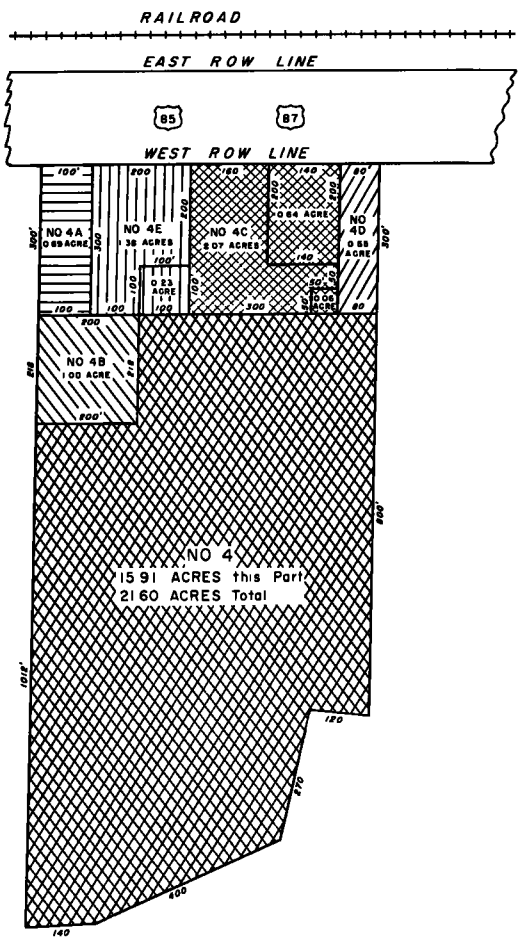

Figure 30. Delineation of a typical tracted area (1957 conditions shown).

MEASUREMENT OF DISTANCE FROM AN URBAN COMMUNITY

The choice of the urban community from which measurements were made to the center of gravity of a given parcel was made according to Reilly's law of retail gravitation (1):

$$d = \frac{D}{1 + \sqrt{\frac{P_1}{P_2}}}$$

in which

- d = highway mileage to the "breaking point" from the smaller of two communities.
- D = highway distance between the two communities.
- P_1 = the population of the larger community.
- P_2 = the population of the smaller community.

If the distance between the smaller community and the center of gravity of the parcel was less than or equal to d, the distance measurement used in arriving at acre-miles for the parcel was made from the smaller community. If, on the other hand, this distance were greater than d, then the measurement was made from the

larger community. In all instances, distances were measured from the 1957 incorporated limits of the community chosen.

INDEX NUMBER USED FOR DEFLATING SALES PRICES PER ACRE

Studies were made by the Colorado State Tax Commission in 1950 and 1951, concerning price changes in sales prices per acre of rural land in Colorado. As a result of these studies, a general index of sales price per acre was constructed for all rural land for the period 1913 to 1952. For the period 1946-1952, this index does not differ substantially from similar indexes published by the Agricultural Research Service of the U. S. Department of Agriculture for Colorado; moreover, indexes published by the Agricultural Research Service were available for Grazing, Dry Farm, and Irrigated lands for the entire period 1946-1957. For these reason, it is believed that the use of the Agricultural Research Service indexes given in Table 3 is justified for purposes of this study.

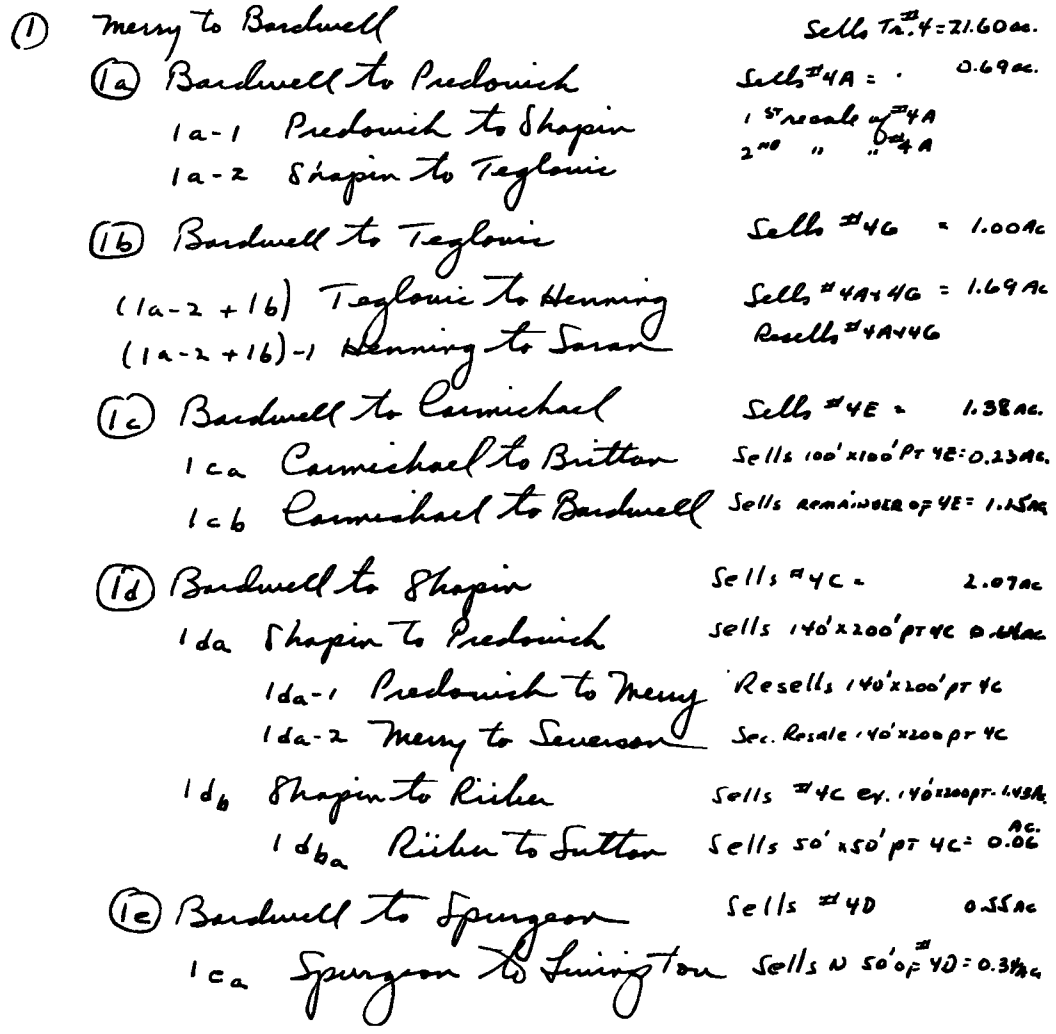

Figure 31. Identification of transactions in tract #4 (same identification procedure used for untracted land) (Jan. 1, 1946-Dec. 31, 1957).

TABLE 3

INDEX NUMBERS OF AVERAGE VALUE PER ACRE BY TYPE OF LAND IN COLORADO (1946 = 100)

Year	Type of Land and Assessed Valuation Per Acre		
	Irrigated ($40 & over)	Dry Farm ($10 & under $40)	Grazing (Under $10)
1946	100	100	100
1947	112	122	126
1948	123	138	140
1949	127	151	144
1950	123	144	144
1951	146	174	156
1952	158	186	182
1953	151	185	178
1954	149	182	175
1955	155	171	174
1956	152	168	167
1957	151	162	160
1958	159	177	175

Source: Adopted from Current Developments in the Farm Real Estate Market, Agricultural Research Service, United States Department of Agriculture, A R S series, various issues.

No specific price index is available for use in deflating sales prices of urban, suburban and rurban land. Construction cost indexes or building cost indexes might be suitable for this purpose. It is felt, however, that price changes in the sale of land parcels in urban, suburban and rurban areas are more likely to follow general price levels than levels established for specific activities such as construction. Lacking a reasonable alternative, the consumer price index for Denver, constructed by the National Industrial Conference Board, has been employed (Table 4).

TABLE 4

CONSUMER PRICE INDEX FOR DENVER (ADJUSTED BASE, 1946 = 100)

1946	100.0
1947	112.5
1948	120.0
1949	118.7
1950	119.7
1951	129.2
1952	130.8
1953	131.6
1954	132.2
1955	132.8
1956	134.1
1957	137.5

Source: National Industrial Conference Board publications.

LIMITATIONS OF THE STUDY

Those limitations which appear to be most important are summarized as follows:

1. Sales price of land parcels, as determined from the value of revenue stamps

on warranty deeds, together with balances of deeds of trust may be unreliable in some instances. The value of revenue stamps affixed to the warranty deeds may misstate for many reasons the amount of cash involved in the transaction. Although it is generally agreed that most lawyers and real estate agents affix the proper value of stamps to the warranty deed, the unknown extent of accuracy of sales price information is a limitation.

2. Even if sales prices are known exactly, the value of the various items transacted are inadequately known. To properly compare one transaction with another, some value should be placed on assignment of water rights that may be included in the sales price, as well as other tangible assets such as mineral rights, machinery, wells, livestock, fruit trees, growing crops and the like. Because every transaction involves varying amounts of these assets, some accounting of them should be made. This was not done in this study, simply because no effective method could be found to do it.

3. Despite efforts to encourage the adoption of uniform assessing procedures and practices in the state, variations still persist in assessments of similar properties located in the counties from which information was gathered. Classification of land on the basis of assessed valuations, as was done in this study, has limitations.

REFERENCE

1. Converse, P.D., "Retail Trade Areas in Illinois." Business Studies, No. 4, Univ. of Ill. Bull., 43:68, 30-31 (July 16, 1946).

An Investigation of Some Economic Effects of Two Kentucky Bypasses: The Methodology

EUGENE C. HOLSHOUSER, Research Associate, Bureau of Business Research, University of Kentucky

● HIGHWAY BYPASS studies are of recent origin, most of them being undertaken as a result of the vastly expanded highway modernization program and of the interest of Congress in an equitable means of financing this program. Bypass facilities may yield benefits to groups other than motor vehicle users. By reducing travel time to various points in the area where they are located and to other areas, these facilities are often credited with value increases on nearby land. By attracting a large stream of through and sometimes local traffic, the bypass can create excellent business opportunities in the general vicinity of the highway.

The Bureau of Business Research, University of Kentucky, has recently completed a study of two Kentucky bypasses: the Northern Belt Line in Lexington and the Watterson Expressway in Louisville (1). The study afforded an opportunity of comparing two bypasses built at approximately the same time, the first of which provided free access; the second, limited access. (The type of access control appears to be an important factor in determining the nature of increments in land value due to the facility. If the effects of the belt line are compared with those of the limited-access Watterson Expressway in Louisville, the following is revealed: (a) the belt line was responsible for the conversion of relatively more land to a higher use than was the expressway; (b) the positive influence of the belt line has been largely confined to commercial and industrial property within ¼ mi of the facility; the expressway seems to have definitely augmented land values as far away as 2 or 3 mi; and (c) with respect to the highway-affected land which has had a similar type land-use history since the preconstruction period (1940-46), the expressway apparently has had a more positive effect.) It represented an effort primarily to determine the influence of these two facilities on land values and land use. Besides attempting to measure land use and land value changes, the researchers made a serious effort to discover why the changes occurred. Because the development of literature on approaches to such problems was limited, considerable attention was devoted to methodology.

It is appropriate in investigations of this kind to employ several different methods of attack in order to shed light on as many facets of the problem as practicable. Inasmuch as no technique without rather serious defects has yet been devised for determining precisely the effect of a new or improved highway on land values and land use, it is particularly appropriate to try every method which offers hope of even partial success. It is impossible to identify and quantify all the factors affecting values and use because the effects are the product of a multitude of simultaneously operating factors. Thus, the difficulty of imputing events precisely to the various causes is great.

The first task in conducting the study was to compile general background information concerning the urban area which the facilities bypassed. The general characteristics of a community and its economic activity, among other factors, can influence the type and magnitude of effects imparted by a new highway. Such information is helpful in predicting the probable extent and rapidity of residential growth, commercialization, and industrialization in the general vicinity of the new highway and the resultant changes in traffic patterns. It also helps to explain the particular influence of the highway on land value and land use which occurs.

The researchers realized early in the investigation that the economic impact of a new highway undoubtedly varies widely among highways and depends on numerous factors. Therefore, an awareness of the general circumstances and events relative to

the specific highway examined was important to the impact analysis. For instance, examination of dates and events pertaining to the Lexington bypass disclosed that the original plan was to control access to the facility. However, in order to avoid trouble promised by adamant property owners, including serious delay and much higher right-of-way costs, the Department of Highways dropped plans for the limited-access feature. The local planning and zoning commission attempted to require service roads as a condition of granting business or industrial zoning. This attempt was thwarted by the opposition of the county fiscal court (the county board of Fayette County) and the commission's lack of legal authority to enforce compliance. Some 80 commercial and industrial firms have thus far located adjacent to the bypass. The property of most of these firms abuts the highway right-of-way, and thus they have direct access to the facility.

It is clear that benefits received by property owners and businessmen have been gained to a considerable extent at the expense of the motorist. The lack of access control and the mingling of through and local traffic have contributed to an atrocious accident rate. The congestion has resulted in considerable diminution of benefits to users of the highway. Conditions on the bypass will almost certainly limit the effectiveness of the whole circumferential route—of which the bypass was the first section—even though access will be controlled on all other sections of the route.

Four major techniques were used to derive information on the land-value and land-use effects of the bypasses. They are the survery-control area comparison, multiple regression analysis, the case study method, and a new technique, the projected land use-value relationship approach. These approaches will each be discussed separately.

SURVEY-CONTROL AREA COMPARISON

The survey-control area comparison is a method of estimating the influence of the highway on the value of nearby land. (This is undoubtedly the most common technique used to isolate the influence of a highway on land values.) Ideally, the procedure would be as follows: An area near the facility is selected for study. A similar area is found which is far enough removed from the highway as to have been unaffected by it. In theory the two areas should have been exactly alike in all respects before the highway was built and any difference since that time should be attributable to the influence of the highway. The real estate sales data are obtained for the two areas for a period both before and after the highway was built. The change from the "before" period to the "after" period in the control area is compared with that for the survey (highway) area, and the effect of the highway is revealed. For example, if on the average, property values increase from $1,000 an acre in the "before" period to $2,000 in the "after" period in the control area and from $1,000 to $3,000 in the survey area, the result of the highway was to increase land values $1,000. The rationale is cast in terms of an ideal situation. Relative to actual practice it represents a goal which can never be reached but only approached. No two areas are alike in all respects, therefore, it is desirable to have more than one control area for each survey area. Unique variables are present in each area which result in varying amounts of change in real estate value.

The question of which characteristics or factors need to be approximately the same to insure a valid comparison is a difficult one. This is to a certain extent a matter of judgment. It also depends in part on the type of land use involved. Ordinarily, the predominant use near a contemplated bypass location is agricultural. There are certain factors which are of prime importance in determining the present and future value of such land and thus should be roughly equal in both the survey and control areas before the highway was built. These factors can perhaps be summarized by the expression "potential for development." Some of the most important factors which determine the potential for development are accessibility to the central business district, size of parcels, existence of a railroad or major highway nearby, presense or absence of blighting influence, and direction of urban growth. Any dissimilarity between the control area and the survey area after the highway is built should be due to the facility and not to other causes. For instance, if farm land in both the survey area and the

control area is converted to a higher use, land development cost should be approximately equal or, at least, should be known in order that account can be taken of differences between the two areas in this respect. In summary, the control area approach requires the acceptance of a control area which is sufficiently similar to the survey area in important economic and geographic aspects, or in which the differences can be quantitatively isolated, but which is negligibly affected by the highway being investigated.

The control area should be chosen with extreme care and only after a thorough examination of similarities and differences between the survey area and possible control areas. Even then, the results should be viewed only as approximations.

CASE STUDY METHOD

The nature of economic effects which may be sustained by an individual enterprise is not disclosed in generalizations concerning the over-all impact of the highway. The former, however, is relevant to an understanding of the total impact. The case approach deals with a rather detailed analysis of events and persons involved in transactions which concern selected parcels affected by the highway facility. (This approach appears to have been largely ignored by highway economics researchers. At least, it has generally not been set out explicitly. An exception is a study of industrial and commercial development along Route 128 near Boston (2).) An examination of selected cases with emphasis on their relationship to the highway is useful not only in providing information and background of an institutional nature, but also in indicating the variety and extent of significant relationships attributable to the highway.

Cases may be selected by various criteria. Suggestions from individuals with considerable interest in and knowledge of the local situation are important bases for selection. In some instances, it was suggested that the particular enterprise appeared to have sustained significant economic impact attributable to the highway. In other instances, location of a plant was of such general importance to the urban area that an inquiry into possible relationships between the bypass and the plant location seemed warranted.

A case study of the IBM electric typewriter plant location along the Lexington bypass revealed that (a) in all probability IBM would not have located in Lexington in the absense of this highway facility, (b) approximately 700 relatively high-income persons were transferred from its other plants to the Lexington location, and (c) several small industries located in Lexington primarily to serve IBM. The economic activity generated in Lexington by IBM, traced through its various ramifications, is quite substantial.

MULTIPLE REGRESSION ANALYSIS

Multiple regression analysis (3, 4) was used in instances in which appropriate control areas could not be found and in certain instances as a check on the results of the survey-control area method. The rationale of the multiple regression method applied to isolating the effect of a new highway on land values is as follows: changes in land values near a new highway result from many different factors, one of which, presumably, is the highway. Ideally, all factors which influence the value of land other than the absence or presence of the facility should be isolated and assigned constant values. Then the remaining effect is that of the highway. In practice, of course, it is not possible to take into account all relevant factors. A common procedure is to select those variables which a priori appear to have the most significant effect on land values, test them by partial correlation, and use the most significant ones.

