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THE NATIONAL SYSTEM OF INTERSTATE AND DEFENSE HIGHWAYS: A GEOGRAPHIC ANALYSIS

By

Thomas E. Niedringhaus

AN ABSTRACT

Submitted in partial fulfillment of the requirements
for the degree of Master of Arts
in Michigan State University

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Department of Geography

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Approved Clarence L. Kingsley

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ABSTRACT

In 1941 President Franklin D. Roosevelt appointed the Interregional Highway Committee for the purpose of studying the feasibility of a Federally-sponsored, national system of highways. The Committee submitted a report to Congress recommending the establishment of an interregional system of highways not to exceed 40,000 miles, financed in part by the Federal government and in part by state governments. These recommendations were enacted into law by the Federal-Aid Highway Act of 1944, and, thus, the National System of Interstate Highways was created. The Federal-Aid Highway Act of 1956 made provision for the completion of the national system to modern design standards within a period of about 13 years with the Federal government furnishing 90 per cent of the funds needed for construction. This law also officially changed the name of the system to the National System of Interstate and Defense Highways.

Among the many problems which might be considered in connection with the construction of the Interstate System, the problem of most geographic interest is the location of the Interstate routes. Since location implies the chorographic approach, or the study of a phenomenon in its spatial context, the major purpose of this thesis is to describe the spatial arrangement of the Interstate highways in their national, state, and local settings.

The spatial arrangement of highways can be described in terms of geometric position on the earth's grid, and this is best accomplished by use of cartographic techniques. In order to explain the spatial arrangement

of Interstate highways reference must be made to the causal factors of location. Causal factors may be classed as: (1) situation factors--those elements, or element-complexes, of the physical and cultural environment which effect the general location of Interstate routes, and thereby limit possible locations to fairly restricted areas; and (2) site factors--those elements, or element-complexes, of the physical and cultural environment which characterize the ground upon which the highway actually stands, and thereby limit possible locations to a specific area.

The approach used in this thesis is to examine these situation and site factors, and relate them to the spatial arrangement of highways. Study of these factors indicates that they are characterized by considerable areal differentiation. It is the conclusion of this thesis that the areal differentiation of the American physical and cultural landscape is basic to an understanding of the observable spatial arrangement of Interstate highways on national, state, and local levels.

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STATEMENT OF PROBLEM

This thesis presents a description of the National System of Interstate and Defense Highways. It consists of discussion of the origin and development of this System (hereafter referred to as the Interstate System), analysis of the causal factors of location, both physical and cultural, and graphic portrayal of the spatial arrangement of Interstate highways. The following ideas are given major emphasis:

(1) road classification,

(2) the Interstate System in its national setting with primary attention directed to causal factors of location and resultant spatial arrangement,

(3) the Interstate System in its Michigan setting, sharper geographic focus on a smaller region, and

(4) the Interstate System in its local setting, based on case studies of several Michigan cities of different population size.

CHAPTER I

FEDERAL AID FOR INTERSTATE-HIGHWAY CONSTRUCTION— ORIGIN OF PROGRAM

This thesis is basically concerned with roads and highways. However, the terms "road" and "highway," as commonly used, have broad meanings. For the purposes of this paper, "road" shall mean a trackless path on the earth's surface over which motor vehicles can travel from place to place. "Highway" shall mean a main road, or through road, open to the use of the public for travel from place to place; the term is not applied to private or access roads intended primarily for use by local inhabitants. Thus, all highways are roads, but not all roads are highways.

During the Twentieth Century the road has become an important and widespread feature of the American landscape. Serving as links between states, regions, and communities, roads are fundamentally significant to the present economic well-being of the United States. The road has reached its greatest importance since the advent of the motor vehicle. In total mileage, amount of funds allocated to their development, and quality of construction, today's roads are far ahead of the roads of any other period in the country's history. The American people, by their economic and social acceptance of the motor vehicle, have magnified the significance of the road. Many desirable results have accrued from this ability to produce and willingness to purchase motor vehicles. These

include greater mobility for more people, an enormous increase in the total volume of transportation, extension of effective transport facilities to many previously unserved locations, destruction of the virtual monopoly of intercity transport long held by the railroad, plus many beneficial effects on the general living standards of the people.[1]

Unfortunately, the blessings are mixed with serious problems. The large number of preventable traffic accidents on the roads, the lack of adequate traffic capacity on many of these facilities, and the traffic-induced blight in urban areas are too well documented and known to warrant further comment here. Many reasons for these problems could be cited, but the one of major interest to this thesis is the lack of properly located roads of the quality and character needed to accomodate the large volumes of traffic.

Several possible solutions for the problems associated with the nation's roads have been suggested. Among these are the following:

> (1) Limit the number and type of motor vehicles allowed on the roads, and regulate them by forcing all motor-vehicle operators to obey more stringent traffic laws. Regulation could doubtlessly be greatly improved if electronic guidance equipment was installed on some of the roads. Even so, major improvements on the nation's road network would probably be needed.
>
> (2) Encourage modes of transportation other than that of noncommercial motor vehicles—that is, bus, taxi-cab, rail, and air transportation.
>
> (3) Provide new and improved road facilities specifically designed to eliminate, or alleviate, problems associated with roads. Although this solution is very expensive, the increased taxes from motor-vehicle users will help to pay the cost, and the induced economies of motor-vehicle operation will benefit the entire nation.

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[1]Truman C. Bigham and Merrill J. Roberts. Transportation: Principles and Problems. (N.Y.: McGraw-Hill Book Co., Inc., 1952) P. 100.

All of these proposals have some degree of merit, and all have drawbacks. Solution three is the one presently being given major emphasis by the Federal and state governments. Funds for the large amount of construction work necessary for this solution are furnished by Federal-aid and state-matching funds.

The purpose of this thesis is to describe and analyze that part of the Federal-aid highway network officially designated the National System of Interstate and Defense Highways (customarily referred to as the Interstate System). The description of this System involves discussion of origin and development, analysis of physical and cultural localization factors, and the spatial arrangement of the highways. The geographic approach is both systematic and regional; the Interstate System is analyzed according to general principles, and examined in its national, state, and local settings.

Federal Government Interest in Highway Construction

The interest of the Federal government in highways reached a peak with the Federal-Aid Highway Act of 1956.[1] This Act is the latest of the several laws which form the basis for the current Federal-aid highway program. The Federal-aid highway program has many phases and consists of many projects; but essentially it involves the payment of funds to the various states by the Federal government, on a matching basis, for the purposes of highway construction. Federal-aid grants to the states are strictly for construction of state, county, and municipally owned roads. In addition the total Federal highway program includes funds for

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[1] U.S., 70 Statutes at Large 374 (1956).

the construction of all roads on Federal property, such as National Forests and Parks, and Indian Reservations. The Federal agency in control of these operations is the Bureau of Public Roads of the Department of Commerce.

The Act of 1916[1] is the framework on which the present Federal-aid program is built. Subsequent laws have functioned mainly as amendments, the most important of which are those of 1921, 1944, and 1956. The general tone of Federal-state relationships was set by the Act of 1916. This Act authorizes Federal payments to be made to the states for the purpose of constructing, or improving, rural post roads. Money was apportioned to the states in the following manner: "One-third in the ratio which the area of each state bears to the total area of all the states; one-third in the ratio which the population of each state bears to the total population of all the states, as shown by the latest available Federal census; and one-third in the ratio which the mileage of rural delivery and star routes in each state bears to the total mileage of rural delivery and star routes[2] in all the states at the close of the next preceding fiscal year."[3]

The Act of 1921[4] initiated a classification of primary and secondary roads, and thereby served to concentrate the expenditure of Federal

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[1]U.S., 39 Statutes at Large 355 (1916).

[2]A rural delivery route is one served by a civil-service employee working out of a single post office and delivering only to rural boxholders. A star route is one served by a civil service employee who may work out of several post offices and delivers mail to small towns, hamlets, and rural boxholders.

[3]U.S., 39 Statutes at Large 355 (1916).

[4]U.S., 58 Statutes at Large 838 (1921).

funds on the more truly national roads. The Act of 1944[1] provided for the inclusion of urban areas within the scope of Federal aid, and officially adopted the Interstate System. This Act also made available to the states the large amount of knowledge based on research of the Bureau of Public Roads and President Roosevelt's Interregional Highway Committee. These data formed the basis for selection of specific routes of the System.

The most recent law, that of 1956, does not represent a radical departure from previous Federal-aid highway laws. It retains the traditional relationship between Federal and state governments: the Federal government furnishes monies and correlates, supervises, and approves state activities; the states match Federal funds according to a fixed ratio, and take the initiative for planning and for letting contracts to private construction firms.[2]

In several respects, however, the 1956 Act does differ from earlier laws. Three major innovations found in the 1956 Act are: (1) the long-range view, or the plan to complete the Interstate System within a period of approximately 13 years in all the states; (2) the tremendous increases in Federal funds allocated for the completion of this System; and (3) the increase in the Federal share on this System from 50 per cent to 90 per cent of the total construction cost. Thus, the most significant fact about the current Federal-aid highway program is the concentration of effort on the nation-wide region-linking Interstate System.[3]

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[1]U.S., 62 Statutes at Large 1105 (1944).

[2]U.S., Department of Commerce, A Ten Year National Highway Program, Report to the President, Washington, 1955, P. 7.

[3]U.S., 70 Statutes at Large 374 (1956).

The Classification Problem: Road Systems

In subsequent portions of this thesis constant reference is made to the Interstate System, and occasional references to other systems. It is necessary, therefore, to consider the classification problem in greater detail.

Many different road classifications are possible. For purposes of administration and fund allocation the most significant classification is one based on function. The need for a functional classification has long been recognized. Experience of highway administrators and others responsible for the operation of the Federal, state, and local road networks indicates that the differences in road use should be given recognition by grouping roads into systems according to their predominant functional characteristics. These groupings permit highway administrators to adopt standards of construction commensurate with traffic volumes, peak-hour flows, and traffic composition.[1]

Three interrelated functional characteristics are recognized to be fundamental in the formulation of a method of road management. From these functional characteristics, a threefold classification of roads may be derived, as follows:[2]

(1) Through roads -- the more heavily traveled roads connecting city with city, city with town, or town with town. These roads accomodate the through, or long, motor vehicle trips. Roads having this function comprise

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[1]U.S., Federal Works Agency, Public Roads Administration, Highway Practice in the U.S.A., Washington, D.C., 1949, P. 60.

[2]Michigan State Highway Dept., "Highway Classification in Michigan," A Mimeographed Report, Lansing, Nov., 1953, P. 1.

the smallest segment of the nation's road network.

(2) Community roads -- major roads within a city, or town, and within its hinterland, and connecting the two. These roads facilitate community life and, also, are the collector roads for traffic destined to the through roads. Trips on these roads average a shorter distance than on through roads. Measured by mileage this class of roads is much more extensive than through roads.

(3) Land-access roads -- minor roads within a city and within its hinterland which provide access to land. Trips on these roads average shorter distances than either through or community routes, but the total mileage is much greater than the other segments of the nation's road network.

Although many roads serve more than one of these functions, one function is usually dominant. The dominant function of each road is the basis for the administrative classifications, which are discussed in the following paragraphs.

