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 goverments, 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

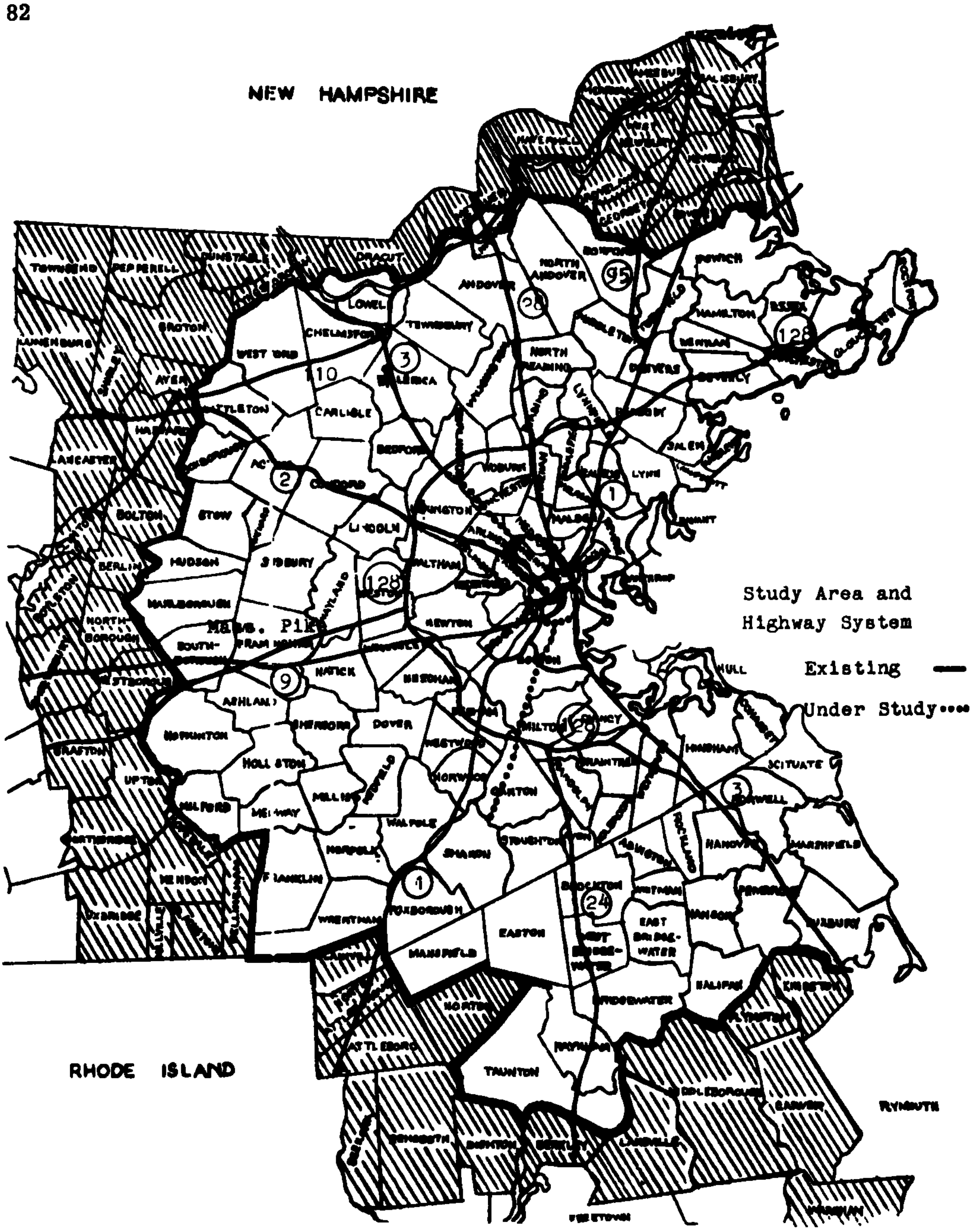

Figure 1. Boston Metropolitan Region—study area and highway system.