Data for all variables to be used are collected for a period of years before and after highway construction. The dependent variable is land values. The independent variable of principal interest—the highway—presents great difficulty. In the regression analysis, the variable must be represented quantitatively, and yet it is essentially a qualitative characteristic. Unless a meaningful quantitative representation of the highway variable can be established, the regression analysis is of limited usefulness. One scheme is to represent the "before" period by zero and the "after" period by one.

This is sufficient to yield a correlation coefficient but it is generally not a satisfactory approximation of the amount of increase or decrease in land values attributable to a new highway. Much research will be required before any numerical representation can be used with confidence.

In the multiple regression procedure, logical interpretation of the results is extremely important. In the Louisville study, for example, this procedure was used for an area in which the land was converted from agricultural to residential use. A high coefficient of correlation was obtained, indicating that some 70 percent of the increase in land values which took place was attributable to the bypass. In this case, however, the result was misleading. The area was purchased for residential development considerably prior to the announcement that the particular facility would be built. The high correlation coefficient doubtless reflects this conversion of land to a higher use. Thus, the association of variables measured by correlation analysis is suggestive, but the importance causal relationships must be sought out by a logical examination of the associations. Otherwise, erroneous conclusions are likely.

PROJECTED LAND USE-VALUE RELATIONSHIP APPROACH

Constructing a new highway on unimproved land near a growing urban area may result in changes in the trend of land utilization for the area. For example, land which most probably would have been developed for residential purposes is used commercially instead. The new highway may also be responsible for an acceleration or deceleration in the conversion of land to the "destined" use. For example, land which probably would have become residential actually is converted to residential use but at an earlier or a later date than would otherwise have been the case.

These possible changes in land use due to the highway suggest a technique which involves an analysis of the use of land for the general urban area, with emphasis on land near the highway. The object of the technique is to project—that is, to estimate based on past trends and data—the actual use that would have been made of the land if the new highway had not been built. Such evidence as that from land-use inventories and master plans, population distribution, planning and zoning activities, building permits and construction, and geographical aspects aid in projecting these trends. (For example, prior to the construction of the bypass in Lexington, the local planning and zoning commission approved two residential subdivision plats near the proposed facility. In fact, one final subdivision plat shows the bypass as the major street of the subdivision. After the facility was built commercial and industrial zoning was allowed along the highway. As a result, today the two subdivisions accommodate a variety of commercial establishments but no residences.) A comparison of probable land use projected for the area presumably affected by the highway with an inventory of actual land use at the present time should indicate the influence of the facility. The researcher undoubtedly will be handicapped in most cases by the lack of sufficient data of the right type to do a thorough job of projecting land use trends. He must, of course, make the best of what information is available. In a community in which considerable land planning is done and in which appropriate records are well-kept, the researcher's task is easier.

After determining the probable effect of the facility on land use, an attempt can be made to establish land value relationships among varying types of use (among, for example, farm, residential, commercial, and industrial land). Application of the value relationships to highway-caused land use changes would provide general indications of the highway impact on land values.

Although some aspects of the approach are obviously somewhat subjective, (that is, personal judgement is involved) the results—particularly when examined in conjunction with those obtained by other approaches—may be quite useful. The approach emphasizes the rather direct but complex relationship between land use and land values. It poses the question: if the highway had not been built at all, what use of the land in the area would have been made? (The question of the effect on land use if the highway had been built at a different location in the community can likewise be explored by this technique.) The use to which land is put, of course, determines to a large extent the value of the land.

Some examples of what was found through this approach should illustrate its usefulness. The examples refer to the Lexington bypass.

This bypass probably contributed to the restriction of postwar residential growth under way in that section of the urban area where the highway was built. It retarded or rendered undesirable the conversion of unimproved land to residential use. Some land close to the highway which most likely would have been converted to residential use actually is being employed commercially or industrially. Farm land farther away, some of which undoubtedly would have been converted to residential use, remains in agriculture. However, the facility has resulted in a net increase in residential land required for the entire area. It was estimated that almost 1,000 additional families settled in Lexington which, in the absence of the bypass, would not now be living there. Thus, the facility contributed to a rapid acceleration of residential development in the other sections of the urban area.

In 1958, of the land with 1,000 ft of the bypass, 23 percent was employed commercially and industrially and 14 percent residentially. On the basis of land-use patterns through the late 1940's and projections for the future, it is probable that commercial and industrial use would have amounted to about 5 percent and residential use to about 25 percent in the absence of the highway.

The establishment of land value relationships revealed that the value of land in parcels of one million square feet and over (23 acres) changes relatively little even though it is in the process of conversion to residential use or to commercial use. This general result was consistent with the survey-control area finding of an increase in value of about 20 percent on nearby parcels of this size attributable to the highway.

An examination of unimproved land in the general area of the highway facility as well as of similar land located elsewhere beyond the "built-up" urban area—utilizing the land use-value relationship analysis—proved interesting. Such land in the 1940-46 period (before plans for the bypass were made public) had a value of about $600 per acre in the 100,000 sq ft to 1,000,000 sq ft range. This unimproved land had a typical market value of from $900 to $2,400 per acre if it was to be used for residential purposes, the price depending on the size of the parcel sold. Residential use seemed probable for much of such outlying land, including a large section of that along the bypass, most of which was platted for residential subdivision purposes. With the construction of the bypass, the area is now near a relatively high-traffic-volume highway. With business zoning, the land has a definite commercial potential. The market value of this land if converted to small commercial parcels, now becomes from three to five times more than it would have been had it been converted to residential lots. As the commercial area becomes established, the typical market value probably increases even more, the amount of increase depending on the specific type of commerical use.

The projected land use-value relationship approach is useful also in connection with the other methods of attack. The examination necessary for projecting land use is helpful in suggesting subjects for case studies and in providing information which aids in interpreting the results of such studies. The results of projecting land use serve as a check on the appropriateness of control areas selected. For instance, assume an area near the new highway is now in commercial use. Assume, further, that the projected land-use approach suggests that in the absence of the highway, the area would be primarily in agricultural use today. The control area should, therefore, be primarily in agricultural use at the present time. In fact, an area selected for control which was mostly in commercial use would be suspect.

This approach is helpful in multiple regression analysis. For example, a regression equation or a coefficient of correlation may indicate that the highway is responsible for about 60 percent of the increase in land values which occurred in a nearby area which was converted from agricultural to industrial land. If this conversion would have occurred regardless of the new highway, then the statistical result is misleading. The projected land-use technique sheds light on whether or not the conversion to industrial use would probably have occurred in the absence of the highway. That is, it aids in the interpretation of the statistical result in the particular case.

ACKNOWLEDGMENTS

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Analyzing the Socio-Economic Impacts of Urban Highways

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● IN THE EARLIER YEARS of this century road construction took place primarily in rural areas "to get the farmer out of the mud." Continued and accelerated urban growth, however, soon exaggerated urban problems of congestion, delay, and inefficiency of movement. These forces have engendered a shift in emphasis from rural to urban highways. The assistance provided in the 1956 Highway Revenue Act permits states to construct major expressways within their dense urban areas. In effect, cities can use these links in the Interstate System to connect their deteriorating central areas to their growing suburbs.

During the era of rural highway construction when highways crossed sparsely populated regions, their limited impact on these areas could be ascertained with ease. But now the social and economic impacts of urban highways were so complex that prior study was essential. The 1956 Act acknowledged this need when it required that states consider the probable effects on their communities of highway construction as an aid in the choice of alignments.

It is the purpose of this paper to present the methodology employed in one such socio-economic analysis, the recent study of the Inner Belt Highway and connected radials in the Boston Metropolitan Area. The group of engineers and planners who in mid-1959 began work on the Inner Belt Highway study had a double task: first, to recommend alignments for the several routes under study; and second, to recommend a priority of highway construction.

To accomplish this the staff first developed a theoretical study model which they then modified to conform to the specific conditions prevailing in the Boston Metropolitan Area. The authors hope this description of their method of analysis will prove useful as a guide to other communities undertaking similar studies in the future. Of course, modifications will be needed wherever the technique is applied to another area.

At the outset the planning staff reviewed past highway impact studies. Particularly helpful were publications by Michigan State University and the University of Washington which reviewed the more important studies undertaken in this area (1, 2). Information about crucial areas of investigation was indicated in several California studies (3, 4, 5) and the study of the Gulf Freeway (6). Both the Gulf Freeway and California studies were ex post facto assessments of the highways' impacts upon specific communities or contiguous areas. Because their purpose was to measure already assessable impacts, they provided only limited guidance in assessing the effects of future highway developments.

In addition to the studies themselves the Highway Research Board Conference's "The Economic Impact of Highway Improvements" helped focus attention on the specific impacts and attendant problems of highways in urban areas (7).

It soon became clear that we would have to broaden the analysis to include many other factors, primarily because the study dealt with not just one highway or section thereof, but several highways that were to complete a net of limited-access expressways serving the entire Boston Metropolitan Area. This net included in addition to the Inner Belt, two outer loop circumferentials—Routes 128 and 495 (proposed)—and seven radials. Of this net the study involved the Inner Belt and connecting portions of four radials (8) (Fig. 1).

The scope of the study included the entire Boston Metropolitan Area and therefore

it was necessary to consider many elements not treated by past studies in any detail: such factors as the over-all economic base, population shifts, the movements of people on other modes of transportation, and the movement of goods by truck and rail. The less easily quantifiable variables considered were social characteristics, political boundaries, ethnic groups, and income factors. The scope of the investigation, through broad and exceedingly complex, was unified by means of several theories now prevalent in the social sciences. These will be discussed at appropriate points in the paper. In summary, the role of the planning consultants was to suggest highway locations that would minimize the deleterious effects of the highway net on existing communities, their neighborhoods and businesses, and at the same time that would make a maximum contribution to the short-range amelioration of traffic problems as well as the long-range growth and development of the cities and towns coming under its influence.

METHOD OF ANALYSIS

Highway impacts were divided into two general categories. The first category considered the impact of the highways as physical entities, whereas the second dealt with the highways' effect on the long-range growth and development of the Boston Metropolitan Area in Functional rather than physical terms. The physical impacts are primarily, but not exclusively, short run effects on displaced families, local municipal governments, neighborhood boundaries, behavioral patterns, the market areas of local merchants, and other persons or institutions directly affected by placing the highway in a particular location.

The first round of adjustments resulting from highway construction, such as the relocation of families and businesses and the increase or decline of sales by local merchants, will be followed by second- and third-round adjustments. For example, if one grocer loses business because the highway's location makes his store relatively inaccessible, other grocers more accessible to the consumers in the area would probably experience an increase in their trade. This assumes a relatively stable environment, an assumption made for the purposes of investigation.

The physical impacts are relatively simple to assess because they relate to tangible alterations in the spatial relationships in and around the highways. Adjustments in the spatial relationships necessitated by construction, however, will influence the highway's effects in its second or functional role. In a sense the new pattern of land uses and land-use controls will act as limiting factors on the changes engendered by the altered time-distance relationships. More intense study is required for the set of impacts related to time-distance changes because they are felt over a longer period of time and manifest themselves in many different ways.

The long-range impact of the highways involves their ability to fulfill the movement needs of the Boston Metropolitan Area in terms of altering the time-distance relationships from home to offices, factories, shopping and recreation centers. Altered time-distances between areas of economic activity, their sources of supply, and the market, will eventually create opportunities for the relocation or new location of economic activity. Again there will be second- and third-round effects. If a new industrial complex takes advantage of the road net, it will create an opportunity for residential development which in turn will create opportunities for new commercial and business enterprises. This new pattern of activity will eventually be reflected in local government revenues and expenditures (9, 10). The general principles on which this analysis was based are those of contemporary systems analysis in which one traces out the chain-like reactions among different sections of the environment to find out how a change in one factor within the environment will influence other components (11).

It can readily be seen that physical and functional impacts affect different individuals and groups in varying degrees. To facilitate the analysis, the persons and groups and the manner in which they would probably be affected were identified. This method corresponds to what might be called an "actor analysis." To summarize briefly, the steps undertaken in the analysis were as follows:

1. Assessment of Physical Impacts
   (a) Field survey

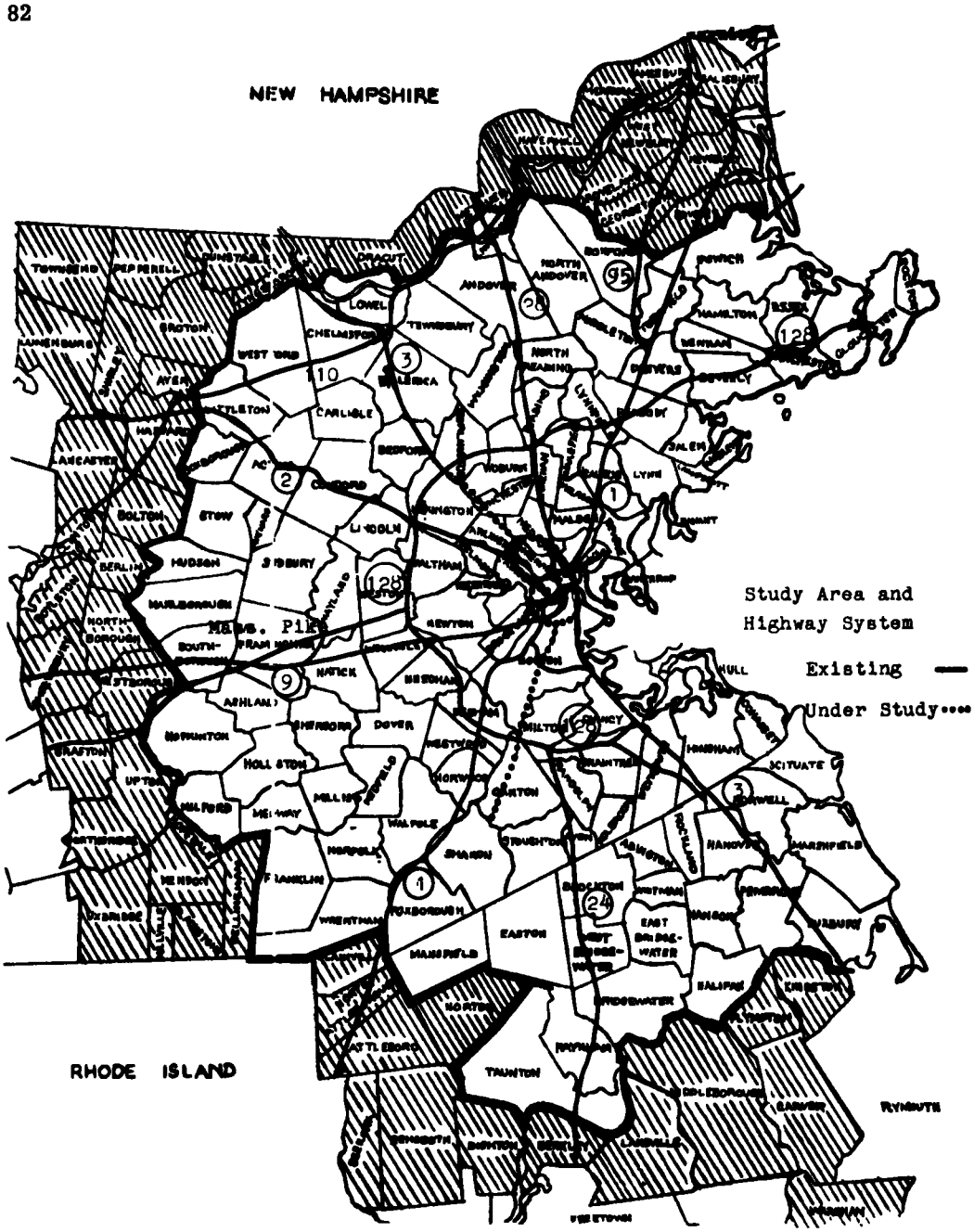

Figure 1. Boston Metropolitan Region—study area and highway system.