The administrative classification of American roads had its origin in the assumption of highway responsibility by the state and Federal governments early in the 1900's, responsive to the emergent demands of motor-vehicle owners and operators. At the beginning of the century, the present distinctions were practically nonexistent. Direct responsibility for road administration fell almost completely upon the county and lesser administrative agencies. The motor vehicle changed the purely local nature of road traffic, and brought about the entry of state and Federal agencies into the highway administrative field.[1]

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[1]U.S., Federal Works Agency, Public Roads Administration, Highway Practice in the U.S.A., op. cit., P. 60.

The state highway systems were generally designated before the Federal systems, but both were chosen by use of the same basic principles. Each system was intended to include the roads of through and community service rather than those of land-access service. Although state systems vary from area to area, they are usually referred to as either state highways or state trunklines. In Michigan, for example, there is only one state highway system and the routes which comprise it are called state trunklines. All land-access roads and some community roads are variously classified into county, township, or municipal systems depending on the agency which has the predominant interest in them.[1]

In like manner, the functional characteristics of roads are the basis for the present administrative classification of the Federal-aid highways. Three Federal systems presently exist: (1) the Primary System; (2) the Secondary System; and (3) the Interstate System. Extensions of Primary and Secondary roads into urban areas can, for some purposes, be considered as separate systems also.[2]

Comparison of the functional classification of roads with the administrative classification indicates the following relationships:

> (1) The Primary System -- through roads selected in each state by the state highway department, subject to Bureau of Public Roads approval. As originally stipulated in the Federal Highway Act of 1921, this System is not to exceed seven per cent of the total mileage of public roads in each state, exclusive of mileage within national forests and parks, Indian or other Federal reservations, and within urban areas. However, when the original seven per cent is

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[1] G. Donald Kennedy, "Planning of the Highway," Highways in Our National Life, ed. Jean Labutut, Wheaton J. Lane (Princeton, N.J.: Princeton U. Press, 1950) Pp. 66-76.

[2] Ibid.

constructed to Bureau of Public Roads standards, a state may petition for additional mileage. As of July 1, 1954 this system consisted of 234,407 miles of urban and rural routes, some of which was already completed to Bureau of Public Roads standards but most of which needed more construction work. The Federal-aid share on the Primary System is 50 per cent of the construction cost.

(2) The Secondary System — community roads selected by the state highway departments with the cooperation of local governmental agencies, and again subject to approval by the Bureau of Public Roads. In making these selections, farm-to-market roads, rural mail routes, public school bus routes, county roads, and certain township roads are eligible for consideration providing they are not part of the Primary System. The Secondary System is basically a rural system, but may have urban extensions under certain conditions. As of July 1, 1954 this system totaled 482,972 miles of urban and rural roads, some of which has been completed to standards but most of which still needs more construction work. The Federal share on this System is 50 per cent of construction costs, the same as on the Primary System.[1]

(3) The Interstate System — After the passage of the first Federal-aid-to-highways law in 1916, responsible officials began to recognize the need for a modern, interconnected highway system designed to high standards, of national importance, and of more limited extent than the Primary System. To study such a system and take action if deemed feasible, President Franklin D. Roosevelt in 1941 appointed a group of experts known as the National Interregional Highway Committee. This group submitted a report to the President, and subsequently to the Congress, which recommended the establishment of an interregional system of approximately 34,000 miles.[2] The President asked Congress to act on this recommendation, and in 1944 the Federal-aid Highway Act was passed. It designated, in general terms, the National System of Interstate Highways,[3] and limited this system to 40,000 miles. The functions of these roads are predominantly through-transportation service.

None of the Federal or state systems contain roads which have land-access as their predominant function. It is a recognized principle

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[1] Ibid.

[2] U.S., Congress, House, Interregional Highways, 78th Cong., 2d Sess., 1944, House Document 379, P. 40.

[3] In the 1956 Highway Act this name was officially changed to the National System of Interstate and Defense Highways.

that these roads are better managed and financed on the local level than on the state or Federal levels. Thus, there exists no Federal or state system which is designed exclusively for land access.

The Federal and state systems usually overlap. That is, a road may be both a state trunkline and a Federal-aid highway. However, the state systems are more extensive than the Federal-aid systems, with some state trunklines not being included in the Federal systems. In other words, the Federal-aid systems are rationally selected portions of the state systems that are of major national importance.

The Interstate System

The Interstate System is the single most important group of through highways in the nation. Although it represents only 1.2 per cent of all the road mileage in the country, it carries nearly 20 per cent of all the motor-vehicle traffic. It links 42 of the 50 state capitals, every city of over 300,000 population, and about 90 per cent of all cities over 50,000 population. The System serves 65 per cent of the urban population and 45 per cent of the rural population. It passes through 37 per cent of all the counties in the nation; and these counties contain over half the population and market nearly 50 per cent of all farm products sold.[1]

The general locational criteria for the Interstate System are as follows:[2]

> "There shall be designated within the continental United States a National System of Interstate Highways, not exceeding 40,000 miles in total extent, so located as to

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[1] U.S., Dept. of Commerce, Bureau of Public Roads, "The Interstate Highway Program Moves Ahead," Memorandum, Feb. 13, 1958, Pp. 2-3.

[2] U.S., 62 Statutes at Large 1105 (1944) Sec. 7.

> connect by routes, as direct as practicable, the principal metropolitan areas, cities, and industrial centers, to serve the national defense, and to connect at suitable border points with routes of continental importance in the Dominion of Canada and the Republic of Mexico. The routes of the National System of Interstate Highways shall be selected by joint action of the state highway departments of each state and the adjoining states, as provided by the Federal Highway Act of 1921 for the selection of the Federal-aid system. All highways or routes included in the National System of Interstate Highways, as finally approved, shall be added to the Federal-aid highway system, if not already included in that system."

The recommended optimum mileage proposed by the 1941 report, Interregional Highways, was only 33,920 miles. This mileage, although including rural and urban-penetrator sections of the system, purposely did not make any allowance for circumferential routes required in the larger cities for the dual purposes of by-passing through traffic and assembling other traffic to and from the several quarters of the city. Because the proper location and necessary mileage for these urban routes can be determined best by detailed study of the conditions and needs of each city involved, the Interregional Highways Report simply estimated that the aggregate of these auxiliary routes would not exceed 5,000 miles. Thus, 33,920 miles were allotted for interregional and intercity connections and 5,000 miles for special urban routes. This is a total of 38,920. The figure of 40,000 is based on 38,920 plus 1,080 miles reserved for contingencies. When the System is finally completed to the specified design standards it will total about 40,000 miles. In the event it should prove necessary to exceed this limitation, Congress has authorized an additional 1,000 miles.[1]

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[1]U.S., Dept. of Commerce, Bureau of Public Roads, "Criteria for Selection of Interstate System Routes," Memorandum, Washington, D.C., Jul. 27, 1956, Pp. 1-2.

Summary

The Federal-aid highway program is designed to improve our presently inadequate road network by constructing modern highways where they are most needed. Tremendous sums of money, running into billions of dollars,[1] are being furnished to the states by the Federal government from receipts of highway-user taxes.[2] In order to spend this money wisely, and in the places where highway use indicates the most urgent need, functional classifications of roads are necessary. This results in the designation of road systems. Of the three Federal systems in existence, the Interstate System is the latest to be selected, has the least mileage, is the most intensively used, requires the highest design and construction standards, will be the most costly per mile to build, and will be the first system to be completed as an interconnected, nation-wide group of highways of uniform high standards. The highways of the Interstate System will have as their major function the furnishing of through transportation service, par excellence.

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[1] The 1956 Act contained an estimate that the 13-year Interstate System program would cost the Federal government 24.85 billions of dollars. This figure has been revised upward slightly because of more accurate estimations and rising costs.

[2] Federal monies for the financing of the Interstate System come from three types of highway-user taxes. These are: (1) gasoline fuel consumed on highways, Federal tax of 3 cents per gallon; (2) a tax of $1.50 per 1,000 pounds imposed on commercial vehicles weighing 26,000 pounds or more; (3) the total proceeds from the excise taxes levied on the weight of rubber tires, and half the proceeds of the levy on the manufacturer's prices of new trucks, buses, and trailers.

CHAPTER II

THE INTERSTATE SYSTEM IN ITS NATIONAL SETTING

Among the many problems associated with the construction of the Interstate System are planning, financing, land acquisition, technical considerations, and location. Although it is recognized that all of these problems are important, and vital to a thorough understanding of the Interstate System, it is impossible to discuss all of them adequately in this analysis. The problem of most geographic interest is that of the location of the Interstate routes. Location implies the chorographic approach, or the study of a phenomenon (the highway) in its spatial context. The purpose of this chapter is to describe the spatial arrangement of the Interstate System in its national setting.

The spatial arrangement of Interstate highways can be described in terms of geometric position on the earth's grid. Causal factors of the spatial arrangement of Interstate highways can be classed as: (1) situation factors--those elements, or element-complexes, of the physical and cultural environment which effect the general location of Interstate routes, and thereby limit possible locations to a fairly restricted area; and (2) site factors--those elements, or element-complexes, of the physical and cultural environment which characterize the ground upon which the highway actually stands, and thereby limit possible locations to a specific area.[1]

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[1]See A. E. Smailes. The Geography of Towns. (London: William Brendon & Son, Ltd., 1953) Pp. 41-43.

Situation Factors

Many different elements, or element-complexes, in the physical and cultural environment could conceivably be situation factors, but not all are of equal importance in effecting highway location. Situation factors of relevance in effecting highway locations are often referred to, by highway engineers, as control areas, denoting by the areal context a general location. Site factors of relevance in effecting highway location are often referred to as control points, denoting a more specific location than control area.[1]

Control areas may exercise either primary or secondary influence on the location of any highway. For example, assume a through highway to be constructed between Detroit and Chicago. Detroit and Chicago would, by definition, be primary control areas. However, several smaller, but important, cities lie in the general area between these two metropolises. The new highway cannot connect all of them without being too circuitous. Those cities which the highway does connect are called secondary control areas, because they do have some influence on the location of the highway but are not as important controls as are Detroit and Chicago.

Selection of original routes.

Situation factors were important considerations in the original selection of routes for the Interstate System made in 1941 by the Interregional Highway Committee. In making these selections, the first step was to specify the basic controls to be used in choosing the routes which

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[1] See Arthur Bruce and John Clarkeson. Highway Design and Construction. (Scranton, Pa.: International Textbook Co., 1950) Pp. 37-43.

would connect the various regions of the country. The original system was very general; the principal controls used in choosing this system, and in limiting its total extent, were:[1]

> (1) the interconnection of the larger cities in all the regions of the nation,
>
> (2) the accomodation of short-trip traffic in and about lesser centers to the extent consistent with the first control, and
>
> (3) the creation of a system having the highest possible intensity-of-use while still satisfying the requirements of the other controls.