   (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		Commerce and Businesses					
			With Capital Invest.	Without Cap Invest	Offices	Retail Trade	Real Estate	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 increase 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-

Land Use Data Sheet

Structure No.	
Use No.	
Alignment No.	
Residential	Structures
Retail	
Wholesale	
Business	
Service	
Industry	
Institutions	
No. households	
Structure Type	
No. Stories	
Age Estimate	
Condition	
Vacant Structure	
Recreation	Other Uses
Off-St. Parking	
Cemeteries	
Agriculture	
Vacant Lot	

Route
Town or City
Part No.
Block No.
Date
Surveyed by

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 highways. 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

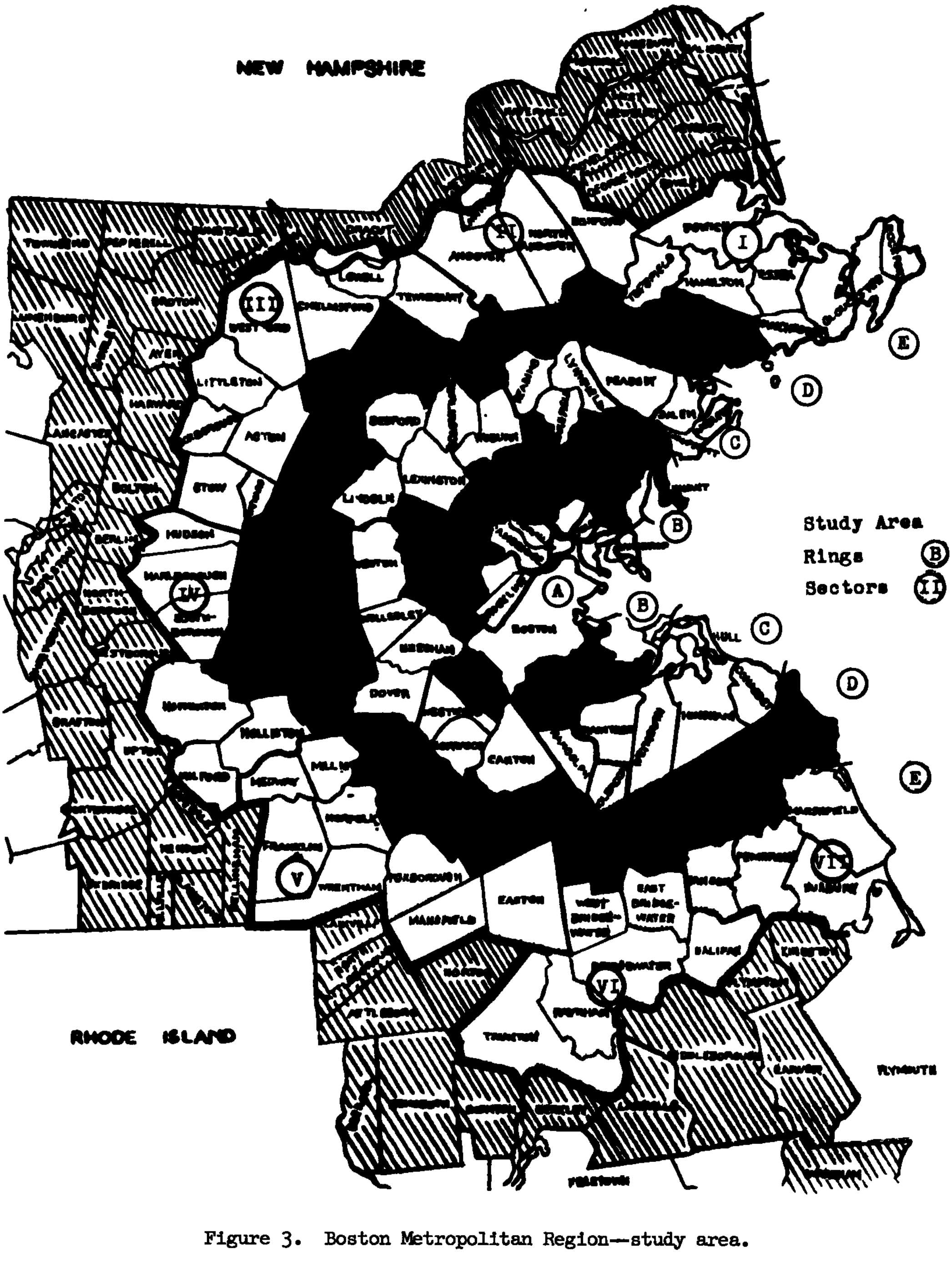

Figure 3. Boston Metropolitan Region—study area.