(b) Tabulation
(c) Actor analysis

2. Assessment of Functional Impacts
   (a) Population and employment forecasts
   (b) Population and employment distributions
      (1) Assuming no highways—median forecast
      (2) Assuming all highways built simultaneously—high economic forecast

TABLE 1

PHYSICAL AND FUNCTIONAL EFFECTS OF THE HIGHWAY NETWORK ON RELEVANT ACTORS

Effects	Local Govt	Residents Displaced	Community Interest Groups: With Capital Invest.	Community Interest Groups: Without Cap Invest	Commerce and Businesses: Offices	Commerce and Businesses: Retail Trade	Commerce and Businesses: Real Estate	Commerce and Businesses: Warehsg. and Truck Terminals	Mfg	Public Service
(a) Physical										
1 Slum clearance under roads-building	+									
2 Use of highways as physical dividers	+									
3 Loss of rateables	-									
4 Displacement of families	-									
5 Disruption of political coundaries	-									
6. Alteration of school, fire, police districts	-									
7. Alteration of utility lines	-									
8 Temporary adjustments in traffic flows resulting from construction	-									
9 Changed living conditions		+-								
10 Alterations in culturally homogeneous areas		-								
11 Movement into different rent areas		-								
12 Alteration of patterns of movement (journey to work, shop, school)		-							+-	+-
13 Elimination of land-uses			-		+-	-		-	-	-
14 Changes in patronage			-						-	
15 Aesthetic considerations—reflected in the price of space					+-		+-			
16 Alterations in trade area						+-		+-		
17 Proximity of highway to establishment						+-			+-	
18 Expansion of contiguous land-uses			-		-	-	-	-	-	-
19. Alteration of directional accessibility							+-	+-		
20 Implementation of master plans	+						-			
21 Alter structure of housing marker							+-			
22. Changes in competition of space								+-		
(b) Functional										
1 Change in rateables through more productive uses	+									
2 Reduction of street congestion	+									
3 Implementation of master plans	+									
4 Loss of competitive position	-									
5 Increase in welfare expenditure	-									
6 Change in the community structure so that expenses exceed revenues	+-									
7 Growth of non-taxable land-uses	-									
8 The resultant effects of changing land-uses in terms of the interest of capital investments			+-	+-						
9 Labor pool					+-					
10 Space competitions (accessibility and availability)					+-	+-				
11 Changes in environmental relationships					+-					
12 Changing shope of trade area						+-				
13 Create investment opportunities for other activities (retail)						+-				
14 Change in land value							+			
15. Alterations of existing housing market							-			
16 Changes in value of the housing market							-			
17 A restructuring of land-use-mix-re-adjustment of different land uses based on competition of use							+-			
18 Alter time—distance relationship with industry (establishments—served)								+-		
19 Alter competitive position vis-a-vis other modes of transport								+-		
20 Modification of transportation factor									-	+-
21 Tend to freeze unamortized industry									-	
22 Early move because enable faster rate of amortization									+	
23 Effect structure of labor force									+-	
24 Market might change due to population shift—distribution costs increase									+-	
25 Increase cost of providing public services due to dispersion of market										-
26 Cost of supply										-

(3) Assuming all highways built simultaneously—median employment forecast
(4) Assuming all highways built simultaneously—low economic forecast
(5) Assuming highways constructed according to given priorities—median economic forecast

(c) Actor analysis

ANALYSIS OF PHYSICAL IMPACTS

Several major groups of actors were identified and the positive or negative impacts of the highway listed for each. The actual research method then grew out of the need for information to verify these effects (Table 1). Some of the more relevant actors and the impacts they might experience are listed in the following (the more obvious

effects common to all actors, such as the demolition of real estate, are not repeated for each).

Local Government

The most immediate impact felt by a local government is the loss of revenues resulting from the acquisition of privately owned properties for the right-of-way of the proposed highway. Another cost may be incurred in relocating the displaced families. Where families are displaced in an urban renewal or redevelopment area direct costs would be incurred. (According to the Housing Act of 1959, relocation payments are a maximum of $200 per household.) If low income families are displaced for whom relocation aids are not available, indirect costs may be felt in the form of municipal welfare expenditures. The highway's construction would also temporarily increase the operating costs of the community as it becomes necessary to readjust local traffic movement and police, fire, school, and other service districts.

More positively, the local government may realize some benefit in slum clearance under Federal road construction and the highway may thus aid in implementing the town's master plan. Although highways may act as unwanted psychological dividing lines between neighborhoods, this division is desirable where an industrial tract is separated from a declining but salvageable residential community (12).

Residents Displaced

The families displaced by the highway would obviously incur moving costs and difficulties particularly if they belonged to low income and/or minority groups. The displaced families may also experience social costs such as the disruption of well-established neighborhood ties. It must be added, however, that many displaced families are happier once the period of readjustment is ended.

Community Interest Groups

This group includes such organizations as social and political organizations, hospitals, churches, and other such nonprofit institutions whose opportunity for physical expansion may be inhibited. Institutions serving a particular area may also experience a reduction in patronage as displaced families relocate too far from the facility for it to be of any future service.

Business and Consumer Services

The physical destruction of office buildings or of other profit-producing properties may not create a hardship if the settlement is adequate and another structure can be built in a similarly advantageous location. Office buildings can also be affected positively or negatively by the aesthetic presence of the highway. If the highway is properly landscaped or removes a nearby blighting influence, the price of space may increase. On the other hand, the highway may obstruct the access and the view to some attractive neighboring use.

Retail Trade

A major effect of the highway on retail activities would be modifications of trading areas. Of course the loss in trade area for one retail activity would probably mean a gain for another. Naturally all retailers near the highway will benefit in terms of sight advertising which can be capitalized on by proper signs or beautification.

Real Estate and Warehousing

Real estate taken broadly to include property owners as well as realtors can be affected positively or negatively in many ways. As was true for office space, the price of real estate will be affected by the aesthetic appearance of the highway. High income residential property would probably be adversely affected if it were near or within sight distance of the highway itself. Industrial or commercial real estate might in-

crease in price as a result of the highway's presence, depending on whether or not time-distance was actually affected. Generally speaking, the entire real estate market would be altered through a diminution in supply resulting from the demolition necessary to construct the highway. Assuming a constant demand, the remaining parcels whether residential, industrial or commercial, would be in a temporarily favored position.

While the effect upon warehousers, truckers, and manufacturers parallels those experienced by the actors already discussed, some significant differences occur in the form of changed accessibility patterns for both people and goods to and from establishments.

A field survey to measure actual physical impacts was undertaken for all proposed alignments in the Boston study. The collection of raw data was essential because past census materials are now out of date. Field workers traversed the routes of the pro-

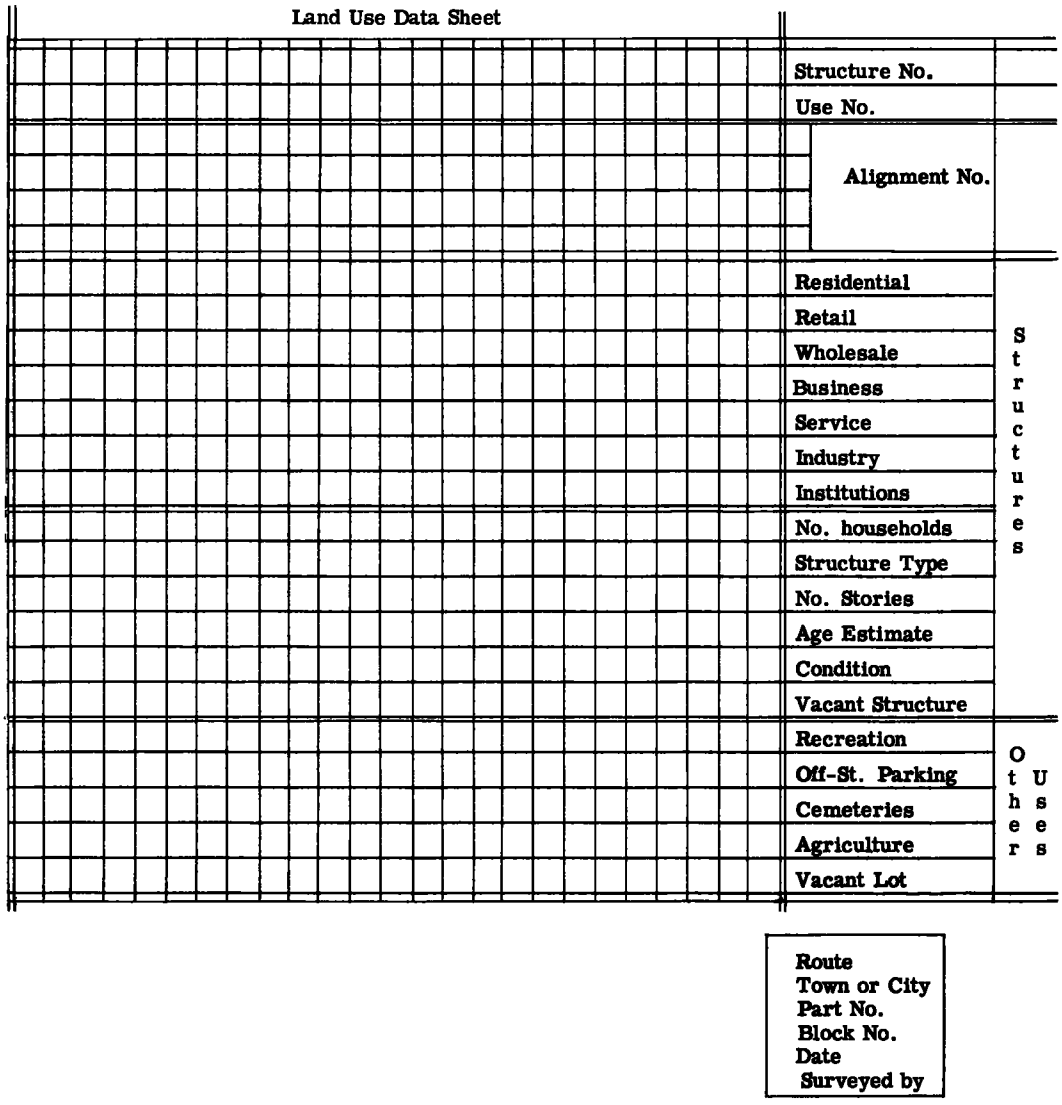

Figure 2.

proposed alignments listing for each property in their path the structure's use, age and condition, number of dwelling units, number of off-street parking spaces, and the name, location, and type of each nonresidential activity (Fig. 2). In addition, field interviews were conducted with realtors, public officials, and leaders of affected interest groups which indicated rents, sale prices, and other characteristics of neighborhoods along the alignment. In addition, an estimate of property values was obtained by collecting complete assessment data along each alignment. These data were then converted into approximate fair market value by analyzing over time reported sale prices in property transfers.

ANALYSIS OF FUNCTIONAL IMPACTS

General

One of the first problems in assessing the functional impacts of the proposed highways was to predict the probable distribution of the population and employment in the metropolitan area that would have occurred if the highways were never built. These predictions served as a basis of comparison with forecasts made assuming that the highways were constructed. The forecasted population and employment were distributed throughout the study area using analysis units corresponding to the spheres of interest of the relevant actors which in this study were the separate towns.

The actors remain the same in both the analyses of functional and physical impacts, but it was felt that each set of impacts would be quite different. For example, though local governments experience an immediate loss of ratables, new businesses and population which in the future would locate in the community because of the improved road service may actually improve the community's economic position. Similarly, street congestion caused and possibly intensified during highway construction, may be considerably alleviated in the long run as traffic is attracted to the new highway facility. Furthermore, as access is improved the local diminution of street traffic may increase the value of both residential and commercial real estate.

With regard to manufacturing, the highways will reduce considerably not only the costs of transportation but also make more industrial sites available. Of course the relocation of a plant will reduce the income of the community which has lost the industry and increase that of the community to which it has moved.

Inasmuch as it can be seen that the same change or a particular change can have both positive and negative effects on actors located in different areas, some criteria for balancing the benefits and costs within the entire metropolitan area must be established. The basis for making these decisions is dealt with in the concluding section.

Population and Employment Forecasts in the Boston Study

A thorough knowledge of economic activity in the study area was obtained through a detailed analysis of the forces influencing employment. Employment trends were analyzed in enough separate components to observe their growth and decline, and the shifting locations of the major industries in the employment base. Ordinarily an industrial breakdown equivalent to the three digit standard industrial classification system used by the Bureau of the Census is sufficient to provide this accuracy. Such a breakdown, in addition to improving the accuracy of the forecast, aids in a more orderly distribution of future employment throughout the metropolitan area.

Once the employment forecast was complete, some index was needed to convert the predicted employment into spatial requirements. The number of workers per acre was first obtained by comparing the number of workers on a particular site with its size. Greater precision was introduced by finding separate indices for each major employment group.

In most metropolitan areas current economic and population projections are often available. Such projections made prior to the announcement of proposed additions to the highway net must be revised to account for the distributive effect of these transportation changes. In any case, however, prior projections will serve as an excellent basis for comparison with new forecasts which include the impact of the proposed high-

ways. In the absence of usable forecasts it will be necessary to predict what may happen as a result of highway construction. For this purpose employment data usually available from Federal, state, and local agencies can be used. This information is collected annually for every community by the local Bureau of Employment Security on total covered employment. Other state departments may also collect related information. (In the case of Massachusetts, it found that there was little comparison between the State Department of Labor and Industries and the Bureau of Employment Statistics. While the attempted correlation was unsuccessful, both series taken separately supplemented each other to serve as useful forecasting guides.)

The employment forecasts for the study area provided one of the most important bases for the population forecast. These were used by converting employment into total population by using an index called the Labor Force Participation Rate, an index of the number of people in the population who are actively employed. (Labor Force Participation Rate data are usually presented for different age and sex groups. However, when estimating future population on the basis of predicted employment, a single index was used because employment totals (based on future output and productivity) made no distinctions as to the age and sex composition of the labor force.) This technique of measuring population is only applicable if all the people working in the study area also live on the area. Modest cross-movement at the borders of a suitably large study area may be largely self-compensating.

The total forecast of population based on employment was then checked against the results of simple apportionments and linear extrapolations. Perhaps the best method to forecast population independently is a method based on local birth and death rates and migration trends, the cohort survival technique. Even this technique can be improved, however, by basing assumptions about future migration to and from an area on local economic trends. The forecasts of employment and population, once reconciled, acted as control totals for the process of distribution outlined below.

Method of Distribution

Perhaps the most complex aspect of the socio-economic analysis is the method of distributing future employment and population. There are three basic distribution methods available to the analyst. The first of these is simply an extrapolation of existing growth patterns for each analysis area. These forecasts are then aggregated and checked against the control totals supplied for the entire study area. While this method builds in the past rate of transportation changes, it does not account for the new rate of change resulting from the additions to the highway network.

The second method compares industrial locational needs with the vacant and buildable lands available throughout the study area. This approach employs the emerging concept of location theory developed by such people as Lösch, Weber, and more recently Walter Isard of the University of Pennsylvania (13). Basically this method requires a detailed knowledge of the locational requirements of each separate industry and a map showing the available sites and their characteristics.

After locating future industrial employment, it is necessary to distribute population using journey-to-work theory (14). This concept indicates the relationship between homes and jobs in terms of how long people are willing to travel to their place of work. This information, which varies from city to city, can be represented on a map showing time-distance around any particular industrial concentration. Then using the probable incomes of employees within that industrial concentration, the analyst can distribute future population to the housing stock within areas having the proper travel time relationship. Once the residential locations of industrial workers have been established, other service activities can be located in relation to the concentrations of industries and workers. Of course, service activities such as retail trade, service industries, institutions, and governmental enterprises, will add to the population and require even further adjustments, Again, this will cause added employment which must be distributed to residential locations on the basis of journey-to-work theory. Using this method the analyst can suggest alterations in location that might result from different proposals concerning transportation in the future. Though theoretically the

best, clearly this is the most arduous, time consuming, and expensive method.

The third method available is a gravity model such as that employed in the Chicago Area Transportation Study (15). Gravity models usually assume that the future location of population and jobs will alter with changes in the time-distance relationships among centers of activity in a metropolitan area. Time-distance serves as the independent variable on which the variables of population and employment depend. Although the gravity model has the advantage of being simple, quick, and objective, it has the disadvantage of placing heavy reliance on the single variable, time-distance. Although several other influences on future distribution are subsumed in time-distance, such as the willingness of people to travel, the availability of space, and fluctuations in the real estate market, it is assumed that their relationship to time-distance is fixed while in reality they vary independently. Therefore, the results of the gravity model must be examined for unanticipated results and then possibly altered with careful judgment.

A combination of all three techniques was employed in the Boston study. The gravity model provided the skeletal structure of the employment and population distributions which was reconciled with separate distributions based on locational theory and an examination of past trends.

Among the basic information collected for use in this process was complete land-use data differentiated by type, by zoning classification, and by the development potential of vacant land. (Two major considerations used in determining development potential were slope and soils conditions.) For the inlying densely settled towns, a study was made of proposed redevelopment projects and the probable future re-use of the land scheduled for clearance. Among the factors investigated affecting future locations of employment were trends in new plant construction, locational needs of different industries, and sites currently offered for sale by industrial realtors. Trends in housing construction and density were examined to provide comparable data for future residential development.

Distribution Procedure

The first step in the distribution procedure was to divide the area into suitable analysis zones. These took the form of a series of sectors or pie-shaped wedges radiating from the center of the study area. Each of these embraced one of the major radial highways in the regional net.

The area was divided further into a series of rings at varying distances from the center. As much as possible, these rings circumscribed areas having similar characteristics. The first was the area of high density, the second included the remaining area served by mass transit, the third was the area of older development, the fourth was the newly developing suburban area, and the fifth included a mixture of suburban and agricultural development (Fig. 3).

The divisions corresponded to town boundaries to facilitate data collection and analysis. Each town, therefore, was a separate analysis area. Population and employment densities were computed for each analysis area and plotted on a distribution curve relating resulting densities to the area's time-distance from the center of downtown Boston. Normally, high densities of both population and employment can be anticipated at the center, with these tapering off as time-distance from the center increases, provided the study area has only one dominant center. (Over-the-road distances were measured from downtown Boston to the population centroids of each analyses area.) If the study area has a single dominant center, then a table of existing and future time-distances from this center can be prepared to estimate future development potential based on the change in time-distance to the dominant center. In the Boston study, however, examination revealed many subcenters influencing growth patterns. (See Figure 4 for an example of this "tailing up" phenomena.) This required the computation of additional time-distances using each subcenter as a secondary centroid for its surrounding area.