The larger cities in each census region were considered to be the focal points for the region in which they were located. With this in mind, the interconnection of the larger cities in each region with the larger cities in the other regions became the most important control in selecting the general routes comprising the Interstate System. Several facts tend to justify this approach. Basic among these are the following: (1) nearly 90 per cent of all traffic moving on through highways has an origin and/or destination in a city; (2) motor-vehicle traffic steadily increases with closer proximity to cities, and on trans-city connections of main routes, traffic rises to volumes far greater than the general levels on rural sections; (3) the heavily traveled sections of any highway system, including the Interstate, lie mainly within relatively narrow zones of traffic influence around cities of 10,000 or more,

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[1] U.S., Congress, House, Interregional Highways, op. cit., P. 40.

population; and (4) the larger the city the wider is its zone of traffic influence and the greater is its traffic generating power.[1]

These facts, plus the obvious relationship between large cities and population and industrial concentrations, make it evident why the prime control in selecting Interstate routes was the interconnection of the larger cities in the various regions of the country.

The second major control used in the original selection was the accomodation of short-run traffic. This criterion is justified on the basis of factual information gathered by various planning surveys which indicates that most trips are short. For example, traffic counts show that about 85 per cent of all trips are for less than 20 miles, and only about 5 per cent are for more than 50 miles. For this reason it was decided to avoid connecting the principal regional centers by drawing straight lines between them. It was considered better practice to connect as many of the smaller urban centers en route between major centers as was practical without making the route too circuitous. Thus, the larger, or more important, cities became primary control areas, while the smaller centers were considered to be secondary control areas, unless they were too far from the direct route between the primary control areas. It should be stressed that the selection of the secondary control areas to be connected by the System was basically a matter of judgment on the part of the members of the Interregional Highway Committee. But in making these selections the situation factors (such as population distribution, industrial development, and military establishments) discussed later in this chapter were taken into account.[2]

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[1] Ibid.

[2] Ibid., P. 47.

The third major control used in selecting the component parts of the System was the principle of maximum utilization, or the selection of a system which would have the highest average hourly traffic volume per mile of any possible group of highways that might be chosen. To illustrate how this principle is related to route selection, consider two possible Interstate Systems:[1]

> (1) The first System would connect all communities in the United States classified as urban, and would include a rather large part of the total rural road mileage in the nation. This system would serve a very substantial part of total highway traffic, but its average intensity of use would be low because of the inclusion of much lightly traveled mileage.
>
> (2) The second system which might tentatively be considered would connect only the very largest cities of the nation, perhaps those over one million population. A few transcontinental highways could accomplish this. But many fairly large, important cities would not be included in this system, and it would serve completely and conveniently only a small part of the total, long-trip traffic. This system would also be of relatively low average intensity of use. This results from the fact that the largest cities of the nation are concentrated in the northeastern and California areas. To connect these widely separated areas would require a large percentage of the system's mileage to pass through sparsely populated territory; and this would result in a low average intensity of use for the system as a whole.

If the foregoing is an accurate analysis, it is reasonable to assume that somewhere between a small system and an extensive one, there should be a system of optimum extent which would have the highest average-daily traffic volume[2] of any group of interconnected, region-linking highways in the nation.

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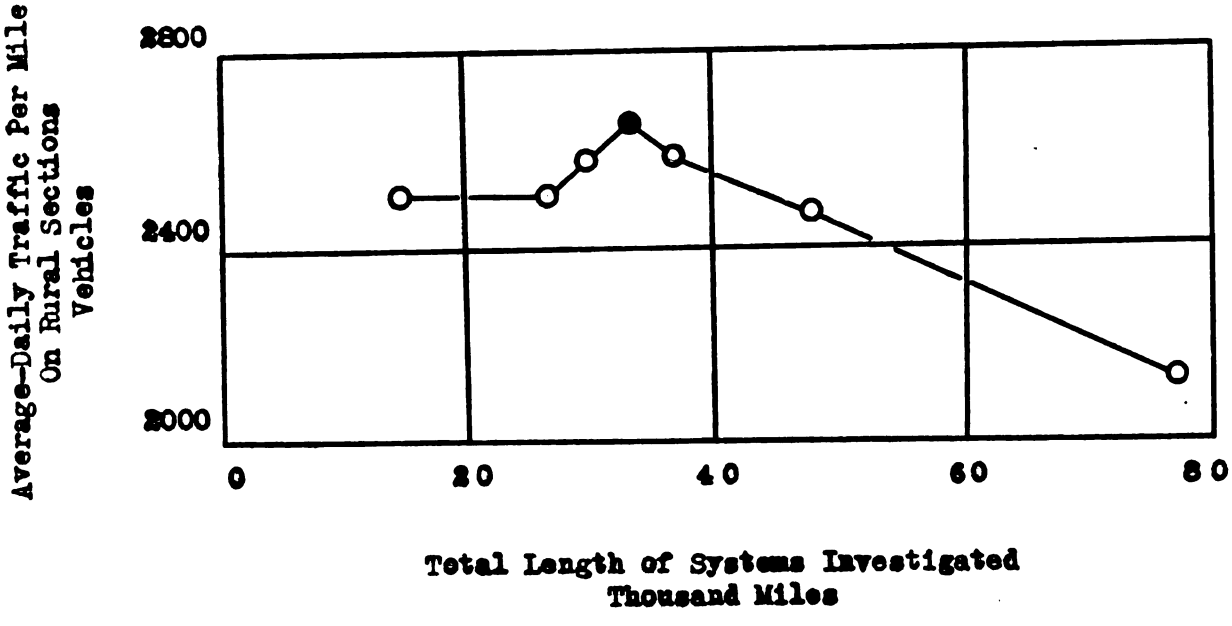
[1] Ibid.

[2] The average-daily traffic volume for any point on a highway is equal to the total number of motor vehicles which pass that point during a period of one year, divided by 365.

To find the optimum mileage a number of systems of various sizes, both larger and smaller than experts thought would be the probable optimum, were selected, and the average-daily traffic volume of each was plotted against its extent in miles. In such manner a curve could be formed, the maximum ordinate of which, representing the largest average-daily traffic volume, would correspond to an abscissa indicating the mileage of an optimum system. Figure 1 illustrates this relationship in graphical form.[1]

Figure 1. Graph Illustrating Selection of Original System



Five tentative systems were planned and mapped. By computing the average-daily traffic volume per mile on rural sections for each of these systems, it was discovered that the 29,300 mile system had the highest

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[1] Ibid., P. 49.

average intensity-of-use. To further check the trend, two more systems were planned and mapped; one of 33,000 miles and one of 36,000 miles. The 36,000 mile system proved to have an average-daily traffic volume just slightly less than the 29,300 mile system, and the 33,000 mile system had a slightly higher average-daily traffic volume. By subtracting from the 36,000 mile system certain of the more lightly traveled sections, it was found that a system of 33,920 miles offered the maximum average-daily traffic volume for any group of highways selected according to the principle of regional interconnection.[1]

This is the system which was recommended to Congress, and which was enacted into law in the Highway Act of 1944. The figure 33,920 does not include the approximate 5,000 of circumferential and distributor routes which are designed to make the Interstate System more effective in urban areas.[2] Table 1 indicates average-daily traffic volumes per mile on rural sections for each of the systems studied, including the recommended one.[3]

Relation of Original System to Situation Factors.

The criteria used in selecting the routes for the original System resulted in a general plan and a system of limited extent. In selecting specific routes, state highway officials, who bore the responsibility for the final locations of Interstate highways, used these Federal recommendations, and also considered the situation factors of particular relevance to their own areas. These situation factors which are of most

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[1] Ibid., Pp. 51-52.

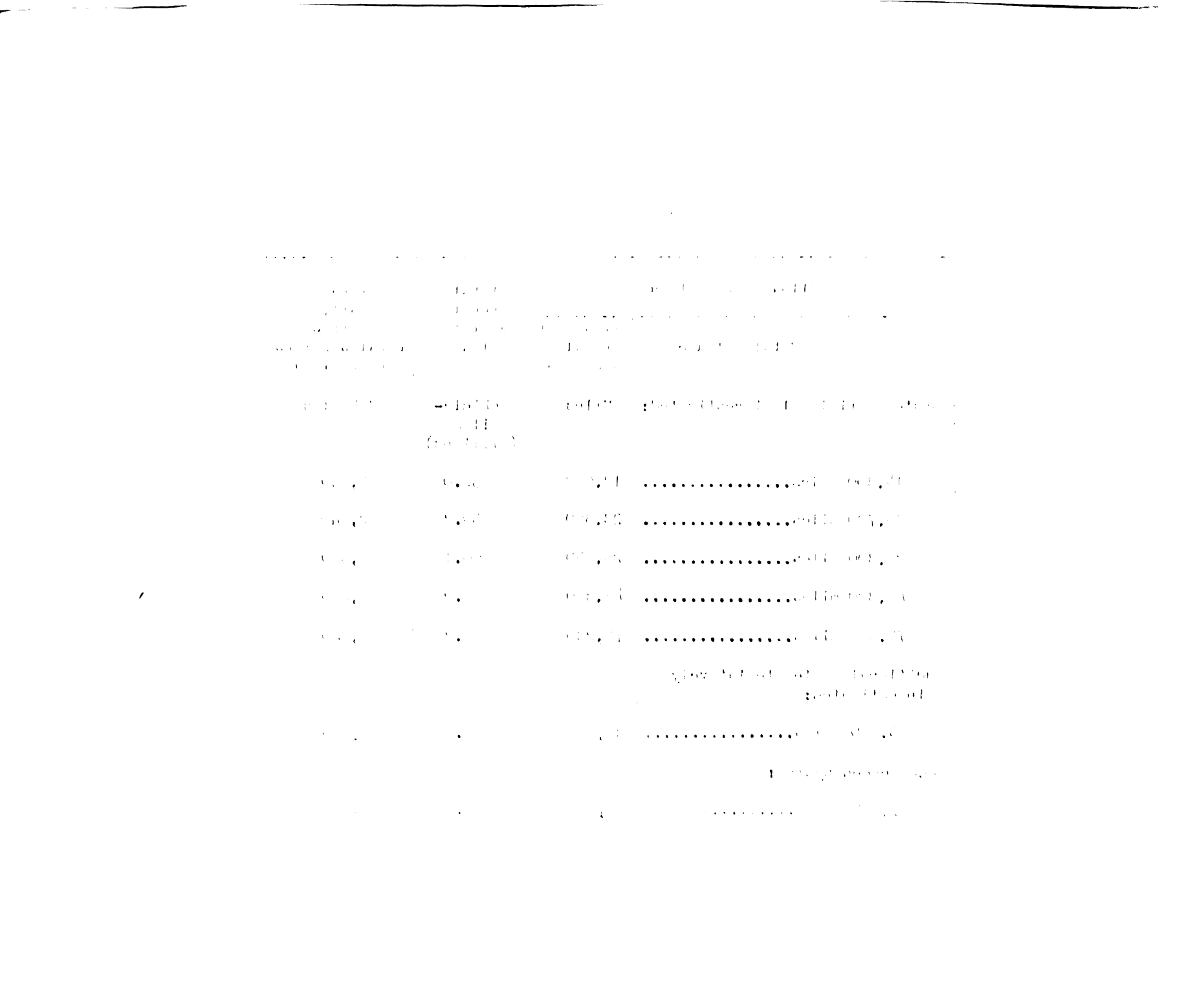
[2] Ibid.

[3] Ibid., P. 49.