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

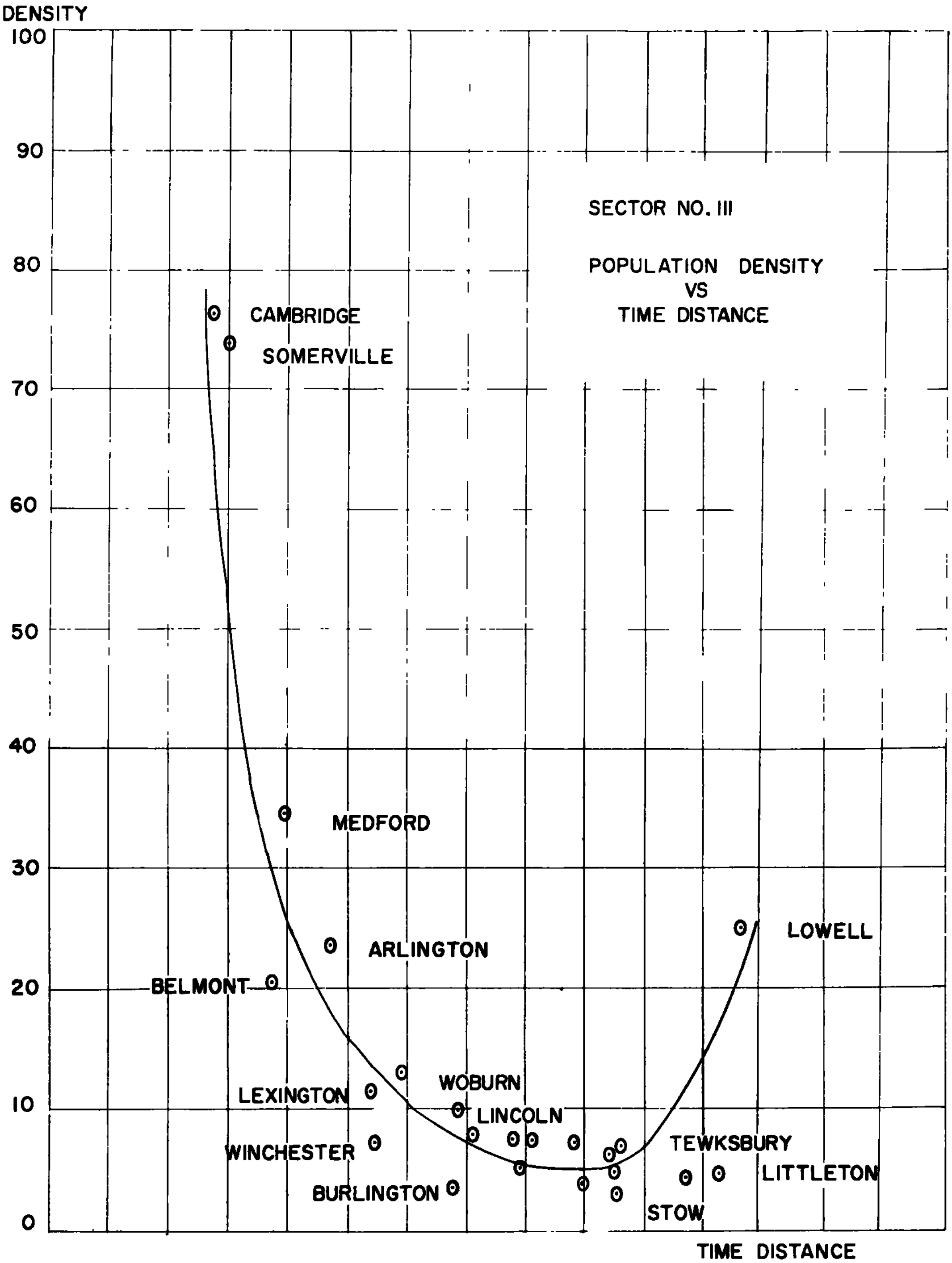

Figure 4.