The original assumption employed in the study was that future densities will be equal to that density on the computed curve presently having the same time-distance

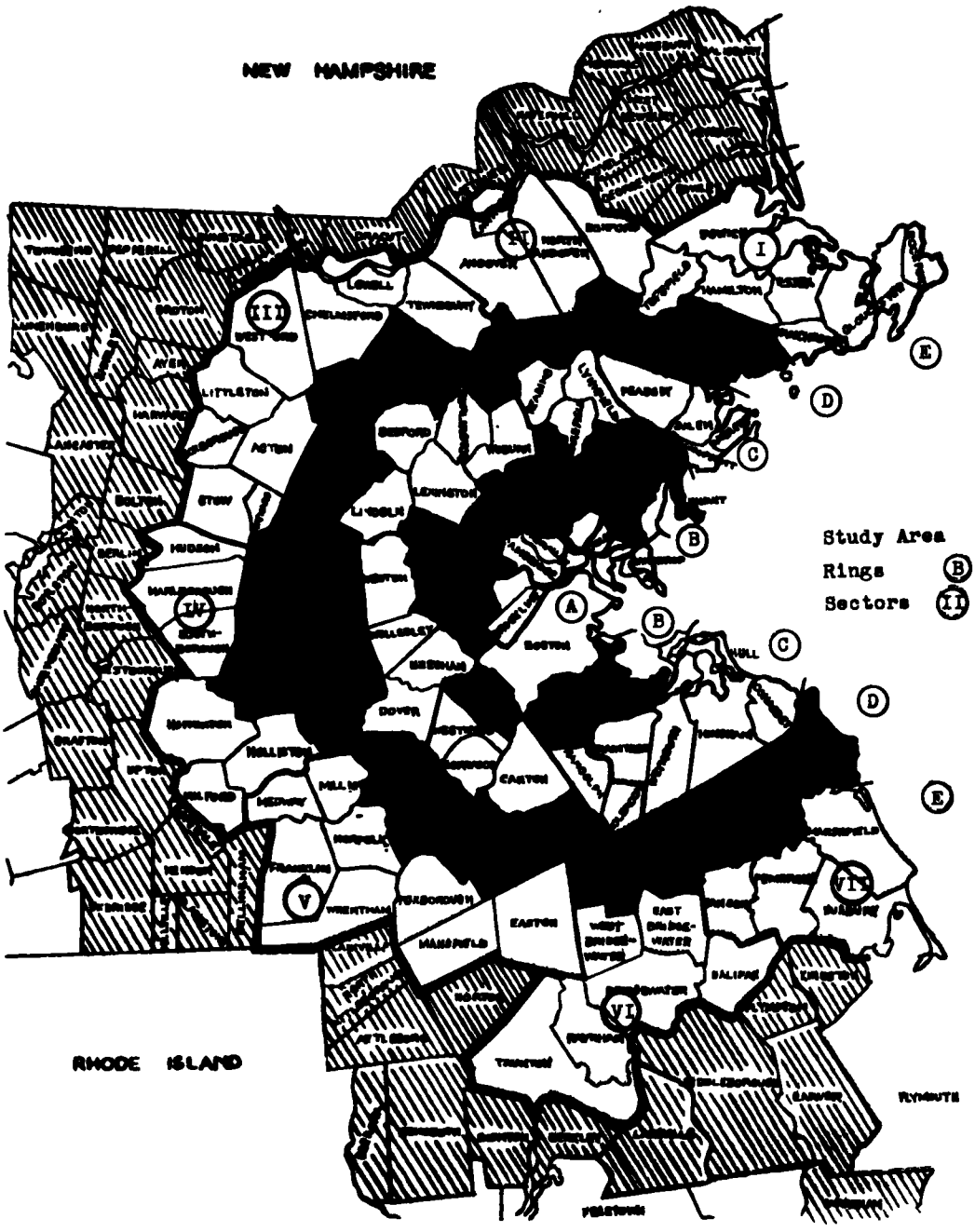

Figure 3. Boston Metropolitan Region—study area.

relationship to the center. For example, assume that a town is 45 min from the center and that the present residential density is three families per acre. If the town will have a future time-distance relationship to the center of 30 min, and towns presently at a 30-min distance from the center have densities of eight families per acre, then this density will be used to estimate the future residential population. The amount of vacant and buildable land that might be developed in the future can be estimated in a

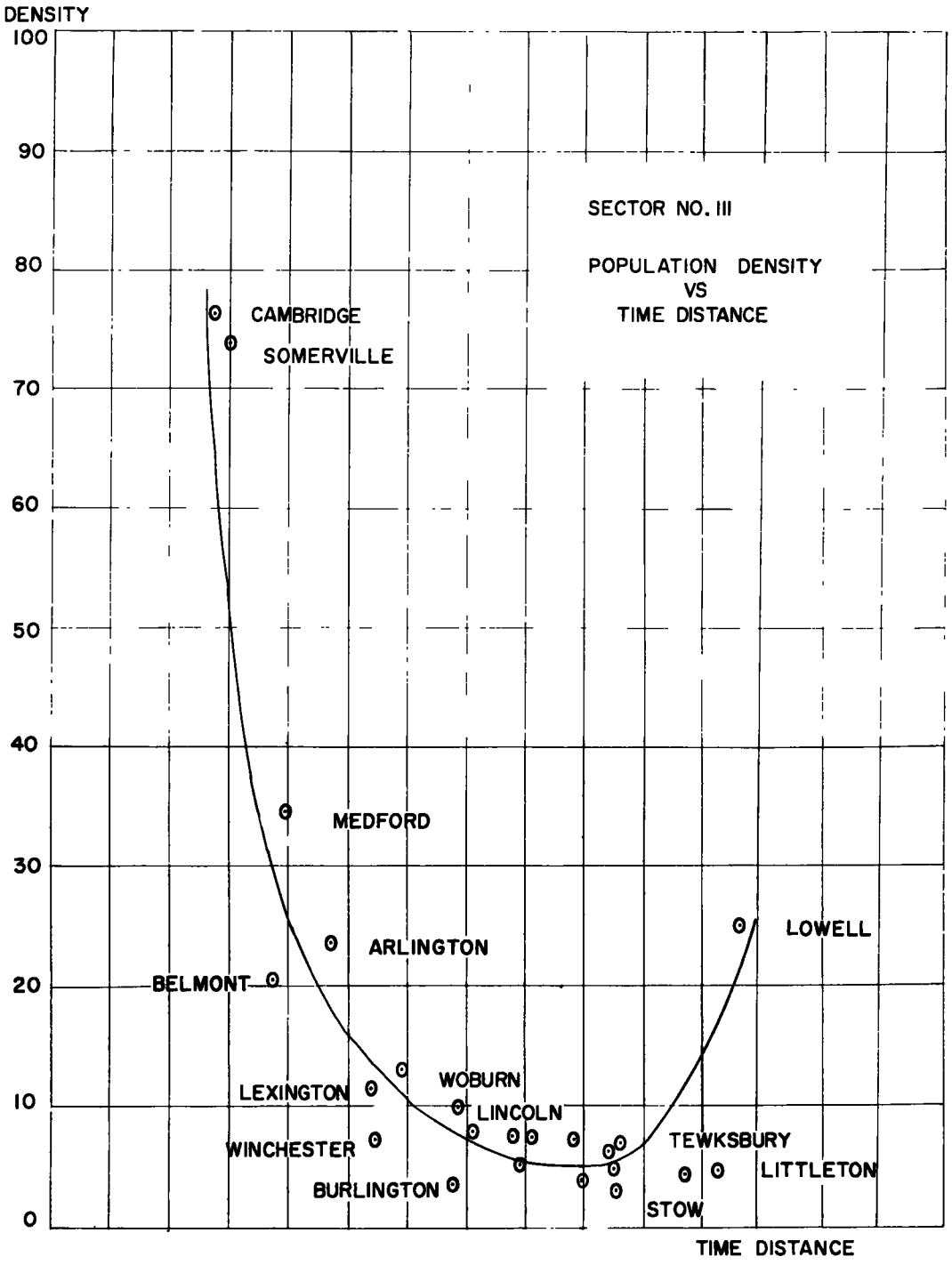

Figure 4.

similar manner by using curves relating the amount of buildable land presently developed in each analysis area to the time-distance from the center (Fig. 5).

Again it must be stated that such a simple method is usually applicable only under

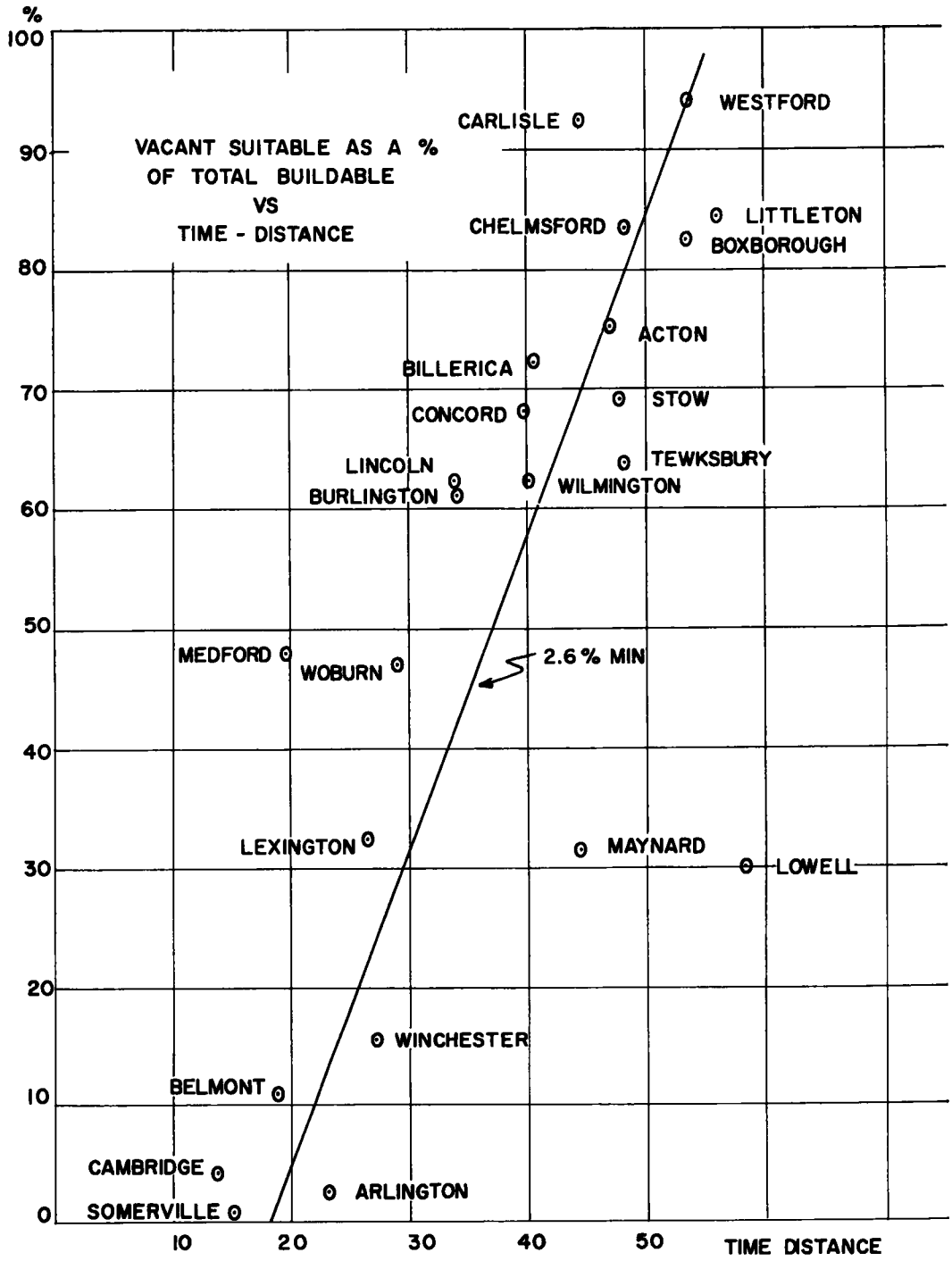

Figure 5.

certain conditions: where there is a single political jurisdiction or in an area where the outlying towns do not employ density restrictions which would tend to impede the development of normal market patterns. In Boston this is not the case. First, Bos-

ton is less than one-fourth the size of its total metropolitan area, both in land area and in population. Second, the study area included 121 towns each of which has its own zoning regulations. Many of these towns restrict the amount of development which normally might occur. The trend toward using larger lot sizes to control residential development, long employed in the Boston area, probably will not change during the forecast period. It can be anticipated, therefore, that even though time-distance may diminish in the future, any new residential development would cause a decrease rather than an increase in over-all densities for any given town. Several adjustments were made in the gravity model to account for this phenomena.

The most important variation employed was the assumption that the future densities of vacant and buildable land in outlying towns would be controlled by existing zoning regulations. In doing this, the staff took cognizance of the fact that the older density pattern was the result of forces acting in the last great building boom of the 1920's rather that the result of forces which will influence development in the area during the next 15 years. However, an effort was made to obtain some sense of whether the zoning ordinances might change in the near future.

Another major adjustment was required to take into account the influence of the subcenters previously mentioned. Thus towns which had an improved time-distance relationship not only to Boston but to one or more subcenters would be affected by several developmental forces. Inasmuch as the developmental influence from these subcenters could not be as great as that of Boston, the influence of development was weighted by the size of the subcenter relative to that of Boston. Similar adjustments were made for the future employment densities. The zoning ordinance was interpreted to suggest a probable employment density in outlying vacant and buildable areas zoned for different classes of industry. The gravity model was employed only to indicate the amount of land that would be developed in the analysis areas over the forecast period in the future.

After estimating the future employment and population which could be held in each of the several analysis areas, termed the "holding capacity", it was necessary to take into account a number of other influences which are not always readily quantifiable. The most important of these is the future land-use plans of the several towns affected by the highways. Probably the next most important influence is whether or not individual towns are interested in accelerating their growth. A measure of this desire was obtained in interviews with local government officials and others interested in development.

Other factors considered were utility coverage, local tax rates and assessment policies, the existence of special local problems such as overcrowded schools or unattractive housing stocks, and the visual setting of the New England town as it might affect the working environment of skilled personnel.

The holding capacities acted as control totals for the amount of population and employment that might be anticipated in any area. All predictions were reconciled with the total population and employment forecasted for the entire study area. This has resulted in some inter-zonal changes and modifications.

The product of this analysis was a table showing predicted population and employment differentiated according to the several industrial categories for each town. Subsequently, employing differing assumptions, several tables were prepared to present the parameters of possible development and change over the planning period. The assumptions were varied in the following manner:

1. High, medium, and low projections of economic activity based on differing assumptions as to the growth potential and growth rates of major industries.
2. Differing assumptions as to the priority of highway construction, the future of metropolitan public transit, and the planning of towns within the study area.

In each case, using the findings an analysis was made of the predicted changes in population and economic activity in terms of the individual actors affected as outlined earlier. The conclusions of the actor analysis of both the physical and functional impacts of each proposed alignment were considered together with accepted engineering criteria in determining which alignment would most nearly satisfy Boston's present and future needs.

Determining Priority of Highway Construction

The forecasts of the future distribution of people and jobs based on simultaneous construction of the several highways were employed by the traffic engineers to determine the probable future traffic volume on all segments of the highway net under study. The traffic distribution was used in the normal manner to determine a preliminary set of construction priorities. Of course the eventual distribution was no more realistic than the original assumption of simultaneous construction.

In general, to properly relate construction priorities to the land-use model, a process of successive approximation can be undertaken. A new set of distributions can be made using the proposed preliminary priorities. The new model will result in traffic estimates which may show some overloaded segments of the net, requiring a new set of priorities. The new priorities can then be used to make another distribution of potential traffic. This process can be repeated through several rounds until the traffic loading and the land-use model are in balance.

The number of successive rounds was limited in the Boston study because the several highways being considered are planned for completion within a relatively short time span. If there was a considerable gap or years between the opening of any two highways under consideration, however, several rounds might be necessary. The Boston study seems to indicate that the full effects of a highway will not be felt for a period of from four to eight years after the highway's opening. The actual length of the impact period is a function of the regional rate of growth: the slower the growth, the longer the period.

This process assumes that traffic improvements skew land-use development in the direction of improved service and that the development of new areas in turn generate new traffic demands. The traditional method of building highways in response to demand will perpetuate the current pattern of regional development. It can readily be seen that inasmuch as the link between highway service and land use exists, to a degree the priority of highway construction alters existing urban forms.

An entirely new dimension is suggested by this relationship. Why should highway construction be used to continue the endless round of more growth in a suburban area and more highways to serve the same area? Why shouldn't highway planners consciously rely on this relationship to create a more uniform distribution of origins and destinations thus permitting a parsimonious use of the entire highway system? Such planning would undoubtedly accomplish major savings in the costs of highway construction.

Unquestionably a program of interrelated highway and land-use planning would require the cooperation of responsible city and regional officials to assure a metropolitan form that would best serve the economic and social goals of the public. The national highway program, however, is of such magnitude that the cooperation of all the vitally concerned interests can be readily obtained. The studies in Boston clearly indicate that only a few months would be needed to bring land-use planning and highway planning into consonance provided it were made a requirement of the Federal interstate program. Early consideration of this vital program could yield impressive benefits to our increasingly urbanized nation.

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Influence of Transportation Changes on Urban Land Uses and Values

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● THE REVOLUTION in transportation methods has been pointed to as the most significant factor affecting the structure and economic well-being of urban communities in the twentieth century. Meanwhile, little is known concerning the actual effects of changes in transportation on urban land uses and land values. Today, highway planners, appraisers, real estate brokers, local planning officials, and the general public ask, "What is the effect on land uses and land values of current programs of highway construction?" Highway right-of-way agents are interested in determining the influences of limited-access highways on adjacent land and the over-all impact of highways on land values. Appraisers are concerned with the impact of highway development on adjacent and nearby property. Real estate brokers and land developers seek to analyze highway impacts on land development and investment prospects. Metropolitan planning bodies must consider the probable influence of highway development as a basis for future master planning. City and county officials are concerned with the impact of highway development on property values which serve as the local tax base.