TABLE I

ESTIMATED AVERAGE-DAILY TRAFFIC ON RURAL SECTIONS
FOR ALL SYSTEMS STUDIED

Mileage of Systems		Total rural vehicle mileage	Average-daily traffic rural sections (per mile)
Total Mileage	Mileage of rural sections		
Systems originally investigated:	Miles	Vehicle-miles (millions)	Vehicles
14,300 miles.....	12,600	32.0	2,540
26,700 miles.....	23,300	59.2	2,540
29,300 miles.....	25,550	66.1	2,590
48,300 miles.....	42,380	104.9	2,480
78,800 miles.....	70,230	150.2	2,140
Additional system tentatively investigated:			
36,000 miles.....	31,350	81.0	2,580
Recommended system:			
33,920 miles.....	29,450	78.2	2,660



importance in effecting man's judgment concerning the location of Interstate highways may be grouped as follows:[1]

(1) Physical environment, including

(a) climate

(b) landforms and drainage

(c) earth resources

(2) Cultural environment, including distribution of

(a) population

(b) productive facilities

(c) transportation facilities

(d) military and defense establishments

Physical environment.- Physical aspects of man's environment are more likely to be important, in the direct sense, as site considerations, or in determining the specific position of the highway than as situation factors effecting the general location. However, in mountainous or hilly areas, landform conditions may have significant bearing on the general location of routes. But the physical environment is of far greater importance to the location of the highways of the Interstate System than is indicated by direct consideration. This relates to the influence which the physical environment has on the cultural environment. Distribution of population and productive facilities, and the transportation facilities needed to connect them, are all related to climate, surface configuration, and earth resources. The physical environment acting in conjunction with the cultural stage of a people occupying an area sets limits on resource potentialities. This results in varied distributions of cultural phenomena. It is these cultural phenomena which are most

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[1]See Vernor C. Finch and Glenn T. Trewartha. Physical Elements of Geography. (New York: McGraw-Hill Book Co., Inc., 1949) P. 3.

significant in the location of Interstate highways; but the basic influence of the physical environment is always apparent.

Cultural environment.- In line with the general recommendations for location of the original system, the present Interstate routes bear a close relationship to population distribution and the resultant settlement characteristics for the entire nation. The routes are designed to connect, as directly as possible, the maximum number of cities of each population size. They are located to provide maximum service to the major metropolitan areas of the nation, as well as to specific cities. Although the distribution of rural settlements and population is not as important to locational theory as are urban settlements and population, the density of rural population is given serious consideration. Thus, the routes tend to pass through the nation's most populous bands of rural settlement. To summarize, the routes have their principal termini in the larger cities, but are located to pass through, or near, as many as possible of the smaller clusters of towns and populous rural areas.[1]

The distribution of productive facilities is also an important situation factor. The Interstate routes are designed to serve the major concentrations of production, including manufacturing, agricultural, and extractive industries. The provision of effective highway transportation service for as much as possible of the nation's manufacturing industry is especially important, because of the large volumes of truck and employee passenger-car traffic generated by these productive facilities. The routes also traverse, to the extent consistent with other

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[1]U.S., Dept. of Commerce, Bureau of Public Roads, Criteria for Selection of Interstate Routes, op. cit., Pp. 3-4.

locational objectives, the areas of high per-acre value in marketed crops.[1]

The third cultural situation factor, the distribution of transportation facilities, is an expression of the necessity to interconnect the settlements and productive facilities of the nation. Roads and highways are, of course, not the only transportation media available in the United States. The nation also possesses several inland waterway systems, a railroad network, pipelines, air routes with associated landing facilities, and electric-powered interurban, suburban, and urban railways.[2] Although the main function of the Interstate System is to provide service to motor vehicles, the highways should also be located so as to interconnect the other transportation media, provide highway service to and from their major terminals, and complement them to the extent possible.

The distribution of military and defense establishments is of direct importance in the location of the Interstate routes. The major types of establishments included in this category of control are military facilities, airfields, proving grounds, arsenals, and defense industries. One of the original basic purposes behind the establishment of the Interstate System was the Federal responsibility to provide for the defense of the nation. Since many of these strategic places and activities rely heavily on highway transportation for their supplies and mobility, it seems quite logical that routes financed primarily by the Federal government should be located in close proximity to the principal military and defense-related establishments in the country.

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[1] Ibid.

[2] Stuart Daggett. Principles of Inland Transportation. (New York: Harper Bros., Inc., 1955) P. 3.

In 1949 the Secretary of Defense appointed a special committee to study the relationship between national defense and the Federal-aid highway system. The report which was submitted to Congress as a result of this study had the support of the entire National Defense Establishment. Some of the major points brought out in this report are quoted in the following paragraph:[1]

> "The National Military Establishment considers a relatively small 'connected system of highways interstate in character,' constructed to the highest practical uniform design standards, essential to the national defense. Subject to the development of more complete basic information the Department of National Defense considers the National System of Interstate Highways and certain other routes of high strategic importance to be the principal 'connected system of highways interstate in character' essential to the national defense. The general location and extent of these strategic routes are the subject of continued consideration and the Commissioner of Public Roads will be currently advised, within security limitations, as to the location and potential traffic considerations which might be helpful in the improvement of such highways. It is considered important that wherever feasible there be incorporated in the design and construction of this system the controlled or limited access principle. This is considered important to preserve the effectiveness and efficiency of the system by preventing ribbon development with direct access and cross traffic, which will ultimately create excessive congestion, and to make possible the exercise of a high degree of control over its use for high priority civilian and/or military traffic in event of an emergency."

It is an obvious fact that the situation factors discussed above show marked differentiation in their areal distributions. For example, the larger cities of the United States are not distributed evenly over the land, but are concentrated within relatively small areas of the nation. Likewise, productive facilities, especially manufacturing industries, are unevenly distributed. In fact, nearly all situation factors,

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[1]U.S., Congress, House, Highway Needs of the National Defense, House Document No. 249, 81st Cong., 1st Sess., June 30, 1949, Pp. 74 and 114-115.

both physical and cultural, are characterized by areal differentiation. As is shown later in this chapter, the areal differentiation of situation factors helps to explain the spatial arrangement of the Interstate System in its national setting.

Site Factors

Site factors, or those elements of the physical and cultural environment which characterize the ground upon which the highway actually stands, are important in effecting the specific location of a highway. Consideration of the various relevant site factors is intimately related to two other aspects of the highway location problem. These are: (1) route surveys, and (2) design standards.

Route surveys involve mechanical techniques which are designed to give the highway its final, geometric location. When plans for a new highway have been completed, or its situation determined, the various route surveys are conducted by civil engineers. These surveys are of three types: (1) the reconnaissance—a rapid and approximate examination of the site controls in the entire area around the proposed highway, the purpose of which is to eliminate from consideration the impracticable routes so that the more promising ones may be studied in greater detail; (2) the preliminary survey—provides more exact and detailed information concerning the routes that appear promising by analysis of the reconnaissance survey; and (3) the final location survey—the actual fitting of the highway line to the ground. When the final location survey has been completed, the highway has been staked on the ground, and an accurate map

and profile sheet have been drawn, the actual construction of the highway may be started.[1]

Before starting these route surveys, however, a frame of reference must be established upon which the engineers responsible for highway location can base their decisions regarding the relevancy, or irrelevancy, of the various site factors. For the Interstate System, the framework on which all site considerations rest is the design standards which have been specifically adopted for this System.

Design and Construction Standards.

The design and construction standards for the Interstate System were not selected arbitrarily. On the contrary, they were chosen as a result of many research activities relating to the volume and character of highway traffic, motor-vehicle capacity of roadways, physical factors involved in pavements, base courses, and subgrades, plus years of experience in designing and constructing roads.

The design and construction standards, adopted by the American Association of State Highway Officials and approved by the Bureau of Public Roads in July 1956, are based on such considerations as;[2] (1) amount of motor-vehicle capacity which the highway should have on a daily basis, and especially during peak hours of traffic flow; (2) control of access; (3) elimination of road intersections and railroad crossings at grade; (4) design speeds of at least 70, 60, and 50 miles per hour for flat, hilly, and mountainous topography respectively, and 50 miles per hour in

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[1] Harry Rubey. Route Surveys and Construction. (N.Y.: MacMillan Co., 1956) P. 4.

[2] U.S., Dept. of Commerce, Bureau of Public Roads, Geometric Design Standards for the National System of Interstate and Defense Highways, July 17, 1956, P. 1.

urban areas; (5) limited gradients; (6) shoulders adequate for all highway conditions; (7) minimum width of paved surface and a minimum number of traffic lanes; (8) minimum width of right-of-way; and (9) type and alinement of bridges and other structures.

All of these design requirements have some effect on site considerations. Among the design requirements which will most effect the sites for Interstate highways are those for control of access, wide rights-of-way, and limited gradients. A controlled access highway (commonly referred to as a parkway or freeway) is especially designed for through traffic, and to which motorists and abutting property owners have only a restricted right of entry, light, air, and view. In most cases controlled-access facilities are multiple-lane, divided highways paved with a high type surface such as portland-cement concrete. Commercial vehicles are excluded from parkways; freeways are open to all customary forms of motor vehicles.[1] The Interstate System, when completed, will consist of a network of freeways, except in those few areas where traffic cnd cultural development is not sufficient to warrant control of access.

Right-of-way refers to the publicly-owned property devoted to highway use. For various reasons right-of-way widths in this country have remained relatively stable once established. Among the reasons for this permanency of right-of-way in a country where traffic conditions have changed so radically are (1) the tendency for settlement to follow in the direction of highway improvements, and consequently, (2) the induced commercial and residential land use concentrations

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[1] David Levin, Public Control of Highway Access and Roadside Development, Federal Works Agency, Public Works Dept., Wash., D.C., 1943, P. 7.

along many highways. Thus, many main roads have been enclosed within a wall of their own making, and to widen the right-of-way on the present site would be too expensive to be justified economically.[1]

The combined effects of controlled access and wide rights-of-way require that the Interstate highways be constructed on new sites to fulfill the adopted design standards without creating economic or social disutility. To control access on the highways comprising the original Interstate routes would mean the virtual destruction of those commercial enterprises directly dependent on the highway for customer access, and would render hardships on individuals whose residences abut on the highways. The same is true with right-of-way requirements, except, in this case, to widen the right-of-way would involve government purchase and destruction or movement of abutting property rather than its strangulation. Because these two standards are basic to a modern, safe, efficient Interstate System, it is imperative that new sites be selected for the routes.[2]

The design requirements for limited gradients also effect site considerations. Gradients are computed as a function of vehicle speed, and since all sections of the Interstate System are being designed for speeds of at least 50 miles per hour, gradients should not normally be greater than 5 per cent (a 5 foot rise or decline in a horizontal distance of 100 feet). The exception to this rule is in terrain with considerable local relief where gradients 2 per cent steeper may be provided. These requirements have a decided effect on the selection of a site. Level

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[1]David Levin, "The Permanence of the Right-of-Way in a Changing Environment," Highways in Our National Life, op. cit., Pp. 281-289.

[2]U.S., Congress, House, Interregional Highways, op. cit., P.84.

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areas are favored wherever they are available. If they are not available without uneconomical deviations from the planned general route, expensive cut-and-fill techniques must be employed to maintain the required horizontal alinement. Other considerations being equal, the highway location engineer will look for a site which reduces the amount of cut and fill to a minimum.[1]

Physical Environment.