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

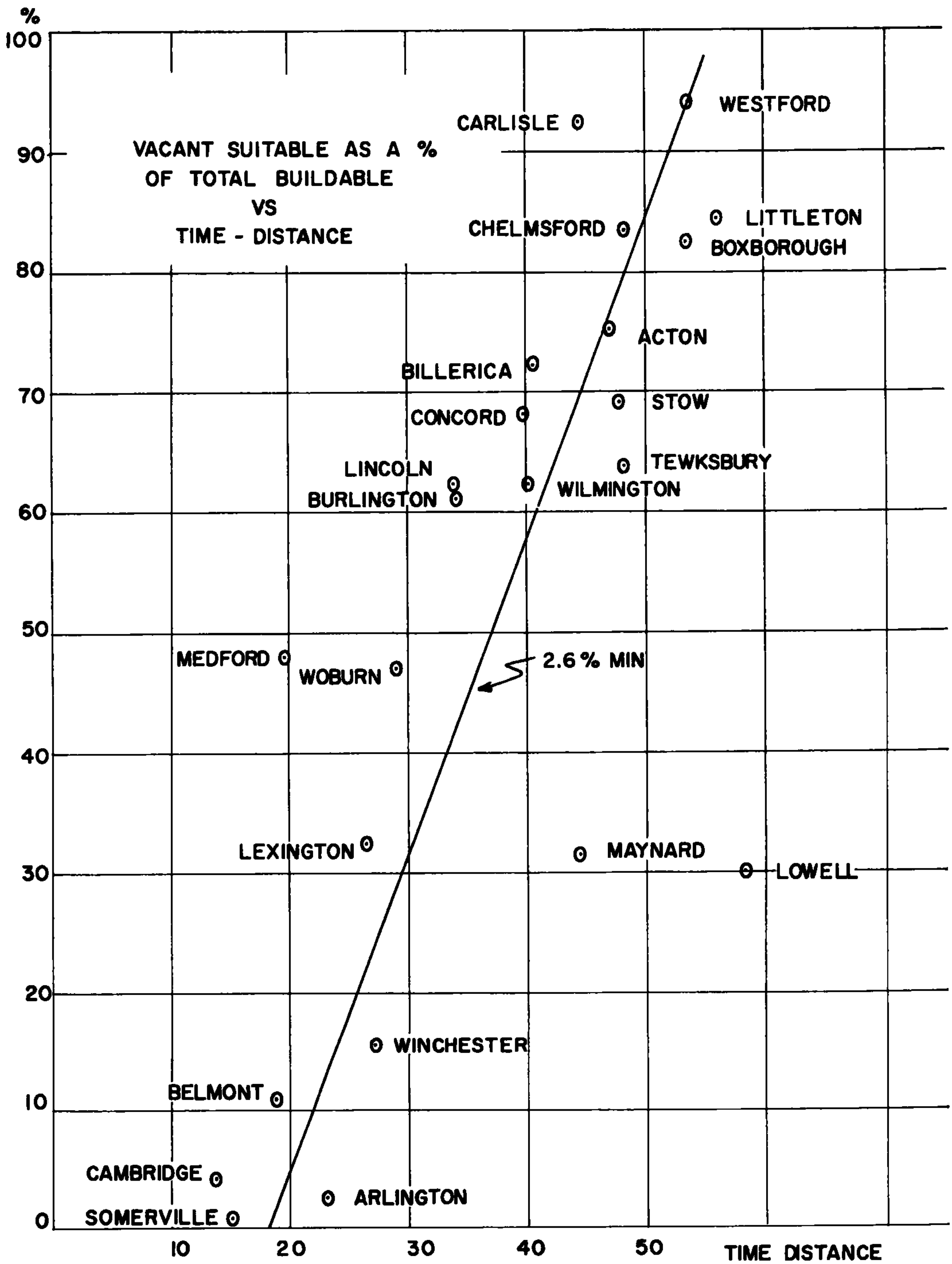

Figure 5.

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, Boston 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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