Although much research has been carried on in recent years by state highway authorities, universities, and others under the auspices of the Highway Research Board and other research groups, the problem of analysis is extremely complex and the results thus far permit only limited generalization.

The objectives of this paper are threefold:

1. To review and evaluate present theories of urban land values with particular reference to a recent exchange of views regarding the effects of transportation changes on land values.
2. To summarize the empirical evidence on urban land value trends.
3. To describe some new research approaches to the analysis of the influence of transportation on urban land uses and values.

REVIEW AND EVALUATION OF PRESENT THEORIES OF URBAN LAND VALUES

Economists are in general agreement that urban land values represent the present value of expected future net returns attributable to land (site rents). It is evident that the determination of urban land values in the market under this theory implies the capitalization of future expected urban land rents by investors, employing selected capitalization rates. This observation highlights the importance of the element of investor psychology and expectations as influences on the determination of land values in the market place.

The classical economic rent theory, which had its roots in Ricardo's rent theory based on differential fertility of soil, holds that site rents result from superior acessibility advantages and that the owners of the relatively accessible sites will impose a rental charge equal to the saving in transportation costs which the use of their sites makes possible. Haig (1, pp. 38-40) in his exposition of this theory, points out that general improvements in transportation or specific developments which make it easier or cheaper to get to or from the center of the city would decrease the relative accessibility advantages of central sites and hence reduce total urban site rents and land values.

Haig's analytical framework and conclusions have been accepted by virtually all

land economists. Based on this general theory, Dorau and Hinman argued that increasing the speed and decreasing the cost of transportation would result in an increase in the supply of urban sites by bringing more land into utilization. Thus, extending the city's boundaries by transportation improvements would increase the supply of sites, reduce the relative accessibility advantages of central locations and lower total land values.

From the same premises, Ratcliff (2, p. 129) argued that an increase in bus fares to the central city from the suburbs would tend to increase total urban land values and that, conversely, the improvement in transportation resulting from the spread in the use of the private automobile has tended to reduce land values in the central areas by making outlying retail centers more generally accessible.

These and other analyses based on Haig's theory, failed to give adequate consideration to the highly important assumptions underlying Haig's theories. Further, in many cases, the distinction between the effect of transportation improvements on downtown commercial site values and total urban land values has not been explicit.

The implications of some of the conclusions which have been drawn for public transportation policy are surprising, if not alarming. If one accepts the conclusions which appear to have been drawn by Haig, Ely, and Ratcliff concerning the probable effect of transportation improvements on land values, without considering the limiting assumptions underlining their theories, any city desiring to preserve its land values as a tax base would oppose improvements in transportation.

Serious shortcomings can be observed in the attempts to apply classical price and rent theories to urban land valuation problems. The author has concluded that many accepted urban land valuation theories represent little more than unsubstantiated hypoteheses and at best are abstract and theoretical formulations based on highly unrealistic assumptions (3, p. 240).

In an attempt to develop a more useful framework for analyzing urban land values, the author has classified the principal factors influencing the aggregate of land values in a city. This theoretical reformulation of a theory of land values represents aggregate land values in a city as the present value of the expected future returns to urban land. A theoretical model of the factors influencing urban land value trends focuses attention on major determinants of urban land values in the following equation:

$$\text{Aggregate Value of Urban Land} = \frac{\text{Average Future Expected Aggregate Net Annual Urban Land Rent}}{\text{Capitalization Rate}}$$

It should be emphasized that, inasmuch as land values are based on investor's opinions which in turn are based on expectations, investor psychology is an important influence underlying urban land value trends. Three sets of factors are identified as influencing the value of urban land based on the foregoing conceptual model.

1. Factors influencing expected revenues to urban land: changes in population, consumer incomes, and total demand for urban services, competitive pull of other areas, supply of land, and prospective and actual investment in public improvements.
2. Factors influencing costs as an offset to urban land revenues: changes in local property taxes, operating and management expenses, interest on capital invested, and depreciation allowances.
3. Factors influencing the rate of capitalization applied in the real estate market to expected net returns from urban land: changes in interest rates, expectations of risk, and capital gains.

This analytical framework focuses attention on the complexity of factors influencing urban land value trends. Specifically, it draws attention to the fact that improvements in transportation to and from urban centers not only have the effect of adding to the supply of competitive land, but at the same time result in an increment to the population served and hence to the demand for urban land and its services.

Ratcliff (4, pp. 360-362) argues that this approach "adds little to our understanding of urban land values." He accuses the author of employing the "straw-man device" in his criticisms of urban land value theories and with missing "the obvious intent of

Ely and Haig to state in hypothesis from a simple cause and effect relationship clearly restricted to a general tendency under limiting conditions". For reason outlined in the following, Ratcliff's rejoinder cannot be accepted as invalidating the criticisms of classical theories as trite and unrealistic.

Specifically, the implicit assumptions in the theories of Ely, Haig, and Ratcliff that "other things remain the same" are not only unwarranted, but also illogical. Where A (a change in transportation) is associated with B (change in demand for urban land) and in C (change in supply of urban land), and where these influences have a combined effect on urban land values, one should not (even in theory) postulate changes in C without recognizing that changes will occur in B also. The unrealistic nature of Haig's theory becomes apparent when the implicit assumptions postulated in the phrase "other things remain the same" are made explicit, as in the following restatement:

> Assuming that accessibility to the center of the city is the only criterion for both residential and business location, that all urban sites are substantially homogeneous, that total transportation costs are minimized by locating at the city's center, site rents and land values will tend to be highest in the center of the city.
> Under the above assumptions, general improvements in transportation might result in a decline in the value of sites in the center of the city, provided that they are not accompanied by an increase in travel to the area or any other increase in the demand for services of central area sites.

The assumption of ceteris paribus in the Haig analysis presupposes a "closed" urban area with constant population and incomes. However, it must also assume something about the relative elasticities of the demand and supply curves for transportation if an improvement in transportation is to result in a lowering of aggregate site values. If the effect of improving transportation is to increase the movement of people and the demand for urban services, it can be expected that even in a closed system such as that postulated by Haig, aggregate land values may rise with improved transportation. The relationships between transportation improvements and aggregate site rents under varying conditions of demand and supply elasticity can be conceived in the following manner.

The basic economic service provided in any city is the service of "getting you there." The place you want to go may be to your job, your church, shopping, or any of a great many objectives. This service may be called the "providing of trips" though it is understood that it is not the trip in itself which is wanted but rather what lies at the end of the trip.

Land and transportation are two factors of production which supply trips in the sense used here. If land is highly accessible little transportation is needed to "get you there."

If land is poorly accessible much transportation is needed. Haig refers to the cost of "getting you there" as the costs of "friction."

In Figure 1 the vertical axis represents either the price per trip which buyers would be willing to pay for different quantities of trips or the cost per trip at which suppliers would be willing to supply. The horizontal axis represents quantity demanded or supplied.

The demand curve indicates that buyers are willing to buy more of the basic service provided the price per trip is reduced. This means that at lower prices they may not be so careful about ganging up working and shopping trips; they may make some trips which otherwise would be too long, etc.

The postively sloped supply curve, mp' represents the transportation charge for providing the quantities and kinds of trips demanded. It indicates that generally speaking, as the number and distance of trips are increased, the cost per trip increases. The basic assumption is that substantial increases in the number of trips are accompanied by increases in distance traveled per trip.

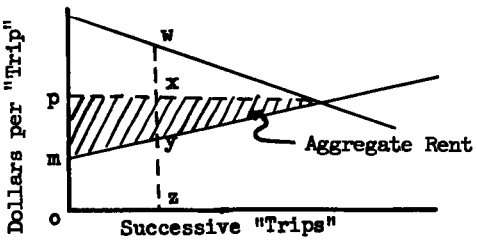


Figure 1.

The market price and quantity are determined at point p'. At this point the value of the last trip demanded is just equal to the transportation cost in providing it. Then line p-p' is the price line for all units of the service.

The width of line wxyz represents one trip. For this particular trip the demand curve indicates that buyers are willing to pay the amount zw. Actually they only pay xyz, for that is the market price. But of the market price the cost of transportation is only zy—for this trip. The remainder, yx, is taken by land. Why does land take this residual? The land involved is so situated as to make possible the relatively low transportation cost zy. Then the rent to land is the whole area pp'm. This is aggregate rent.

Suppose the transportation system is improved. Line mp' becomes line m'p'''. The new price becomes op''. The new aggregate rent to land becomes p''p'''m' (Fig. 2).

The new rent to land may be either greater or less than before, depending on the elasticities of demand and supply.

The more inelastic the demand and the more elastic the supply becomes, the greater is the tendency toward a reduction in the aggregate rent to land as a result of an improvement in transporation as shown in Figure 3. The more elastic the demand and the more inelastic the supply becomes, the greater will be the tendency to an increase in the aggregate rent to land as a result of an improvement in transportation. This is illustrated in Figures 3 and 4.

Actually, relatively little is shown at this time about the elasticities of the demand and supply curves for transportation. It is clear, however, that the conclusion that an improvement in transportation will result in a decline in aggregate rents and hence in land values, represents a special case, and one that is unlikely to occur.

An absolutely inelastic demand curve for transportation to the center such as that postulated in Haig's theory is virtually inconceivable. Any improvement in transportation which increases travel by an existing population, or extends the boundaries of the area served by the center of the city, is certain to increase the number of trips by some amount, and this amount will be larger as the relative elasticity of the demand for transportation services is increased. The prospects of an upward shift in the demand for trips with any improvement in transportation are magnified by the fact that transportation improvements are usually made in response to an increased demand. Although the author is not prepared to present empirical evidence of the increases in travel to the center of American cities with the improvements in auto transportation facilities during the past decade, he is certain that transportation engineers will need little convincing that the price-elasticity of demand for trips may be high.

When these and other limitations of Haig's theory are carefully considered, it is apparent that one should not draw conclusions concerning the practical effect of a change in bus fares or of other transportation facilities on land values within the framework of his partial analysis.

The assumption that all urban sites are relatively homogeneous further vitiates the use of the classical analysis. In one sense, the supply of urban land is unlimited, inasmuch as virtually all cities can expand in some direction. In another sense it can be argued that urban sites

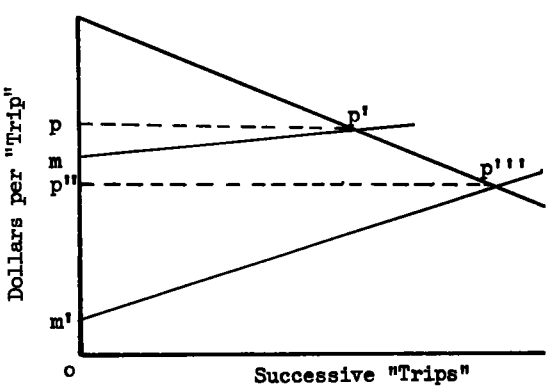


Figure 2.

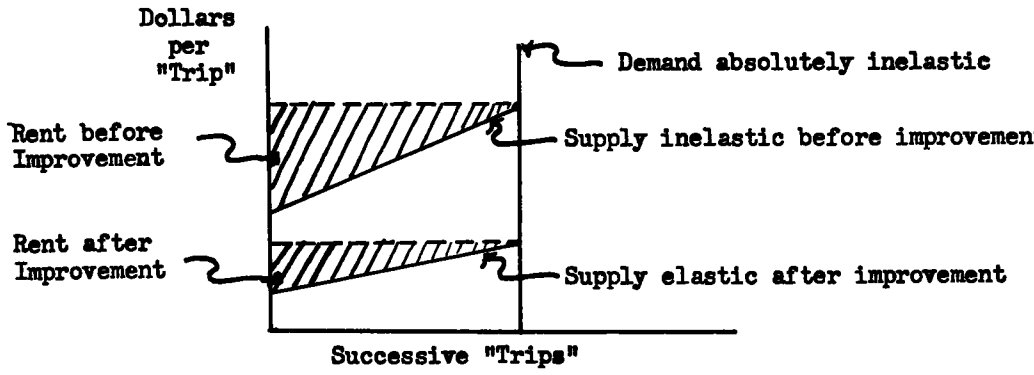


Figure 3.

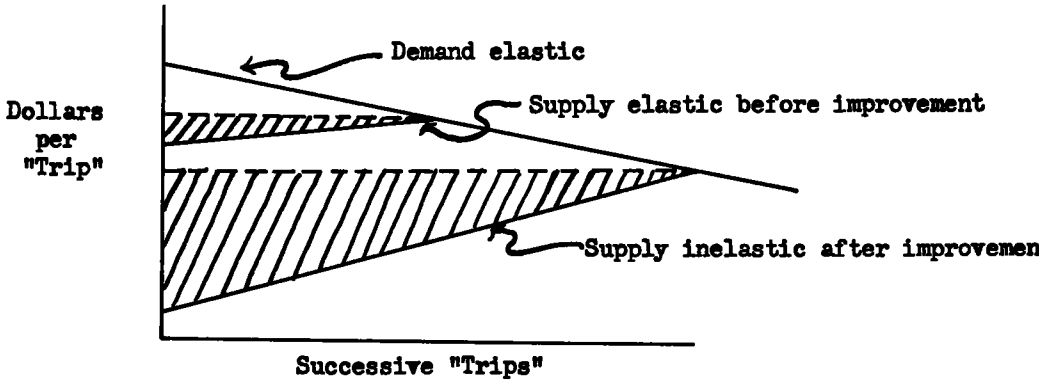


Figure 4.

are highly differentiated and that the urban land market is distinctive. Linkages between various types of activities which impede shifts in location are an important factor influencing differentiation of real estate markets. The effects on such markets of increments to supply are quite different than if land units were identical. Improvements in transportation must be viewed, therefore, in the light of their particular effect on various submarkets rather than on the urban land market as a whole. Freeway construction, for example, may result in major additions to supply of residential land without increasing the supply of commercial or industrial land. Zoning, of course, and the tendency for complementary uses to be "linked" together contribute to site differentiation and to the compartmentalization of different segments of the real estate market.

The argument that the principles of monopolistic competitive pricing rather than pure competition pricing prevail in the urban land market has been misinterpreted by Ratcliff (4, p. 362). He fabricates his own "straw man" in attributing to the author the view that urban property owners have "monopoly" control over the supply of urban land. Because of this misinterpretation, most of his discussion has no bearing on the central argument that increments to the total supply of urban land may have limited effect on downtown commercial site values because of the highly differential character of urban sites and the existence of distinct submarkets.

The importance of the fact that the urban land supply is differentiated into various submarkets can be observed in Figure 5, which represents the supply of land with

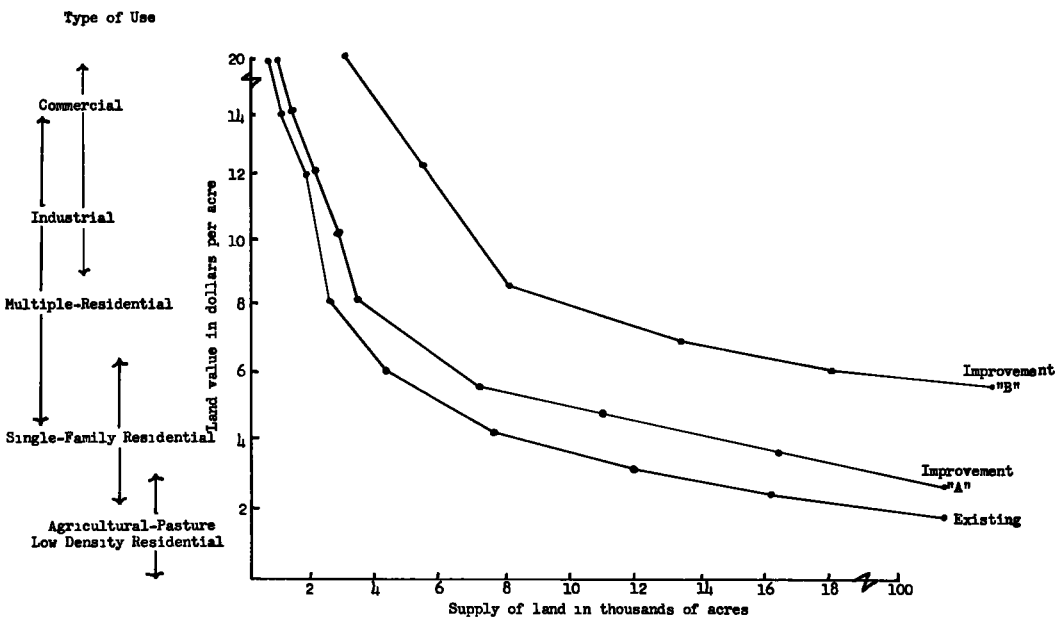
various accessibility advantages at three time intervals. The existing supply curve shows a relatively limited supply of sites with high accessibility features and hence high dollar values per acre. The supply of low-density residential land is, of course, much larger in amount and lower in value per acre. An improvement in transportation "A" (freeway construction), may result in a large increment to the supply of land suited to residential subdivision, but may not add appreciably to land suited to commercial and industrial uses. A different type of transportation improvement "B" may, however, add substantially to the supply of land with accessibility advantages suited to commercial use. Differences in the characteristics of land and in relative accessibility advantages contribute to the difficulty of generalizing concerning the effects of any given change in transportation on urban land values.