Elements of the physical environment which may be site controls are as follows:

(1) surface configuration, including

(a) local relief

(b) earth materials-bedrock and soil

(c) drainage characteristics

(2) natural vegetation

Surface configuration refers to the relief and slope characteristics of the various types of landforms. These factors--relief and slope--can be vital in controlling the site of the highway, especially in hilly or mountainous terrain.[2] Earth materials associated with surface configuration may be extremely important in the control of site. Bedrock outcrops of any extensive size are usually avoided, although the highway may pass close to them for scenic purposes. Highways should not be located on unstable bedrock or bedrock which is liable to lateral movement.[3] Soils likewise influence the site of the highway, with some soils being

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[1]Bruce and Clarkeson, loc. cit., Pp. 37-43.

[2]American Association of State Highway Officials, A Policy on Geometric Design of Rural Highways, (Wash., D.C.: AASHO, 1954) P. 53.

[3]Bruce and Clarkeson, loc. cit.

excellent as road foundations while others are very poor, or even unsatisfactory.[1]

The drainage characteristics of land are also important site controls. Good natural drainage is always desirable for a highway site; if it cannot be obtained because of the necessity of heeding other factors, it must be provided artificially. Rivers and streams must be avoided or bridged. Lakes, or other large bodies of water must be avoided as sites, for obvious reasons. Natural vegetation may be an important site control especially in wooded areas.[2]

Cultural Environment.

Cultural features and characteristics of the land are also important in determining sites for Interstate highways. The following two general classifications include those cultural factors which are primary and secondary controls in site considerations:

(1) motor-vehicle traffic flow

(2) land use

If one factor can be rated the most important site determinant, it is motor-vehicle traffic flow. Although traffic considerations do not dominate site determinations to the exclusion of all other factors, no modern highway is located without close scrutiny of the traffic situation and especially the desire lines of traffic movement between origins and destinations.

Motor-vehicle-desire lines of movement are determined by origin-destination surveys (O-D surveys). Highway engineers consider these

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[1]AASHO, A Policy on Geometric Design of Rural Highways, op. cit., P. 53.

[2]Ibid.

surveys to be the most satisfactory and accurate method of estimating the volume of traffic that would use a new highway were it to be constructed. The O-D technique involves the establishment of certain cordons, or lines, which intersect all highways focusing on an area. Counting stations and interviewers are situated on these cordons where they intersect the highways. Each vehicle which passes the cordon is stopped, the driver is interviewed, and information is obtained as to where his trip originated and to where he is destined. Data from these surveys are usually plotted on maps. The lines which are plotted indicate the major-desire movements of traffic, or the direction that vehicles would travel if they could go from origin to destination by the most direct route.[1]

In general, the site of the highway should coincide as closely as possible to the densest concentration of desire lines of movement. Since, however, other factors besides traffic must be considered, it is not always possible, nor even desirable, to fit the new highway onto the exact position of the desire lines.[2]

Land use, including cultural features associated with man's occupance of the land, is likewise an important site factor. Sites for highways are usually chosen on the least valuable and least intensively used land within any areas. This is not always the case because of various other site considerations which may tend to discourage utilization of the low value, low intensity-of-use land.

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[1]R. N. Grunow, "Location Needs to Get Full Benefits from Freeways," Proceedings of American Society of Civil Engineers, Journal of Highway Division, Vol. 83, Paper 1294, July 1957, Pp. 1-10.

[2]AASHO, A Policy on Arterial Highways in Urban Areas, (Wash., D.C.: AASHO, 1957) P. 84.

Land use may be considered under the heading of two basic divisions. These are: (1) urban, and (2) rural. Each of these categories, of course, contains many subdivisions. The difference between urban and rural land uses is primarily a matter of degree rather than kind, although some land uses are found in urban areas that are rare in rural areas, and vice versa. In rural areas the possibilities for highway sites are usually greater than in urban areas because of less development and consequent wider range of available, satisfactory locations for a highway. The urban area, in contrast, is usually congested, little land is unused, and the possibilities for highway sites are severely limited.[1]

Each of the subdivisions of the basic land use types (agricultural, residential, commercial, recreational, manufacturing, etc.) offers variant possibilities and poses different problems for highway sites. For example, if a highway is to be located through a highly productive agricultural area, it should remove as little of the better land from production as is physically attainable. This requirement, of course, would not be important on unused land. If manufacturing or commercial uses are found in the area through which a highway is to pass, the facility should be located to serve these establishments. The recreational area may provide a special case. Here, scenic values, general esthetics, and recreational roadside development may be of prime importance in controlling the site.

In summary, highway site determinations are usually more complex and expensive to solve in urban areas than they are in rural areas. This

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[1]AASHO, A Policy on Geometric Design of Rural Highways, op. cit., P. 53.

is largely the result of inherent differences in intensity of land use found in the two situations. Interstate highways in rural areas are designed for high speeds, and thus require a site which will provide better alinement, longer views, and greater lateral clearances than do similar highways in urban areas. But in urban areas, although speed and other design requirements may be lower than for rural areas, there is less choice of site than in open areas, and route termini controls are more rigid.[1]

The site factors discussed above, like the situation factors discussed previously, show marked differentiation in their areal distribution. For example, some areas of the country, such as the Central Lowlands, have relatively little local relief, while others, such as the Rocky Mountains and Appalachian Highlands, are characterized by considerable local relief. Likewise, some areas, such as the northern glaciated parts of the United States have an abundance of earth materials desirable for road construction, while other areas, such as the Mississippi delta plain, are lacking such materials. In fact, nearly all site factors, both physical and cultural, are characterized by areal differentiation. In the next section of this chapter, discussion is centered on the manner in which the areal differentiation of situation and site factors effects the spatial arrangement of Interstate highways.

The Spatial Arrangement of Interstate Highways

The spatial arrangement of highways refers to the location and distribution of these facilities on the earth's surface. From what has

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been previously said about the areal differentiation of situation and site factors, it should be expected that the Interstate routes are distributed in somewhat uneven fashion over the nation. Also, it should be expected that spatial arrangement of the Interstate routes bears a definite relationship to the distribution of the various situation and site factors discussed. Although it is not the intended purpose of this thesis to indicate the areal differentiation for all the situation and site factors, it should be valuable to show, in cartographic form, the relationship between the spatial arrangement of one situation factor and the spatial arrangement of the Interstate System.

Figure 2 shows the spatial arrangement of the Interstate routes in relation to the spatial arrangement of the Standard Metropolitan Areas of the nation.[1] It is evident that the majority of the Standard Metropolitan Areas in each region of the country are served by one, or more, Interstate route. The only states which have more than two unserved metropolitan areas are Texas with 4, and Iowa with 3. Several routes, however, pass through territory which has no metropolitan area. These routes are justified on the basis of other factors, the most important of which are the desire for an interconnected system and balanced regional distribution. Most of these latter routes have termini in centers which, although not populous enough to rate metropolitan status, are of considerable regional importance.

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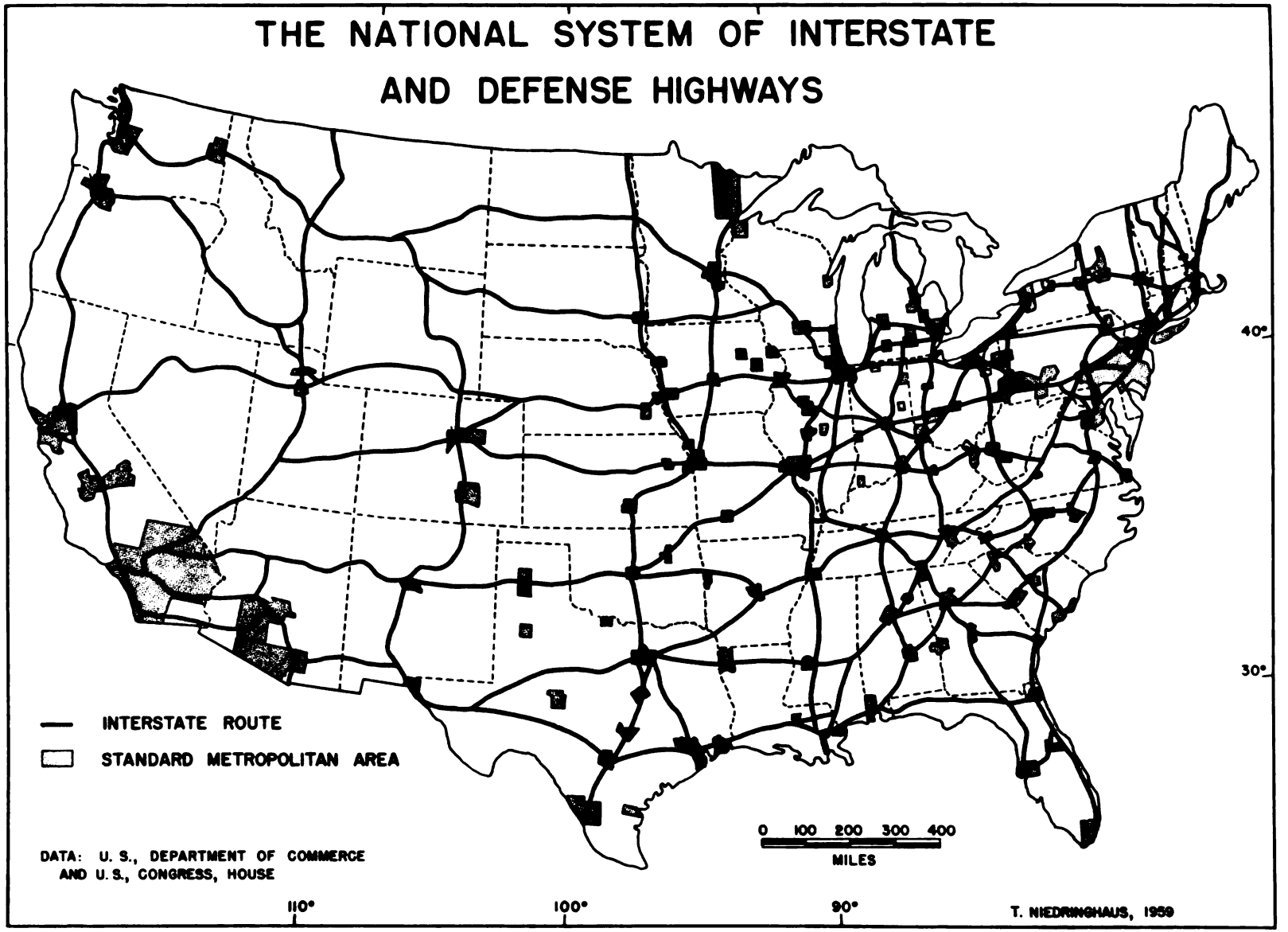
[1]A Standard Metropolitan Area is a county, or group of contiguous counties, which contains at least one central city of 50,000 inhabitants, or more, except in New England where it is defined by a population density criterion of 150 persons, or more, per square mile. For more detailed information see, U.S. Dept. of Commerce, Bureau of the Census, County and City Data Book, 1956, Washington, D.C., 1957, P. xi.