Although Ratcliff acknowledges the central premise that Haig, Ely, and others do not "set forth a comprehensive theory of urban land values" and that their analysis was "clearly restricted to a general tendency under limited conditions," he offers no explanation for the fact that he and others have employed such a restricted and noncomprehensive theory to draw conclusions regarding influences of transportation changes on land values that appear both illogical and indefensible.

Ratcliff's comment that "Professor Wendt is, of course, thinking in terms of the net effect (of transportation changes) which is quite another concept," is a partial recognition of the shortcomings in earlier analyses. It is indeed comforting to find that he agrees that "whether the total effect of all factors is a decline (in values) can be determined only by empirical methods." On this note of agreement, a review of the evidence concerning recent trends in urban land values follows.

Urban Land Value Trends

Well-organized data describing trends in urban land values in the United States are lacking. Any conclusions drawn, therefore, must rest on the pioneering work of Hurd and Hoyt during the period from 1900-1933, supplemented by more recent studies in a relatively few major cities. A limitation on interpretation of research results arises



A - Improvement in transportation - expands supply residential land

B - Further improvement - commercial and multi-family uses Expand into outlying areas

Figure 5.

from the uneven quality of the basic data employed in various studies, because some rely on assessed values, whereas others are based on relatively small samples of market sales. Further difficulties arise from the fact that many of the existing studies are confined to land value trends in specific areas of cities, preventing descriptive analysis of changes in total values or of the internal structure of values within cities or metropolitan areas.

Notwithstanding these limitations, broad trends in urban land values can be described. Recent studies confirm the findings of Hurd and Hoyt that urban land values rose quite rapidly during the first quarter of the 20th century, culminating in a speculative peak in the late 1920's. Commercial land in the central business districts of the larger cities rose to particularly high levels during this period, although land speculation resulted in rapid increases in outlying commercial and residential land as well. Following a disastrous period of liquidation and foreclosures during the Great Depression, urban land values rose gradually in the prewar years, and more rapidly during and immediately following World War II, under the stimulus of high rates of urbanization and business property (5). By 1950, urban land values in the central business districts of some larger cities had recovered to the previous speculative peaks of the 1920's, although values appear to have risen more slowly in New York, Chicago, and a few other of the largest cities. Since 1950, land values in the central business districts of most large cities have risen further, accompanied by relatively high levels of commercial and office building activity. Rising local property taxes have constituted a "drag" on urban land values generally.

Recent studies of urban land value trends in the San Francisco Bay Area (7, 8) revealed that total Bay Area urban land values have probably more than doubled since the peak of 1929-30. The percentage increase in land values was substantially greater in outlying commercial and residential areas than in the central areas of San Francisco or Oakland. Value increases during the postwar period were most striking, of course, in the newly developed commercial areas and shopping center locations. Although land values rose in both the central core and in the suburbs, striking differences in urban land value trends were noted within different parts of both central and outlying areas.

The dynamics of change in the structure of urban land values adds greatly to the difficulties of generalizations concerning trends. It is apparent that a general rise has occurred in the aggregate current dollar value of urban land values in the San Francisco Bay Area. Because of the more rapid rate of increase in land values in the outlying areas, the percentage of total increase in land values appears greater as the area included is increased in size.

Although these views cannot be supported with well-organized statistical data it is believed that distinctive trends can be observed in various Bay Area submarkets for urban land in the past decade. Rising values in the office building sections of the larger cities have been accompanied by lagging value trends for some downtown and string street retail store sites, and rapidly increasing values for newly developed retail areas. Meanwhile, booming values for sites suitable for high rent apartments or hotels have been countered by a relatively stable trend for other residential land within central areas. The impact of Federal subsidies for urban renewal programs has gradually been reflected in higher land values in selected slum areas. High rates of tract building in the suburbs have resulted in lot prices in many outlying areas equaling or exceeding those in more central locations. Little evidence can be found for a gradient of land values from the center to outlying areas in today's market.

These apparently diverse trends reflect in part imperfections in the real estate market apparatus, but to a degree they also support the view that urban sites are highly differentiated and enjoy narrow and specialized markets. Changes in the aggregate of urban land values in the Bay Area, therefore, cannot be identified as resulting from a total increment to supply, but rather from the totality of increments to both demand and supply for various sites having particularized accessibility and other advantages.

It is arguable whether a real rise has occurred in urban land values since 1939, after adjusting for changes in the value of the dollar. Because urban land values have risen more rapidly in outlying suburban areas, the conclusion reached might depend

on the size of the geographical area included. There can be little doubt, for example, that total urban land values have risen substantially in constant dollars in the San Francisco Bay Area, in Los Angeles County, or in the New York Metropolitan Region over the peak level of the 1920's. It is probable, however, that the value trends in the City of San Francisco or New York would show a lesser increase, because values have risen more rapidly in outlying suburban locations.

The double peaks in land values reached in the 1920's and the 1950's adds to the difficulty of describing long-run trends in urban land values. The trend appears clearly upward if the researcher accepts the year 1900, 1940, or 1950 as a base, but the slope of the long-term trend line in urban land values is quite different if he uses the high levels of the 1920's as a base period.

Few systematic studies have been made of the relationship between transportation changes and land values. Research in the San Francisco Bay Area suggests that the influence of increments to the supply of urban land resulting from improvements in transportation are much more complex than assumed in classical economic analysis. Improved freeway transportation has undoubtedly been a factor influencing the more rapid rise in urban land values in outlying suburban areas. One might also conclude that the expansion in auto transportation has restricted the expansion in central city land values that would have occurred in the absence of extensive highway development. A decline in some central city functions can be observed. The results of the United States Census of Business for 1954 reveal, for example, that the percentage of total retail sales accounted for by cities with 100,000 or more inhabitants declined from approximately 43 percent in 1939 to 38 percent in 1954 (9, p. 307). This observation, however, obscures the relatively large absolute increase which has taken place in retail sales in central cities, and takes no account of the expansion in administrative, financial, and tourist functions. It thus reflects the relative change in demand for only one type of urban service performed by central cities and may have been offset by an increasing dominance of the central city in the furnishing of many other types of business services.

The complex structure of urban land values and the constant shift in the internal structure of urban land values restricts generalization concerning value trends. One might be justified in concluding that the combined influence of improved transportation and other factors present during the postwar decade has been to result in a major expansion of urban areas, an increase in the demand for all urban services and a rise in land values in the central business districts, central cities as a whole, and in outlying residential and business locations.

Increases in aggregate urban land values in the San Francisco Bay Area during a period of rapid expansion in urban facilities for auto transportation suggest that any declining value influences resulting from the increase in supply of competitive urban land have been more than offset by expanded demand for urban land and its services. This observed trend would appear to confirm the earlier hypotheses that increments to the supply of urban land are usually accompanied by concomitant demand increments. In some sense, it can even be argued that increases in demand appear to bring about the increases in supply, rather than to follow.

Lessinger, of the Real Estate Research Program, is developing a comprehensive methodology to forecast the impact of highways on urban land use and values. Certain aspects of the method are in process of being tested in the nine-county San Francisco metropolitan area. The following brief account of the tentative method is necessarily oversimplified. There are eight essential points, as follows:

1. An economic concept of the metropolitan area is adopted to provide a land market within which highway impacts are considered.
2. Land use impacts are put in terms of different "rates of urbanization." The rate of urbanization is the number of acres urbanized over a period per 100 acres which are suitable and available for urbanization. The rate of residential urbanization is correspondingly the number of acres converted to residential use over a period per 100 acres which are suitable and available. Likewise there are commercial and industrial rates. Different degrees of intensity in each use may also be identified as a basis for determining "rates."

3. Sectors are defined within metropolitan areas on the basis of different rates of urbanization. Suppose an entire metropolitan area is divided up by a grid of very small rectangles. Suppose the rate of residential urbanization is observed for each rectangle. The different rates can be visualized as different "heights" on a relief map. Presumably there will be a series of "hills" and "mountains" formed. These can be represented by a topographic map showing contour intervals. The contiguous area within any two contour intervals is defined as a sector. It is a residential sector if the rates are residential rates. It may be any other type of sector depending on the nature of the rates. Of course a map of residential sectors will be very different from a map of industrial sectors. It should be noted that the sectors are not fixed, but constantly shift in response to a large number of factors.

4. Factors explaining the boundaries of sectors can be organized into four groups: supply of and demand for accessibility, supply of and demand for base-productivity. Accessibility refers broadly to ease of making ground trips from a site to other sites. Base-productivity refers to the ease of producing goods and services at a site. Buildings, views, drainage, and zoning are examples of base-productivity attributes. These illustrate the nonhomogeneity of sites. Incidentally, Lessinger's approach argues against the too inclusive preoccupation with the accessibility factor. In practice it is likely that there are large research benefits from the relative expansion of attention to the base-productivity variables.

5. In contrast to earlier theories, accessibility is identified as a cost schedule to reach wider and wider groupings of jobs, shopping services, and other potentially desired opportunities.

6. A study is carried out to determine for a particular metropolitan area how different accessibilities and base-productivities are associated with the various sectors. Two kinds of products are obtained from this study:

   a. Combinations of accessibility and base-productivity are derived which belong to different sectors.
   b. Projected sectors can be put in an array as to superiority or inferiority for each set of uses.

This kind of study is being carried out in the San Francsico area for residential sectors. The nine counties facing the San Francisco Bay are divided into a grid of more than 35, 000 rectangles. Random points are projected within relevant rectangles, and over 25 types of information are compiled for each. This information bears either on the rate of urbanization or on accessibility or base-productivity.

7. An empirical law of distribution of land uses among the sectors tends to hold. This law is in the following form: the best 10 percent of all the land in the metropolitan area (as determined by the empirical work already described), will obtain x percent of the total acreage in the given land use. The best 20 percent will obtain y percent and so on. This is strictly comparable to the empirical laws of income and wealth distribution in economics which are represented by "Lorenz curves." It is determined from data for a given period, and then assumed to change slowly enough so that it would tend to hold for future periods.

8. Finally, it is desired to project for some future time period, changes in land uses (and ultimately land values) which are due to changes in a highway system and other variables.

   a. Estimate total urbanization of a given type; for example, residential, for the metropolitan area as a whole.
   b. For every site calculate accessibility and base-productivity attributes, given the future highway system.
   c. Future sector boundaries are determined. This depends on the future accessibility and base-productivity attributes, and the relationships between accessibility base-productivity and sectors determined for a past period.
   d. The total estimated acreage of the land use is then distributed over the various sectors in accordance with the empirical law of distribution.
   e. Further periods may be projected by taking the results of initial periods as a feedback.

f. Further refinements may be added: totals may be determined simultaneously with distributions on all levels.

As a result of the methodology developed by Lessinger, the impacts of highways emerge as one facet in a closely connected web of factors. The answer emerges from the reconstruction of the total web of factors. Further impacts may then be sought within the sectors. There, physical proximity to highways and freeways may be most important in differentiating sites.

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Evaluation of Highway Impact

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● THE SUBJECT of highway impact has received much attention from highway planners, engineers, and administrators. Certainly the subject deserves all the attention it can get. The authors' present concern with the subject is that of the planner, or more precisely of the engineer as he operates within the framework of the planning function. In selecting a highway location is "impact" something to be considered? What is impact, and what kinds of impact are there? If impact is something to be considered, how can it be identified and predicted? What should be done with these measurements or predictions? These are questions which unfortunately are more complicated than they sound. Hopefully, they are questions for which workable answers will soon appear. They are questions, however, to which the sort of answers needed are not now available. It is this last fact that is of principal concern.

Briefly, the authors not convinced that either the data on highway impact thus far collected or the uncertain conclusions advanced therefrom are of any real use in making decisions regarding the economics of a highway program. If these findings do have a use, it seems most logically to be in connection with traffic prediction (1), over-all land-use planning, or land acquisition, but not with the economic justification of location and design. This is notwithstanding the fact that some very complete studies of so-called "economic impact" have been made in recent years (2, 3).

It is important to note that the discontent with these findings is as engineers, not as social scientists, though perhaps the questions at issue are more properly within the realm of the social scientist than the engineer. However, engineers cannot escape the responsibility for bringing highway planning and location studies to some definite conclusion. The social scientist, who should long since have surpassed the engineer in his ability to render sound judgments on the very complex questions here at issue, has thus far shared very little in this responsibility. The fault, is largely the engineer's, not his. The engineer's concepts of such things as "economic impact" do not seem to do the job. Not only do the engineers need the economist, the sociologist and others; but they need to use them.

Sharing the responsibility does not, however, mean renouncing it altogether. This, highway engineers cannot do. They must still understand the problem as it relates to the engineering job, even though this may not require them to formulate the basic concepts. It is in this spirit that the authors have undertaken to review the subject of highway impact.

WHAT IS IMPACT?

It is impossible to separate the question of whether impact should be considered in planning and location from the more basic question of what is meant by highway impact. In the ultimate sense, if it could be specified exactly what is meant by impact, all questions regarding its measurement and how it should be accounted for in decisions would be answered. It does not seem the matter can be disposed of so easily. In general, it can be agreed that when the "impact" of a highway is spoken of the effect of its construction and operation on the character of its total environment is brought to mind. Within this definition highway impact can still mean many things to many people. It can be and often is thought of solely in economic terms. It can be but is not so often thought of in social terms. It should be and fortunately is being thought of more and more in aesthetic terms. It is almost always thought of, though perhaps not by engineers, in political terms. Which frame of reference is the important one, then? Where does one begin?

Clearly all points of view are important. To say one is most important is probably not meaningful as a general statement. Yet it would seem possible to reduce the problem in some respects. One can logically suggest, for instance, that the aesthetic impact of a highway manifests itself in part as either an economic or a social impact. That is, the impact of a highway on the senses of those who use it or those who inhabit its environment has an ultimate effect on the way in which those people are impelled to order their economic and social activity and the degree of satisfaction which this produces for them. By similar reasoning one might also account for the political impact of a highway by specifying its economic and social impact.

One might go even further by explaining social impact in economic terms. If people have a discernible preference for one alternative social situation as compared to another, then presumably they will be willing to pay something for it. Inasmuch as anything for which a money market exists can be said to have economic value, the shift from a social to a strictly economic point of view is perfectly possible in theory. Yet the practical difficulties are too obvious to mention. In the present state of ignorance, moreover, the probability is that if such simplifications as these are made, the extremely complex set of relationships which are actually involved may be obscured. Thus, it seems not only necessary but desirable to consider the question of impact from at least these four points of view, economic, social, aesthetic, and political.

Of these four, economic impact has received the most attention in recent years, and for obvious reasons. There has been a profound restructuring of economic activity in the environs of many controlled-access highways immediately after their construction. This experience has raised the possibility of using highways as an instrument in a purposeful program of economic change. It has also suggested that to the extent the resulting changes are desirable one might find in them a further economic justification for the building of highways. These possibilities appeal greatly to highway administrators and to engineers. The interest in economic impact is, therefore, logical.

This paper is primarily concerned with economic impact largely because this puts both the reader and the authors on somewhat more familiar ground, and not because of any intention to minimize the importance of the other types of impact mentioned. It is the authors' conviction, in fact, that the social impact of highways will in the long run be the more important problem.

WHAT IS ECONOMIC IMPACT?

"Impact" has been defined as the effect of a highway improvement on its total environment. It seems logical that to the extent this effect manifests itself in an economic form it can be spoken of as "economic impact". Again, one should not confuse this economic impact with the value which may be attributed to, say, the aesthetic benefit of an improvement. To put it another way, if impact is what happens to the environment of a highway, economic impact is what happens to the economy of the environment. As such it has little necessary connection with aesthetics or with social and political structure.

Each of the many economic impact studies seems to have redefined, either explicitly or implicity, the term "economic impact". Most commonly, however, these studies incline to the view that the non-user (non-vehicular) economic benefits (or changes) resulting from an improvement constitute its economic impact (4, p. 20). This point of view is not entirely consistent with the more general definition suggested previously. It does, nonetheless, serve as a fairly good working definition. The distinction made between user and non-user benefits (which may also be referred to as vehicular and non-vehicular, or as direct and indirect benefits) is one which facilitates the study of impact questions.

Excluding user benefits from economic impact does not obviate the need to include them in this discussion. It is necessary to understand the nature of user benefits to avoid confusing them with economic impact (4). User or vehicular benefits are a key, in fact, to an understanding of non-user benefits; that is, economic impact (1).

Basically user benefits take the form of: (a) vehicle operating cost savings; (b)

time savings; (c) a reduction in accident costs; and/or (d) an increase in "comfort and convenience." Where an existing highway has been improved, for example, the users of that highway presumably will receive benefits in one or more of these categories. Characteristically improved roads will do more than that, however, in that they will serve some (and perhaps many) users who either did not use the old road or who did not use any road before the improvement was made. There are three classes of users (5) then, that are of interest here:

1. Those who used the old road (if any);
2. Those who previously used another road; and
3. Those who previously did not use any road;
   (a) More frequent trips between previously existing origins and destinations,
   (b) Trips previously made by other modes of transportation, and
   (c) Entirely new trips which the improved facility has now made "worthwhile".

Some comments on the benefits realized by the last two of these three classes of users are in order. In the case of a user who formerly took another route, the time and operating cost benefits on the new route may be negative. The comfort and convenience benefits may appear to be negative as well. One may be tempted to suggest that the user is therefore acting irrationally and to point out that it is impossible to predict irrational benefits on a rational basis. The answer to this apparent inconsistency is that if a user changes his route he does so because he is receiving a positive benefit as far as he is concerned. If he were not, he would not have made the change in route. If the values which engineers choose for time or comfort and convenience do not correspond with what the motorist actually does, then it is the engineer's values which are wrong. Whether one can consider the user's action rational or not is beside the point.