Figure 2


THE NATIONAL SYSTEM OF INTERSTATE AND DEFENSE HIGHWAYS
INTERSTATE ROUTE
STANDARD METROPOLITAN AREA
0 100 200 300 400
MILES
DATA: U. S., DEPARTMENT OF COMMERCE AND U. S., CONGRESS, HOUSE
110°
100°
90°
40°
30°
T. NIEDRINGHAUS, 1959

Casual examination of Figure 2 indicates that the Interstate routes serve every region of the country. Closer examination, however, indicates regional differences in density of network. The eastern half of the nation, including the North and the South, has a significantly denser network than does the West. This is basically a result of differences in the physical and cultural environments of the areas. In the humid North and South, agriculture forms the basis for the support of a large number of people, while in the arid and semi-arid West, agricultural possibilities are more limited. Topography, local relief, and soil conditions are likewise more favorable in most parts of the North and South than they are in the West. In the North are found most of the nation's larger cities and its densest concentration of productive facilities, as well as fairly dense concentrations of rural population. In the South are found relatively closely spaced regional centers of large size, and some of the nation's densest concentrations of rural population.

Each of these broad regions (the North, the South, and the West) exhibits considerable internal contrasts. The nation's densest network of Interstate routes is in the North, roughly coinciding with the American Manufacturing Belt. The American Manufacturing Belt, of course, contains much of the urban population of the nation, a preponderance of the manufacturing industries, and a significant share of the nation's agricultural production. The South has its densest concentration of routes in the area near the southern extremity of the Appalachian Mountains where the Piedmont Upland and the Ridge and Valley Section of the Appalachian Highlands meet. Here, as indicated in Figure 2, is a concentration of metropolitan areas in the young, but rapidly developing, industrial region of the South.

Other regional contrasts are noticeable in Figure 2. In the extreme northern portions of the East, the network is broken into tentacles. This is particularly evident in northern Minnesota, northern Wisconsin, northern Michigan, and Maine. In these areas climatic and soil conditions are not as favorable for agricultural production as they are further south, and this has resulted in lower population densities, smaller urban centers, fewer manufacturing establishments, and consequent lower density of Interstate routes. The South also has some poorly served areas. The most obvious of these are the predominantly agricultural Delmarva Peninsula, the poorly drained North Carolina coastal plain, and the Everglades area in Florida.

West of the 100th Meridian, or at the edge of the Great Plains, the Interstate network thins noticeably in response to various physical and cultural factors. These factors include the general aridity or semi-aridity of much of this area with consequent limited possibilities for agriculture, the rugged mountainous terrain which is widely distributed, and the sparse population. In the American West, settlements are basically of the oasis type, with urban centers being surrounded by relatively empty areas. Examination of Figure 2 indicates that throughout much of the West, metropolitan areas are few and dispersed, especially in comparison to parts of the humid North and South. However, most of the major centers in the West are connected by more than one Interstate route. These centers include Albuquerque, Denver, Cheyenne, Butte, Salt Lake City, Phoenix, Portland, and Seattle.

In and approaching California the network again attains a density comparable to the North and the South. This is particularly noticeable in the vicinity of Los Angeles and San Francisco. These two cities mark

the cores of what might be called the California urban-manufacturing region. The nation's only region of Mediterranean climate is found in California, and this has helped to attract large numbers of people for recreational and agricultural pursuits. Recently, the area has also become a major manufacturing section of the nation, and this has tended to further increase the population. Much of the remainder of the state, outside the zone of Mediterranean climatic influence, is either desert or mountain, and does not have population densities or agricultural production comparable to those in the urban-manufacturing region.[1]

In summary, the various physical and cultural situation and site characteristics show considerable areal differentiation over the face of the nation. Probably the single most important locational criterion involved in the distribution of Interstate routes is motor-vehicle traffic flow, both actual and potential. But motor-vehicle traffic flow is effected by numerous other factors, the most important of which are population and productive-facility distribution. And, furthermore, the location of population centers and productive facilities can themselves be traced to the historical development of the American cultural landscape based in large part on areally differentiated natural resources.

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[1]See, Edward A. Ackerman, "The National Environment of Urban Growth and Highway Construction," The New Highways: Challenge to the Metropolitan Area, Urban Land Institute, Technical Bull., No. 31, Wash., D.C., Nov., 1957.

CHAPTER III

THE INTERSTATE SYSTEM IN ITS MICHIGAN SETTING

In many respects the Michigan portion of the Interstate System is representative of other regions in the nation; on the other hand, certain characteristics of the state have produced a spatial arrangement of Interstate routes which is unique. This chapter is devoted to an analysis of the situation and site factors peculiar to Michigan, which have effected the spatial arrangement of Interstate highways.

Situation Factors

The situation factors of Michigan that have been important controls in the general location of Interstate routes may be broadly classified as follows:[1]

(1) physical environment, including
   (a) climate
   (b) landforms and drainage
   (c) earth resources

(2) cultural environment, including distribution of
   (a) population
   (b) productive facilities

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[1]Above, P. 22.

(c) transportation facilities

(d) military and defense establishments

Physical environment.

The physical environment of Michigan, especially its climate, landforms, earth resources, and land-water relationships, is a basic situation control. However, the first three of these physical elements--climate, landforms, and earth resources--are mainly important in an indirect sense as far as their influence on Interstate-route locations is concerned. These elements have influenced the cultural environment of Michigan, which, in turn, has effected the general location of Interstate routes. However, Michigan's peculiar land-water relationship has had direct influence on the location of the Interstate network.

The physical setting of Michigan is dominated by its position relative to the world's largest system of inland, fresh-water lakes: The Great Lakes. Michigan is nearly surrounded by these large lakes, and is divided by them into two separate peninsulas that have only recently been physically united by a bridge spanning the Straits of Mackinac. The significance of this peninsular location amid the Great Lakes is that limitations are automatically set on the directions of approach available to through routes entering the state. Re-examination of Figure 2 indicates that Interstate routes enter, or leave, Michigan from the south only; There is no other possibility for a land route into Michigan from American points except from northern Wisconsin into the Upper Peninsula, a route not presently included on the Interstate System. In addition, sites for roads from Canada into Michigan are restricted to relatively small areas around the straits of the Detroit River, along the St. Clair River, and near Sault Ste. Marie in the Upper Peninsula. In each of these cases,

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bridges or tunnels are necessary to make the desired connections. For these reasons the northern parts of the state have tended to be more isolated than they might otherwise have been.

The other physical factors—climate, landforms, and earth resources—have a strong effect on the general cultural situation of Michigan. Climatically, Michigan is part of the Humid Continental regime (Köppen Daf and Dbf), and consequently has marked seasonal contrasts with warm summers and cold winters.[1] Precipitation is adequate for the growth of vegetation and crops throughout most of the state (average of 30.45 inches per year). Average length of growing season varies from 180 days in the southwest to 80 days in small areas of the Upper Peninsula; thus, in most of the state a variety of crops can be grown.[2]

Topographically, Michigan is chiefly part of that huge area of North America known as the Central Lowlands. Michigan is, thus, a plains area, although here and there minor relief features and mildly rough country break the monotony of flat or gently rolling terrain,[3] Plains areas are generally the best sites for human habitation providing climate and resource bases are also favorable. These areas do not, in general, pose major difficulties for modern highway construction, provided they are well-drained. Only the western half of the Upper Peninsula has relief and other surface conditions which might exercise dominant control over highway location, and this area of the state has no Interstate route at present.

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[1]Finch and Trewartha, Physical Elements of Geography, loc. cit., Appendix, Plate III.

[2]Bert Hudgins, Michigan: Geographic Backgrounds in the Development of the Commonwealth. (Ann Arbor, Mich.: Edwards Bros., Inc., 1958) Pp. 31-37.

[3]Wallace Atwood, The Physiographic Provinces of North America. (Boston: Ginn and Co., 1940) Pp. 186-189.

Michigan is fairly well endowed with earth and vegetative resources. Water resources of the land are outstanding for human habitation, although the many swamps in the state were a deterrent to early settlement. Michigan's podzolic soils (in the north) and grey-brown podzolic soils (in the south) are generally fair to good for agricultural use, although there are considerable differences even within small areas. Economic minerals are widely distributed and have added greatly to its habitation possibilities. The native vegetation of Michigan, largely mixed broadleaf and needleleaf forest, has likewise contributed greatly to the development of the state, although years of exploitation have reduced the virgin forests to a mere remnant of their former extensive cover.

Michigan, though relatively a small area, does have great internal contrasts. Its areally differentiated fundament modified by the cultural stage of the people has resulted in the varied distributions of cultural phenomena. It is the cultural phenomena of Michigan which are most significant in the general location of Interstate highways; but the basic influence of the physical environment is always apparent.

Cultural environment.

The cultural environment of Michigan is a product of the people who inhabited the state, the physical environment which they found, and the resultant historical development. These factors have influenced the present distributions of population, productive facilities, and transportation facilities.

Distribution of population.- Detroit was the first permanent white settlement in Michigan; it was established by the French in 1701 on the

straits[1] of the river between what are now known as Lakes St. Clair and Erie. For many years after Detroit was settled it remained an isolated outpost in the wilderness. Not until Detroit became part of the United States in 1796 (de facto control), after which the Michigan Territory was opened for settlement, did pressure grow for penetration of the interior of the Lower Peninsula. Detroit was quite naturally the center for this outward movement, and major Indian trails leading out of the Detroit area served as the first inland routes. These major Indian trails (Figure 3) were the Sauk, St. Joseph, Grand River, Saginaw, and Gratiot trails.[2]

These trails became the approximate sites of the Territorial Roads, so-called because they were constructed with Federal money while Michigan was still a Territory. Relationships between the Indian trails and Territorial Roads were as follows: (1) Grand River Road — Grand River Trail; (2) Chicago Road — Sauk Trail; (3) Territorial Road — St. Joseph Trail; (4) Saginaw Road — Saginaw Trail; and (5) Fort Gratiot Road — Gratiot Trail. A military road of importance was also constructed during the Territorial Period. This was the famed Detroit-Fort Meigs[3] Road which traversed a historic barrier to land communication, the Black Swamp, and, thus, finally gave Detroit effective land connection with the area to the south.[4]

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[1]The French translation of "a straits site" is detroit, from which is derived the name of the river and the city.

[2]A. E. Parkins, The Historical Geography of Detroit. (Lansing: Michigan Historical Commission, 1918) Pp. iii-iv and 153-154.

[3]The old site of Fort Meigs is now called Toledo.

[4]Roger L. Morrison, The History and Development of Michigan Highways, University of Michigan Official Publications, Vol. 39, No. 54, 1938, Pp. 3-4.