In the case of the entirely new trips using the improved road, a similar confusion may arise in that the operating and other user costs are necessarily greater than when no trips were being made. It would thus seem that these were negative benefits, but quite the opposite is true. The question of how large these benefits really are is discussed elsewhere (6, p. 40). It is important to point out, however, that this situation necessarily involves a diversion of consumer expenditures from other sectors of the economy. (When a highway attracts new trips in this fashion, the government has, in effect, set itself up in business to compete for more of the consumer's dollar. If the consumer sees fit to buy, moreover, it is an indication that the service offered is justified—assuming, that is, that he not only pays the full costs involved but realizes as well what he is paying.) As a result, the actions of this class of users may be of interest in connection with the total impact of the improvement on its environment. Unfortunately this shift of expenditures is generally so diffused as to be relatively unsusceptible to measurement.

There is one additional class of user benefits which deserves mention, if only because it is so generally ignored. These shall be called second-order user benefits to distinguish them from the benefits discussed previously (which can thus be thought of as first-order user benefits). Second-order user benefits are those accruing to the users of routes which have been partially abandoned by other users in favor of a new or improved route. These benefits will characteristically take the form of a reduction in congestion delay, and thus are clearly net benefits. Because they may in some cases be significant, they merit consideration in any complete economic analysis.

Highway improvements do not necessarily produce user benefits (or disbenefits) which are significant. In a case where they do not produce user benefits, it is doubtful that there can be any non-user benefits either. In the more likely case where there are direct user benefits (in detail if not in the aggregate), one might expect, however, to find some non-user benefits—that is, economic impact—as well. Before going on to discuss this possibility, exclude from consideration a type of benefit which really does not belong in this picture. This is the sort of benefit exemplified by an improvement to local drainage incident to the construction of a highway. This, it is true, may be an economic gain to the community and as such may justify part of the construction costs. It is, however, a tangible external economy that is more proper-

ly classed with user benefits than with the less tangible non-user benefits of interest here. For the time being, similarly exclude social, political, and aesthetic benefits, though for different reasons.

Can a highway produce anything other than transportation which has economic value in its own right? One notion of the transportation product would seem to suggest an entirely negative answer. This is the notion that almost no one wants transportation for any by itself. Everyone seems to want it only to get something else; to get to work, to see a movie or to get cargo to some place where it can be used. It is always what takes place at the end of the trip which has real value, not the trip itself. Thus, in most cases transportation is merely a means to an end, not the end itself.

In this sense improving the transportation system can only be a conservative process. That is, by improving highway facilities the best that can be hoped for is to conserve the total resources expended on transportation so as to make them available for some truly desired objective. This is possible, of course, only if more user costs are saved than expended on the highway plant. Thus, one returns to vehicular benefits.

What about an increase in land values? Highway improvements seem to have an effect in this respect. Yet, a highway cannot create land. It can only increase the relative accessibility of that land. Increased accessibility is just another way of saying that the difficulty of getting to the land in question has been reduced. That is, the cost of transportation to the user has been lowered. Increased land values, therefore, are merely a reflection of user benefits which have been realized or are anticipated. This is the sort of shift in benefit which Zettel has explained. An increase in real estate tax receipts, though clearly a benefit to the communities concerned, similarly has its origins in these same vehicular benefits.

What about improvements in a production process which stem from improvements in transportation? Economics of scale in production are often realized when better transportation permits a concentration of production activities. At first glance it might seem that economics of this sort are separate and apart from the savings in transportation costs. A closer look reveals that this is not so. In the first place, if an activity which formerly was performed at several locations is now to be performed at one, the total transportation requirements characteristically will increase. Thus, the transportation costs will tend to increase. The question is whether or not they will increase more than the rest of the costs of the activity decrease. If the transportation costs do increase more than other costs decrease, the concentration is not economically desirable. If they do not increase that much, the concentration is economically desirable.

If concentration of a certain production activity did not take place before the transportation facilities were improved, this would indicate that the unit cost of transportation to the producer was too high to make the concentration economically desirable. Lowering the unit cost of transportation by highway improvements could make it economical to concentrate, on the other hand, and to realize the benefits of lower production costs in the process. Notice here that a lowering of transportation (that is, user) costs is a necessary condition. Notice further that this reduction in total transportation costs under what they would have been had the new road not been built must be at least as large as the saving in production cost. It must, in fact, be larger, or there will be no net benefit to the economy. Yet if the benefits accruing to the three classes of users mentioned earlier are properly accounted for credit will already have been taken for all of this reorganization benefit in the form of user benefits. (Again the question of how one should properly account for these vehicular benefits will be left unanswered. It sufficies to say that only part of this apparent benefit is actually realized.) Thus, even this type of non-user benefit seems largely imaginary.

The foregoing discussion leads, in any case, to the conclusion that the net economic benefits of highway improvement are all user benefits—that there are no net non-user benefits over and above the user benefits. Even so, the restructuring of economic activity which highway improvement so often catalyzes is of importance in highway planning. It definitely can produce benefits to some sectors of the environment; apparently it may, however, produce disbenefits to other sectors in the process. To

signify that these non-user benefits are a mere reflection of direct user benefits, they shall henceforth be referred to as secondary benefits.

HOW MIGHT SECONDARY BENEFITS BE MEASURED?

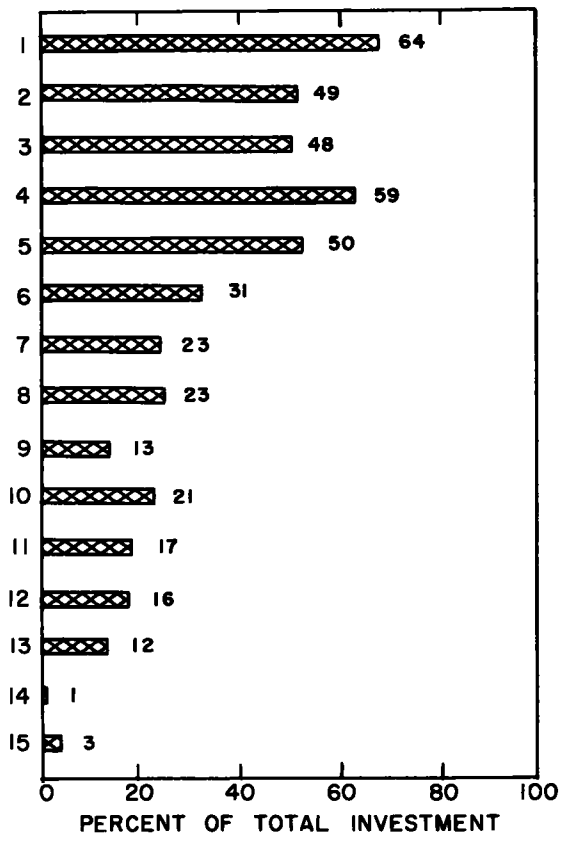
The process of identifying the changes in economic activity (including expansion, consolidation, and/or relocation) resulting from highway improvements is extremely complicated. Determining the magnitude of such changes is even more difficult. The relative accessibility of new and old locations—whether evaluated in terms of market size offered, or in commercial transportation costs—is but one of the variables which will affect the short- and long-run land-use changes taking place. For any economic activity there are also other considerations such as the relative importance of accessibility, space requirements, water supply, etc., to different types of activity; availability of land with varying degrees of accessibility; relative importance and magnitude of transportation costs (in terms of markets or movement of goods per se) as opposed to other production costs; tax structure of new and old locations; and marketability of the firm's existing plant.

At the outset some remarks regarding past economic impact studies are pertinent. First of all, these studies have dealt primarily with what the authors have called secondary benefits. Also, they have generally restricted their attention to measurement of changes in value of those properties (both improved and unimproved) abutting or within perhaps two miles of the highway. This is tantamount to saying that changes will take place only in this limited region. Some studies have reduced these value changes to the percentage increases which have followed the highway improvement; others have rated the increases relative to those of "control" zones or properties deemed unaffected by the facility. Where absolute values have been used and it has been implied that all these values were secondary benefits of the facility, some clarification is necessary. Certainly land value increases can and do result from user or primary benefits; they should, therefore, be classed as secondary benefits of the highway. On the other hand, it would not be correct to assume that all of the value of the improvement to that land was secondary benefit of the highway. This improvement value increase can be included only to the extent that accessibility (or other forms of direct highway benefit) played a role in the location and development decision.

In determining the extent of the highway's influence on relocation decisions, the results of one recent study of industrial development (2) may be of some aid in suggesting an approach. About 80 firms which relocated following the construction of Massachusetts Route 128 (a semi-circumferential route surrounding Boston on the western side) were interviewed and questioned regarding the major factors in their decision to move to Route 128. The replies were then tabulated under one or more of 15 factors or headings and each factor, if more than one was given, was "weighted" equally (Fig. 1). The investment represented by those companies indicating the factor of "Land for Expansion", for example, was then added up. This sub-total divided by the total investment of all 80 firms interviewed is the "Percent of Total Investment", or an index of importance, attached to the "Land for Expansion" factor. These percentages or indices are thus a measure of the relative importance of these factors to the industries involved. How then might they be used to evaluate the extent of the highway's influence?

The sum of the percentages of all 15 factors is 430. Thus, the importance of any one factor (or group of factors) might be expressed as its percentage divided by the total percentage of 430. Assume, for example, that the only location factors which can be traced directly to the user benefits of the highway are:

No.	Site Location Factor	Percentage		
2	Labor market	49		
3	Employee accessibility	48		
4	Commercial accessibility	59		
6	Advertising	31		
10	City congestion	21		
12	Commercial market	16	Grand total for all	
	Group sub-total	224	15 factors	430



FACTORS

1. Land for Expansion	6. Advertising	11. Lower Taxes
2. Labor Market	7. Parking	12. Commercial Market
3. Employee Accessibility	8 Land Cost	13. Railroad Facilities
4. Commercial Accessibility	9. "Package Deal"	14. Other
5. Attractive Site	10. City Congestion	15. Potential Value Increase

Figure 1. Rating of major factors considered in site selection by industries interviewed on route 128—September 1957.

Inasmuch as the factors having a direct relation to the transportation service offered by the highway make up slightly over 50 percent (224/430 x 100) of the total decision, it might be concluded that 50 of any improvement value changes (of the area being studied) can be classified as secondary benefits of the highway.

Two other important aspects are worthy of consideration at this point. First, because property value increases can be a reflection of either first- or second-order user benefits, the area of consideration must not be limited solely to bands or zones within close proximity of the new highway. Development some 5 or 10 miles distant from the road may be affected to the same or greater extent than that adjacent to the highway, and, again, either by first- or second-order user benefits. Research must also be sufficiently accurate to identify whether these transportation benefits are in fact associated with the facility in question rather than with other transportation improvements which occurred elsewhere at approximately the same time (or a combination of these events). Secondly, if the development being considered is one of relocation, the losses or decreases in value at the former locations must be taken into account.

The foregoing remarks also apply to new development taking place following highway improvement. For example, assume a highway is constructed which provides sizeable tracts of vacant land with good accessibility to large consumer markets where previously the transportation service was inadequate. That is, the unit cost and/or total cost of transportation prior to the improvement was high enough to discourage travel between other land uses and the vacant land. As a result of the improvement, realtors, developers and retailers combine interests and construct a large-scale shopping center on a portion of the vacant land. Certainly the added value can properly be considered as a positive secondary benefit of the new highway to this area. However, it would seem that at the same time disbenefits will accrue to other parts of the community where this new investment is not being made. These disbenefits should be balanced against the gains. In this case, as a result of the change in retail attractive forces (that is, there are now two centers of attraction, one for example, at the downtown core and the other adjacent to the highway) and the change in relative accessibility of these centers to their employee and consumer markets, the attractive force of the former retail center has been reduced. It thus stands to lose business and profits. This is another way of saying that the property values at the old center may decrease in the long run, at least with respect to what they would have been without the highway. Should not these disbenefits be balanced against the gains realized at the new shopping center?

"Reorganization benefit" is another secondary effect, resulting from reorganization or relocation of activity following a highway improvement (4). This reorganization may be required to take advantage of a shift in markets (that is, a change in relative accessibility) and may represent gains to an individual firm. These gains may be measured in terms of more profit for the industry, a lower unit price of the product (or service) to the consumer, more production (which might follow the previous gain), and/or an expansion of the company. This type of secondary benefit must be measured and included in any comprehensive secondary benefit study.

It is also of interest to ask what is known about measuring these benefits at the present time. Thus far the tendency has been to conduct research only on those highways which have had an obvious impact, and then only in so-called "zones" of influence. Research this narrow in scope can only yield information that is biased. In other words, the "sample" on which present thinking must be based is not representative. Any generalizations made can be applied only to impact that takes places adjacent to a road, only to industries of certain types, only to areas abutting certain types of roads, etc.

If more general questions with regard to secondary benefit are to be answered, investigations in both scope and depth must necessarily be extended. The entire community or region in which the highway improvement takes place must be studied before, during and after construction. Perhaps a region can be cross-sectioned in much the same fashion as that used for some of the more recent transportation studies. In general, it must be known what kinds of secondary benefit take place as a result of highway improvement, how much benefit there is, and where it occurs. Listing all the information which must be collected and analyzed to answer these questions to the satisfaction of all concerned is a research study in itself. Nevertheless, it is not impossible to identify some of the major areas of inquiry which a study of secondary benefit might include:

1. Investment in land and improvements.
2. Production costs (by amount and percent in labor, rents, raw material, and transportation).
3. Market characteristics.
4. Accessibility (7).
5. Land prices and quality.
6. Other site location factors (such as listed in Figure 1).
7. Incidence of highway costs.
8. Local economic conditions.

Each of these factors should probably be evaluated in both absolute and relative terms, before and after the highway improvement. Each factor should also be evaluated by industry or activity type.

Although one is led to the conclusion that non-user benefit is more properly a secondary effect of highway user benefit and thus of itself provides no net economic impact, it must be recognized that this conclusion remains to be proved by field experiment. (It must also be realized that no study to date has proved the converse, that non-user benefit does in fact provide some net benefit.) It is the authors' feeling that research of the nature suggested here could not only establish more definitive relationships between highway improvement and its secondary effects but also allow engineers and planners to test the hypothesis that the net non-user benefits (over and above the user benefits) of a highway are zero. If the sum total of these non-user effects exceeds that of user benefits, then obviously the conclusions would be incorrect.

THE IMPORTANCE OF SOCIAL IMPACT

It was suggested earlier that the economic impact of highways might in any case be less significant than their social impact. Unfortunately this is a subject to which highway planners and engineers have devoted only the most meager attention in the past. Yet, the changes which highway transportation has wrought in the structure of society are everywhere so obvious that they scarcely need mention.

Hennes (8) has pointed out, in fact, that at one time highway construction was impelled largely by social, not economic motives. This was at a time when the absence of all-weather roads meant virtually that people living in the country could not get around at all. This is no longer the important problem. More recently the problem has been one of getting around more quickly and more economically. Another force has been at work, however, as more and more people have acquired their own automobiles and the time to use them. Universal mobility on a local, regional, and continental scale has been achieved. Though this certainly has much to do with the structuring of the economy, it seems even more significant as a social fact.

Why, then, have highway engineers and administrators made almost no attempt to evaluate this aspect of highway impact? Several reasons can be advanced. First, one could say, this is a problem for politicians, not highway administrators. Second, the change takes place rather gradually, at least on a national scale, so that the problems are more long-term than the average engineer or administrator can handle effectively. Third, no reliable techniques for identification and measurement of social impact are available. Fourth, there is not any clear-cut or even any not-so-clear-cut scale of social values against which to weigh decisions.

Yet, these objections fail to alter the facts of the case. Major changes in accessibility and personal mobility are producing profound changes in the structure of social life. Certainly what highways or a lack of them will do to the way of life in large cities is no longer an idle question. Rational planning of transportation systems can no longer be done in the absence of some consideration of the social structure one wants most to promote (9). Nor is it likely that one can ignore such questions on a regional or national scale either.

Highway administrators and engineers could, in fact, find a number of compelling arguments to refute these reasons for indifference to the problem. Why, for instance, are social impact questions left entirely in the hands of the political process, where they currently can be answered only with the utmost difficulty? Is it not because those responsible for highway improvement programs have failed to examine and report to the public on expected social impact? It seems entirely reasonable to suggest that highway planners are just as responsible for providing this sort of information as they are for providing an estimate of costs and economic benefit. This argument does not, of course, do away with the difficulties involved. Social change is something which takes place relatively slowly and it is difficult to measure. Yet the fact that one must speak in qualitative terms, and then with much uncertainty, does not mean that one should not try at all. Presumably the concern is with rational planning. The very word rational implies attention to the outcome of the planning process. Social change is an outcome of highway planning. (The authors do not mean to imply that no one has worked on these problems. Some excellent work is even now in progress. The important thing here is that those responsible for highway planning seem to pay little attention to what has been or is being done.)

The problem of establishing a scale of values is admittedly confusing. Certainly little is known about what social change is "worth" to people. As suggested earlier, an attempt to translate social gains into explicit money terms can do more to obscure the problem than to solve it. Yet much could be done if studies were undertaken to identify and evaluate even in qualitative terms the expressed preferences of people involved in the political (that is to say, ultimate) decisions relative to highway construction. Such studies might also identify the extent to which decision-makers at various levels are truly aware of the implications of highway improvement. This could, among other things lead to a better specification of the data which highway administrators should have and should furnish in connection with the total planning process.

In any case, there is much to be done on the question of social impact. Highway planning has long since passed the stage where it can proceed in a vacuum, social, economic, or otherwise.

CONCLUSION

A number of suggestions have been advanced here. Foremost among these is the authors' conviction that there is no logical basis for assuming highway improvements can produce any net economic benefits over and above user benefits. Not only have the authors and other students of the problem argued this point of view, but the highway impact studies to date have failed to prove the contrary point of view. One important conclusion follows immediately from this; namely, that non-user benefits cannot be used as economic justification for improvements. This is not to say, however, that what the authors have called the secondary economic benefits of an improvement are of no importance in the planning process.

Secondary benefits such as increases in land values, increased industrial investment, and expansion of retail trade areas are obviously of importance in the over-all picture of land-use development. An ability to predict the nature and magnitude of such benefits is a prerequisite for the formulation and implementation of any effective land-use plan.

Secondary benefits are of even greater interest, perhaps, because of their effect on traffic generation. An estimate of the magnitude of this feedback effect is an essential part of the highway design process. It is, in fact, a problem which has received major attention in several urban transportation studies, though the term impact itself may not have been used. Insofar as these secondary benefits affect traffic, moreover, they affect total user benefits as well. (Where the change in accessibility which results from an improvement is large, the admissible benefits for vehicles making entirely new trips may be substantial. If the impact (that is, secondary benefits) of the improvement produces large volumes of such new traffic, the total vehicular benefit thus may be very large.) Inasmuch as user benefits are the basis for economic justification, secondary benefits can thus have an important, though indirect bearing on the economics of planning and design.

Unfortunately there is not enough understanding about the relationship between highway improvement and its secondary benefits to make reliable judgments in connection with both land-use planning and traffic estimation. Though some very interesting studies have been done, they have had some serious limitations. They have concerned themselves only with roads whose impact was clearly significant and, more than that, with roads whose benefits were apparently heavily on the plus side in the zones of influence studied. (It is possible that the study of the eastern end of the Connecticut Turnpike, for example, will yield a far less bouyant picture than have most of the earlier studies.) The restriction of the influence zones themselves has been another limitation. A third difficulty with these studies is that they have generally failed to distinguish that component of economic activity which depends in some way on transportation from that component which does not. The net result of all this is that the available findings probably have a heavy bias. More than that, though there is information on what has happened following highway improvements, there are not yet any really clear ideas of how to predict what will happen for highways still in the planning stage.

There is a good deal to be learned, then, about the economic impact problem. There

is even more to learn about other types of impact. There is reason to suspect that haste to justify highway improvements economically with a great array of non-user "benefits" may be a diversion to a relatively unimportant byway. The most important questions which highway planners will have to answer in the next few years may be social and not economic ones.

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Discussion

SIDNEY GOLDSTEIN, Bureau of Public Roads—The writer would like to state that there is almost complete agreement on the need for economic impact materials for various planning purposes. Professors Lang and Wohl do concern themselves mainly with the economics of location and design and the use of these materials for such a purpose. In the process, however, the authors make some statements which have broader implications, and it is to these that the writer directs his comments.

Highway impact has many facets. There is no doubt that in a sense the first order of any impact is through vehicle use. To separate vehicular from non-vehicular uses, however, so as to measure benefits derived in each of these categories is neither better nor worse than specifying these as first- and second-order benefits as is done by the authors.

Economic impact of a highway improvement can be approached in different ways. For instance, if one could measure economic activity fully and account for property values fully and all transfers not counted in the activity measures—and if these measures were supplemented by a means of allocating various items of highway influence, one would be able to trace the changes in activity occurring because of highway impact.

Rather than separating the economic impact into different kinds of benefits, the writer believes it might be more appropriate to look at types of consequences. Highway activity once identified finds its way through the market system and "triggers" other activity.

To say that economic impact is vehicular-derived and therefore that non-vehicular or second-order benefits may virtually be ignored in highway justification is like saying that because employment is derived from sales or demand—an axiom in textbook economics, there is no use to study employment, occupation, income, etc., but rather that one should study only demand or sales. The measurement and evaluation of economic activity through such a development as the reorganization engendered by a highway improvement is certainly an alternative approach to understanding the underpinnings of highway impact.

If the writer may draw another analogy—the fact that the national income accounts

collect information on expenditures is no reason to abstain from collecting income data from sources derived or factor payments. The two make a totality. Similarly, because benefits or effects are counted at the user level is no reason to ignore the rearrangement of resources (the non-user level). In a dynamic situation, the rearrangement of resources to achieve economies and more efficient allocation of resources may be only partially related to time-distance. There may be compelling socio-economic motives for rearrangements ranging from institutional prestige, parking facilities, labor supply, neighborhood, to cost determinants for investment. For these reasons, the origin and the incidence of economic activity are both equally and alternatively means of measuring "benefits" to the community or to the economy.

The economic impact studies, it is true, have been concerned with local effects adjacent to the highway. Although a measurement of this type doesn't show the effect upon the community as a whole it does provide a measure of the restructuring that takes place within proximity to a highway facility. The use of the "study" and "control" mechanism is at least some attempt to filter out influences which are attributable to the highway.

Transfers in economic activity are always occurring. In the most sophisticated analysis of national income, transfers are completely disregarded, although activity measures are included. To the extent that economic impact studies attempt to determine the influence on investment, land values, or property transfers, they provide information beyond the scope of the usual economic approach for the economic impact studies also provide information on such activity as employment, retail and wholesale sales, services, etc.

The fact that economic activity in one location might have occurred in another location if the highway had not been built, is like saying that national income analysis is faulty because consumers have substituted one industry for another in their demand for products. The interest is in how the highway improvement restructures economic activity and its physical organization. The assumption that business and labor saw fit to reorganize implies an economic advantage for them from the point of view of costs or utility.

The authors' familiarity with metropolitan area studies appears to bias them in the direction of desiring answers for an entire metropolitan area rather than the area adjacent to the facility. In some localities, of course, economic impact studies can arrive at net consequences through the normal study and control approach; in other communities, even in metropolitan areas, an approximation of the influence of the most sensitive areas are desired (adjacent to the highway).

As to whether the benefit to an entire community can be adequately evaluated in terms of net dollar value of property gains, net dollar value of economic activity and net dollar value of transfers implies a finer knowledge and development of local economic accounting than has been done thus far even in the more sophisticated transportation studies. This is not to say that the researchers are not aware of the needs for a framework of local accounting which can fit into a national accounting scheme and can provide this type of information.

To say, however, that these benefits are vehicular derived ignores the concepts of the restructuring of people, commerce and industry. These engender other advantages through the market process over and above transportation costs, and change the production cost structure because of the reorganization of the factors of production. The impact is no different from any other dose of investment in the economy with the attendant consequences.

Because a highway may be considered a technological improvement, an innovation, a dose of investment, it changes conditions from what they were. The influence may be traced through a community and the dollar effects and restructuring effects can be approximated.

Although it is conceded that these economic impact studies have considerable use in connection with traffic prediction, land-use planning and land acquisition, it is believed that to the extent that it has been possible to document occurrences and restructuring that occur, the economics of location and design should and many times do take these into effect in determining proper load factors, in determining relative use of the high-

way, and in considering the service of the highway. Location should not be separated from the other items. If the results of economic impact studies give some indication of different-order effects, it is only logical that they should be used. In fact, by the time the authors get to their conclusion, they are no longer as sure that such information cannot logically be used.

The authors say "if these findings do have a use, it seems most logically to be in connection with traffic prediction, over-all land-use planning, or land acquisition, but not with the economics of location and design. This is notwithstanding the fact that some very complete studies of so-called 'economic impact' have been made in recent years." Later they say: "Inasmuch as user benefits are the basis for economic justification, secondary benefits can thus have an important, though indirect bearing on the economics of planning and design."

They also state that "the engineer's concepts of such things as 'economic impact' do not seem to do the job." In all studies in the economic arena, it is acknowledgedly difficult to hold the environment constant. It is to the credit of highway engineers that they have attempted these studies and have progressed further than others in related public works fields. In other fields, impact studies, using perhaps only one or two criteria, have been made of the effects of various types of investment, public investments, raising minimum wages, etc.

The exact definition of impact is, of course, difficult because of its ramifications. But merely defining impact will not determine measurement. In fact, in some respects, defining measurement may be a prelude to defining impact. Researchers have given considerable thought to the subject of economic impact. In a number of studies of experimental design the Bureau of Public Roads has been directing its attention to determining a framework for measuring impact. A study at New Mexico State University is concerned with the use of accounting at the local level—to determine the effect on the economic base of the community; a study for the Boston Inner Loop has given thought to the use of economic impact data in highway location and planning; a Northwestern University project is concerned with the entire area of net non-user concepts; University of Washington studies, the University of Kentucky, and many others have grappled with these problems. There is no reason to expect that spatial relationships encountered here should not be given consideration in highway location (not strictly defined as return on highway investment).

The main theme that goes through the paper is "are there really any other non-vehicular economic benefits? Can a highway, for instance, produce something which has economic value in its own right?" All economic activity is a means to an end, the enjoyment of utility. Yet all persons who work do so to buy goods and leisure. This doesn't mean that there are no benefits from their activity. Our entire system benefits and we agree that it is derived from a combination of all factors. This is equally true of transportation. It provides utility which when combined with all other utilities furnish income and activity and goods.

The authors say "a highway cannot create land that is not already there. It can only increase the relative accessibility of that land." However, there appears to be a relationship of a complex of socio-economic factors rather than just accessibility. Much more research is needed on this question of accessibility and land values before one can accept the statement that the land values are the result of time shifts which lower costs of transportation. To the land buyer, is it simply user-savings that he evaluates in his purchase price or is it a complex of factors of which user-savings may even be minor although proximity as a convenience is important?

A highway cannot create land that is not there, but it can change the character and intensity of land use. To this extent, it can set into motion a "triggering" influence on other activity which results in community benefits. To say that land is there and cannot be increased ignores the fact that land's value in use can be changed by changing the use, and land's value in exchange or price may have different utility to various groups. It is like saying that one cannot create labor because persons are already there, but one can train labor, provide it with skill and capital improvements and make a different form of labor. So it is with land.

The reorganization benefit referred to by Garrison (4) is of course the purpose of

all activity in a dynamic society; namely, to obtain the best organization of resources to arrive at a least cost combination.

Lowering of transportation costs may not be as important in some locations, however, as lowering of labor costs or internal economies of scale. These are not always completely dependent on transportation costs. The authors state that "if the benefits accruing to the three classes of users mentioned earlier are properly accounted for, credit will already have been taken for all of this reorganization benefit in the form of user benefits." The benefits do not end at the user level, for other income and investment is generated as are transfers which generate income effects. This is all economic activity. Perhaps other matters to which economic research activities should be directed are such items as economies of storage and warehousing and their relation to economies of scale because of highway location.

The authors also state: "In the first place, if an activity formerly performed at several locations is now to be performed at one, the total transportation requirements characteristically will increase. Thus, the transportation costs will tend to increase. The question is whether or not they will increase more than the rest of the costs of the activity decrease. If the transportation costs do increase more than other costs decrease, the concentration is not economically desirable."

Concentration of decentralized activity in most cases means economic reorganization both internally and externally of which transportation cost is only one consideration.

New market and demand situations and new technical coefficients of production could conceivably swamp certain amounts of increased transportation costs.

Even though increased transportation requirements may bring about increased total transportation costs, this does not mean that marginal costs exceed marginal benefits derived as a direct result of an improved transportation facility.

Thus the writer suggests that cost is not the sole determinant for the feasibility of making an investment. The question must be decided in terms of net benefits capitalized through time.

Concern with development that occurs beyond the point of immediate highway contact has certainly intrigued researchers and this is being analyzed where it appears applicable to the problem at hand.

Many of the researches sponsored by the Bureau and State highway departments are experimenting with community studies rather than sections of the road. Although not implemented yet, discussions of economic impact have centered about tracing economic activity through local accounting, local input-output, local money flows, statistical isolation of factors, etc. What is significant from the point of view of the highway engineer is not the total of user or non-user benefits—but the identification of where these advantages and disadvantages occur so that they may be taken into account in planning location.

Finally, if benefits are looked at as total economic welfare added to a community by the improvement, it must be agreed that there are tangible and intangible factors that go to make up the increment in total welfare. In this respect welfare is a function of many items. For example, $W = f(x, y, z)$. Changes in welfare would be represented by $dw = f_x dx + f_y dy + f_z dz$. That is, incremental changes in x, y and z will bring about incremental changes in total welfare in the community. To determine the economic impact of a highway $I = f(x, y, z)$, then total impact would be of the form $dI = f_x dx + f_y dy + f_z dz$ where dI represents an incremental change in impact of a new highway over a previous highway or no highway. Therefore, theoretically, the impact of vehicular benefits can be determined by holding all other benefits invariant. But total impact must be determined by bringing all of the other direct and indirect benefits into consideration.

Uses of vehicles are functions of many other variables so that vehicular benefits fall short in themselves of explaining the economic impact of highway improvements. The vehicular benefits may be multi-valued. But there is no more reason to assume all other variables in a dynamic economy to be constant and then determining what happens to vehicular benefits and consider this a partial derivative than it is to assume vehicular benefits as constant while varying each of the other factors.

Social Impact

The writer agrees with the authors that there is a need for work on the qualitative aspects of highway influence. The subject of social impact is something of which the Bureau of Public Roads is certainly aware. More and more, the Bureau's impact studies and instructions are suggesting the use of mobility information, and non-work associations in order to understand the meaning of a highway to the individual and to his community The Bureau has sponsored studies on such varied subjects as public services, tax bases, public utilities, small community considerations, and wherever possible, in newer studies the Bureau has emphasized the aspects of personal relocation.

The Bureau has suggested the evaluation of social influences in both quantitative and qualitative terms. Of course income analysis at the local level, with its emphasis on the identification of various income receivers, is another dimension of a social impact study.

Despite all of these comments, the writer agrees with the authors' conclusions wholeheartedly. "There is a good deal to be learned, then, about the economic impact problem. There is even more to learn about other types of impact. The most important questions which highway planners will have to answer in the next few years may be social and not economic ones."

A.S. LANG and MARTIN WOHL, Closure—The authors have redefined vehicular and non-vehicular benefits or consequences as primary and secondary benefits, respectively, to reflect the fact that non-user benefits are merely transferred from user benefits and do not therefore represent any net gain to the economy. As such, it would be improper to include secondary or non-user consequences in an economic analysis for the justification of a highway. On the other hand, the authors did not say that secondary benefits should be ignored in an over-all highway justification analysis. They strongly emphasized that secondary benefits must be given consideration, but from the standpoint of the social structure of the community.

Again the authors emphasize the danger of restricting attention in economic impact studies on the local effects adjacent to the highway. First of all, use of the "influenced" and "control" zone technique does not in any sense identify the extent of the influence of the highway; it merely indicates relative value changes without reference to cause. Second, and perhaps more important, to measure the gains at the roadside without including losses elsewhere in the economy provides information which can be and often is used incorrectly in highway justification analyses. Inasmuch as highways typically are paid for by the community at large, highway planners and engineers are justified in constructing or improving them only to the extent that they represent a reasonable profit on the investment thus being made.

The authors must disagree with Mr. Goldstein with regard to his statements on highways "triggering other activity." Highways can only affect the economy to the extent that they alter highway operating costs, accident costs, and time-distance relationships. On the other hand, highway improvements cannot, as Mr. Goldstein suggests, "change production cost." Further, economies of scale which industry realizes because of relocation or consolidation cannot exceed the transportation cost savings, where these savings are the full difference between what transportation costs with the new highway and what it would have cost with the old highway.

It is worth repeating that the term "transportation costs" is meant to be all-inclusive. That is, these costs should include operating, time, accident, and comfort and convenience costs (real or apparent) to users of the transportation facility, whether they be commercial operators or private vehicle owners.

Mr. Goldstein quotes the authors correctly in saying that "if these findings (those of economic impact studies) do have a use, it seems most logically to be in connection with traffic prediction, over-all land-use planning, or land acquisition, but not with the economics of location and design. This is notwithstanding the fact that some very complete studies of so-called 'economic impact' have been made in recent years." He goes ahead to quote another section of our paper out of context, "Inasmuch as user benefits are the basis for economic justification, secondary benefits can thus have an

important, though indirect bearing on the economics of planning and design." His implication is that the authors have said that non-user benefits thus have a role in the economic analysis. This is, of course, incorrect. They merely tried to point out that to the extent that relocated industry, for example, generated new traffic or altered traffic patterns, this would affect user benefits and thus affect the project justification.

As for the question of whether highway engineers have done a good job with their economic studies, it is agreed that it is to their credit that they have tried to do this job. The authors do not feel this alters the facts of the case, however; namely, that so far highway engineers have not done too well. Nor does it alter our opinion that highway engineers have been slow to avail themselves of the help which economists and social scientists are now in a position to give.

With regard to Mr. Goldstein's remarks about incremental changes in welfare as a result of a highway improvement, the authors would suggest that his equations ought to look somewhat as follows:

$$W = f(x, y, z)$$

$$\Delta W = \frac{\partial f(x, y, z)}{\partial x} \Delta x + \frac{\partial f(x, y, z)}{\partial y} \Delta y + \frac{\partial f(x, y, z)}{\partial z} \Delta z$$

$$\Delta W = \left(\frac{\partial W}{\partial x}\right) \Delta x + \left(\frac{\partial W}{\partial y}\right) \Delta y + \left(\frac{\partial W}{\partial z}\right) \Delta z$$

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