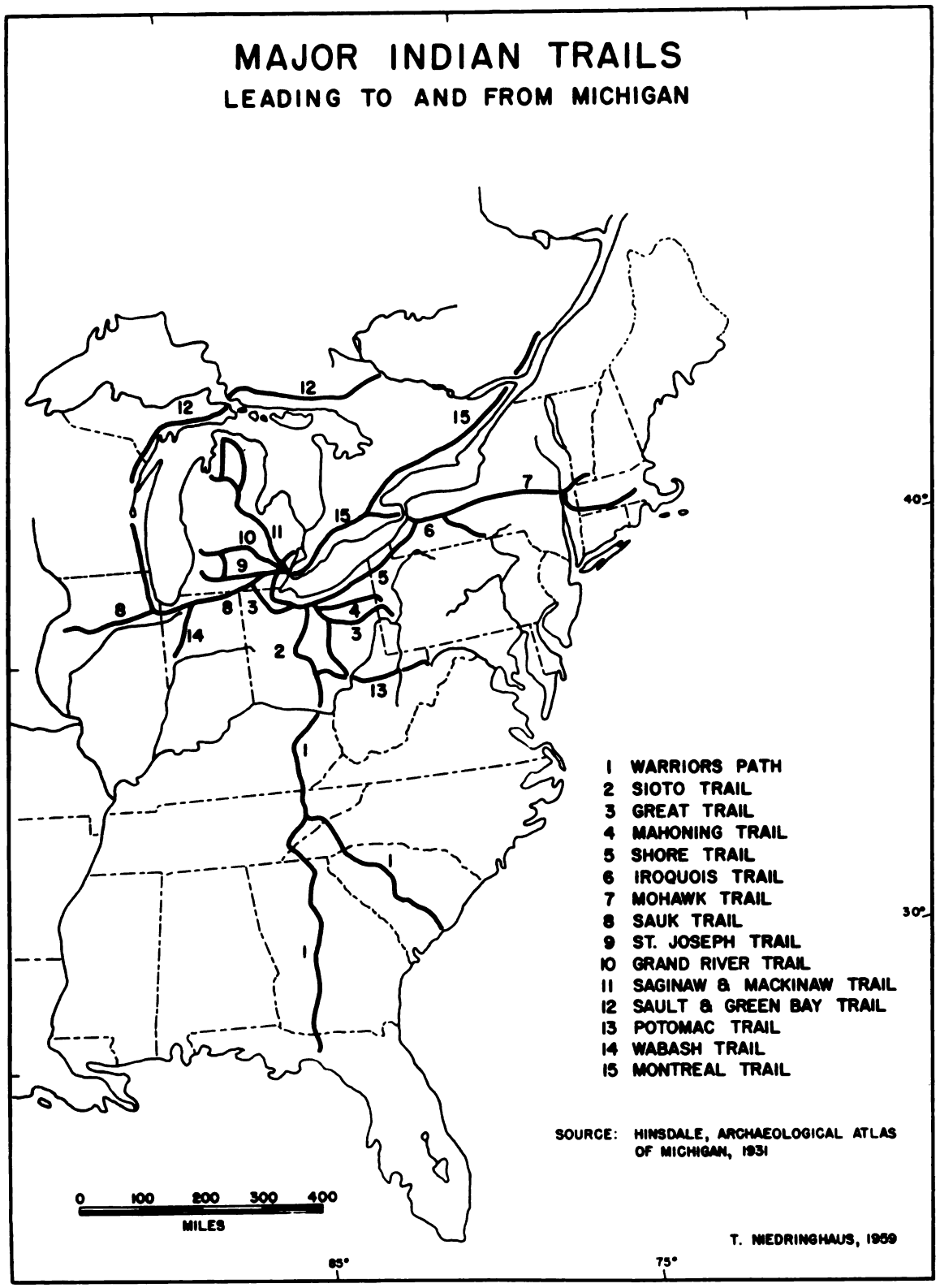
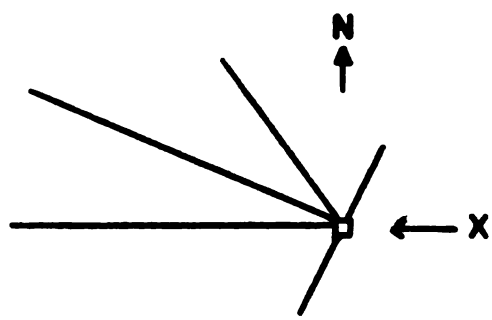

MAJOR INDIAN TRAILS
LEADING TO AND FROM MICHIGAN
1 WARRIORS PATH
2 SIOTO TRAIL
3 GREAT TRAIL
4 MAHONING TRAIL
5 SHORE TRAIL
6 IROQUOIS TRAIL
7 MOHAWK TRAIL
8 SAUK TRAIL
9 ST. JOSEPH TRAIL
10 GRAND RIVER TRAIL
11 SAGINAW & MACKINAW TRAIL
12 SAULT & GREEN BAY TRAIL
13 POTOMAC TRAIL
14 WABASH TRAIL
15 MONTREAL TRAIL
SOURCE: HINSDALE, ARCHAEOLOGICAL ATLAS OF MICHIGAN, 1931
0 100 200 300 400
MILES
T. NIEDRINGHAUS, 1959
85°
75°
40°
30°

Figure 3

The importance of these early roads relates to their influence on the population distribution of Michigan. With Detroit as the center, population waves moved out over the Territorial Roads to establish new settlements. Many of these settlements were dispersed farmsteads; but, at favored sites along the roads, urban settlements developed. The urban settlements established along these Territorial and military roads are, at present, the major urban settlements of Michigan.

The relationship between the Territorial Roads and the major urban settlements of Michigan can be illustrated by use of a generalized diagram. In this diagram let X represent a focal point. Through this point draw four straight lines, none of which is extended in a due east direction. This would appear as follows:

Figure 4. Urban Settlement Pattern of Michigan



If Detroit is considered to be point X, and the Territorial Roads and military road to be the lines, it can easily be proved that every city in Michigan of 25,000 people, or over, lies either at the center, along one of the lines, or in close proximity. This unique arrangement can be traced to the physical setting of Michigan and the historic evolution of population distribution. Examination of Figure 5 shows that, with certain

extensions and additions, this arrangement is basically similar to the arrangement of the Interstate routes in Michigan. This similarity is no accident.

Several other population characteristics of the state also influence the location of Interstate routes. In 1950 Michigan had a population density of about 112 people per square mile. However, this population was distributed in markedly uneven fashion. If a line were to be drawn between Muskegon and Bay City west-east across the state, about 86 per cent of the total population[1] would be found living south of this line, although over half the area of the state lies to the north. Furthermore, every available indicator shows a trend towards an even higher percentage of total population in the southern half of the state.[2]

Likewise, the urban-rural totals and ratios of population show considerable geographic variation. Michigan is, today, essentially an urban state. The 1950 census indicated that about 71 per cent of the population resided in urban places. This contrasts rather sharply with the national average of 56 per cent. Most of the urban population of the state is concentrated to the south of the aforementioned Muskegon-Bay City line. The 31 largest population centers of the state are located to the south of this line,[3] and, of these, the larger are distributed according to arrangement outlined in the above diagram. And to describe the population distribution of Michigan at even sharper focus, it should be noted

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[1]The population of Michigan in 1956 was 7,516,000 (est.). See U.S., Dept. of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1957, 78th Annual Ed., 1957, P. 10.

[2]Hudgins, loc. cit., Pp. 111-112.

[3]Ibid., P. 112.

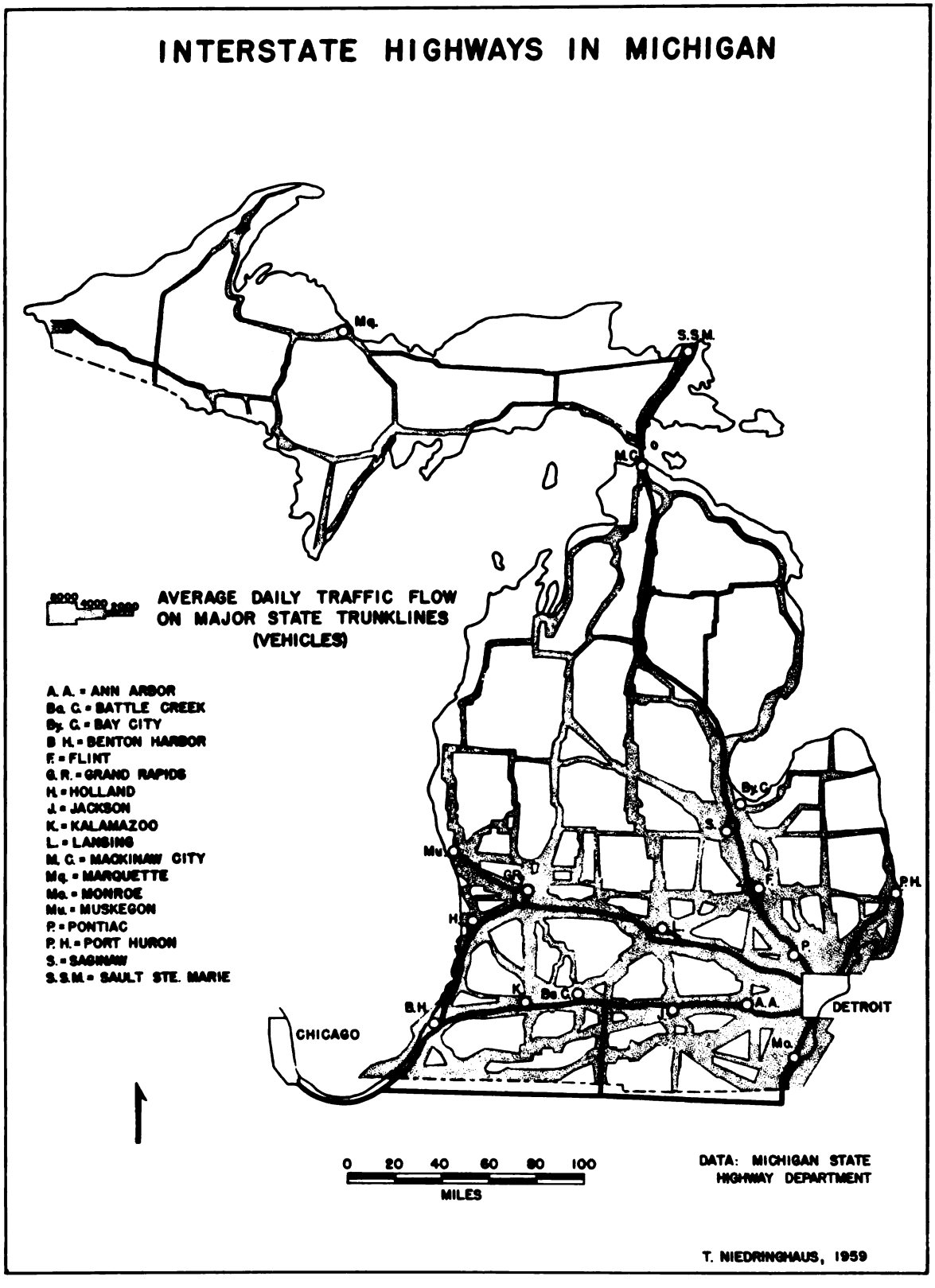
INTERSTATE HIGHWAYS IN MICHIGAN
Mq.
S.S.M.
M.C.
8000 4000 2000
AVERAGE DAILY TRAFFIC FLOW ON MAJOR STATE TRUNKLINES (VEHICLES)
A. A. = ANN ARBOR
Ba. C. = BATTLE CREEK
By. C. = BAY CITY
B. H. = BENTON HARBOR
F. = FLINT
G. R. = GRAND RAPIDS
H. = HOLLAND
J. = JACKSON
K. = KALAMAZOO
L. = LANSING
M. C. = MACKINAW CITY
Mq. = MARQUETTE
Mo. = MONROE
Mu. = MUSKEGON
P. = PONTIAC
P. H. = PORT HURON
S. = SAGINAW
S.S.M. = SAULT STE. MARIE
By.C.
S.
Mu.
G.R.
F.
P.H.
H.
P.
K.
Ba.C.
B.H.
A.A.
DETROIT
CHICAGO
Mo.
0 20 40 60 80 100
MILES
DATA: MICHIGAN STATE HIGHWAY DEPARTMENT
T. NIEDRINGHAUS, 1959

Figure 5

that about one-third of the people are settled in the Detroit Metropolitan Area.

To summarize, the population distribution of Michigan is fundamentally important in understanding the reasons for the location of Interstate highways in Michigan. The straight-line, radial arrangement focusing on Detroit, is also the basic pattern for Interstate highways. Examination of Figure 5 should confirm this.

Distribution of productive facilities.- A second cultural factor of importance in the location of Interstate highways in Michigan is the distribution of productive facilities. In order of importance the major classes of productive facilities found in Michigan are as follows:[1]

(1) manufacturing

(2) tourist and resort trade

(3) agriculture

(4) exploitation of natural resources

Michigan is a major manufacturing state. In 1954 the state had 12,711 manufacturing establishments which made it the seventh ranking state in this respect. Value added by manufacture in Michigan was nearly nine billion dollars and placed the state in fifth position.[2] Although Michigan has several manufactures of importance, transportation equipment, particularly motor vehicles, is by far the leading one. The manufacture of motor-vehicle units and parts dominates Michigan's economy more completely than does a single industry in any other large state. To

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[1]Michigan State Highway Dept., Highway Needs in Michigan, Lansing, 1948, P. 14.

[2]U.S., Dept. of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1957, op. cit., Pp. 792-793.

illustrate this, consider the fact that in 1954 motor-vehicle units and parts alone accounted for over one-third of the total value added by all manufacturing in Michigan.[1]

Of special significance to any analysis of situation factors in Michigan is the fact that highways are an essential element in the motor-vehicle production process. The highway is as much a part of the assembly line as the machine that makes engines or the conveyor belt which moves needed parts. Mass production of bulky motor-vehicle products depends on an uninterrupted flow of materials and parts from many subsidiary plants to a single point of final assembly. To bring together at the assembly line thousands of parts from numerous suppliers, at the time needed, without devoting excessive space to storage, motor-vehicle manufacturers rely heavily on truck transportation, and consequently the highway network.

The Detroit Metropolitan Area (Wayne, Oakland, and Macomb Counties) is the primary center for Michigan motor vehicle production. Other urban centers in Michigan which are important manufacturers of motor vehicles are Flint, Lansing, and Saginaw. Numerous other places, largely in the southern half of the state, provide parts for the assembly plants located in the above centers. Observation of Figure 5 indicates that all of the major motor-vehicle production centers are served by one or more Interstate routes.

Many other manufacturing industries are located in Michigan. Among the more important of these are: machinery; fabricated metal products;

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[1]U.S., Dept. of Commerce, Bureau of the Census, U.S. Census of Manufactures: 1954, State Bull., MC-121, (Michigan), 1957, Pp. 2-17.

[2]M.S.H.D., Highway Needs in Michigan, op. cit., P. 16.

primary metal industries; food and kindred products; chemicals and products; pulp, paper, and products; and printing and publishing. In addition to the transportation-equipment centers listed above, other important manufacturing centers are: Grand Rapids, Kalamazoo, Muskegon-Muskegon Heights, Battle Creek, Midland, Benton Harbor-St. Joseph, Bay City, Port Huron, Jackson, and Monroe.[1] Figure 5 indicates that all of these centers are located in the southern half of the state, and that most of these centers are connected by one, or more, Interstate routes.

The tourist and resort industry is the state's second most important economic base. Michigan has a number of natural features which are of recreational value, and many of these are developed for the tourist trade. Highways and motor vehicles are the means by which most people travel to these areas, and for this reason, Michigan's second industry, like the first, is fundamentally dependent on the state's highways. Unlike population and manufacturing centers, however, recreational areas are distributed throughout the entire state in fairly even proportions. It cannot be expected, therefore, that an Interstate network of limited extent will furnish equal service to all recreational areas of importance in the state.

Agriculture is now the third most important general economic base in Michigan, although at one time it was the leading industry. The principal crops grown are corn, hay, wheat, oats, field beans, sugar beets, and various kinds of fruit. The state is also an important producer of livestock and associated products.[2]

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[1]Hudgins, loc. cit., P. 111.

[2]Ibid., P. 70.

The southern section of Michigan took an early lead in agricultural production, largely because of accessibility. However, the southern section has continued to hold this advantage because of such factors as the longer growing season, the better quality soils, and the closer proximity to the larger markets. The number and distribution of farms, and the value of farm products sold by counties illustrate this fact strongly.[1]

Highway transportation is vital to Michigan's agricultural production. The truck has become a major farm tool, with such diverse agricultural producers as fruit and vegetable truck gardeners, specialized cherry growers, and dairy farmers depending almost exclusively on highway trucking for their marketing activities.[2]

In the fourth ranking major industry of Michigan, the exploitation of natural resources, highways are becoming increasingly useful. But highways are not of such prime importance to mining as they are to other industries. For movement of such basic resources as iron ore, coal, petroleum, and limestone greater reliance is placed on rail, water, or pipeline transport than on highway trucking. But even for these products, highway transportation is becoming more important on short hauls. In the logging industry, truck transportation is making selective cutting of small woodlots economical. Low-cost logging roads, largely in the northern portions of the state, connected with the main highway

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[1]Elton B. Hill and Russell G. Mawby, Types of Farming in Michigan, Spec. Bull. 206, Michigan State Agricultural Station, Sept. 1954, Pp. 6-7.

[2]Hudgins, loc. cit., Pp. 69-79.

network, convert forests from a one-time exhaustible resource into a continuous steady-flow resource.[1]

Distribution of transportation facilities.- The existing transportation networks of Michigan comprise another situation factor of relevance in the location of the Interstate System. Basic geography would tend to indicate that the state needs a well-developed transportation network to facilitate economic activities, and connect widespread but important centers. To illustrate this hypothsis, consider the fact that the overland distance from Detroit to Ironwood, in the Upper Peninsula, is approximately the same as from Detroit to New York City.

The Great Lakes provide water transportation for many raw materials which are extracted in, used in, grown in, or just transported through Michigan. The importance of this route should not be underestimated, especially with the growth of traffic on the St. Lawrence Seaway. Yet this transportation route is, for Michigan, largely peripheral; in the interior of Michigan there is little available navigable water which could be economically used to form a consistent network interconnecting with the Great Lakes system.[2]

Railroad service in Michigan is less developed than in many other parts of northeastern United States because it lies out of the path of most east-west transcontinental rail routes. Although rail routes helped to build and settle Michigan, and are vital to many heavy industries, they are becoming relatively less important than they were several generations

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[1] M.S.H.D., Highway Needs in Michigan, op. cit., Pp. 28-29.

[2] Ibid., P. 13.

ago. To illustrate, railroad-route mileage within the state was approximately 9,000 in 1910, but less than 7,000 in 1946.[1] Although rail and water transportation facilities are available to parts of Michigan, and certainly should not be discounted, roads are necessary to complement these media, and to provide transportation to those areas unserved by them.

The modern system of roads and highways in the state owes its existence to successive generations of builders--Indians, early settlers, soldiers, the Federal government, and various state and local agencies. The road network which they have created now totals approximately 109,600 miles, by far the most extensive transportation system in the state.[2]

But despite this extensive mileage, the state is in need of major road improvements. In 1948 forty-six per cent of the road mileage within the state was deficient in some respect. It was estimated that five-sixths of aggregate expenditures required to overcome the above deficiencies were needed on through and community roads, which together comprise less than one-third of the state's total road mileage.[3] Thus, despite recent construction, there is an especially strong need for expressways in large urban centers, by-passes around smaller centers, and modern through-highways to move the large motor-vehicle volumes between the principal traffic-generating areas of the state. The Interstate System will not solve these problems completely, but it is designed and located to alleviate these problems to the maximum extent at the minimum cost.

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[1] Ibid., Pp. 13-14.

[2] Michigan State Highway Dept., Modern Highways for Michigan, Lansing, 1955, P. 19.

[3] Michigan State Highway Dept., Highway Needs in Michigan, op. cit., P. 8-9.

Distribution of military and defense establishments.- Michigan contains many places and activities which are vital to the nation's military plant and its defense security. Because, in all probability, some of the more vital of these installations could not be identified even with diligent research, little will be said about this factor here, except to indicate its great importance to Interstate-highway locations. In general, however, it is well known that Michigan's defense industries coincide rather closely with the major manufacturing centers of the state. It is also well known that a major United States Air Force base is located at Selfridge Field near Detroit, and that the Soo Locks, at Sault Ste. Marie in the Upper Peninsula, are considered to be one of the most strategic points in the United States. Examination of Figure 5 indicates that these areas are all served by Interstate routes.

Summary.- Michigan situation factors show considerable differentiation in their areal distribution. This is particularly true of the major urban areas and manufacturing establishments which are concentrated in the southern part of the state, especially along the straight-line, Detroit-focused design previously indicated. The intensity and type of agricultural production also exhibits considerable areal differentiation from place to place in the state. In fact, nearly all situation factors in the state are characterized by some degree of areal differentiation. As is discussed later in this chapter, this variance in distribution of situation factors, along with the varying distributions of site factors, helps to explain the spatial arrangement of the Interstate routes in Michigan.

Site Factors

In Chapter II site factors were considered to be either physical or cultural elements, and of primary or secondary importance depending on their degree of influence in the location of a highway. Site factors of relevance in effecting highway location are often referred to as control points, denoting a specific location on which the highway will stand.[1]

Physical environment.

Elements of the physical environment in Michigan which are important site controls are as follows:

(1) surface configuration, including
    (a) local relief
    (b) earth materials—bedrock and soil
    (c) drainage characteristics
(2) natural vegetation

Surface configuration.- The local surface-configuration variations to be found from place to place in Michigan can be traced to the effects of Pleistocene continental glaciation. It is impossible, here, to give even a cursory treatment of glacial history and its resultant landforms. It can be pointed out, however, that the glaciers and their meltwaters both eroded and deposited. In the western Upper Peninsula the process was primarily erosion. In the eastern Upper Peninsula and all of the Lower Peninsula, deposition was the major result of glaciation. The material which was deposited is known as glacial drift; the Lower

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[1]Above, P. 15.

Peninsula is covered by this material to an average depth of 100 feet.[1]

The features left by these glaciers range from relatively flat outwash plains to hilly recessional moraines, with ridgelike rises (eskers), spoonshaped hills (drumlins), gravelly-sandy hills and terraces (kames), pock-marked plains (pitted outwash), extremely flat land (former glacial-lake beds), and gently rolling terrain (till plains) appearing from place to place in reasonably predictable associations. A noteworthy characteristic of these glacial landforms is the general lack of local relief produced by them. Although a few places in the state have local relief of 1,000 feet or greater, most of the state has a local relief of around 100-125 feet at the maximum.

Highway engineers, although perhaps not interested in glacial history and landforms per se, are concerned with the surface configuration in relation to road building. The engineer classifies terrain according to the special design requirements or mechanical techniques necessary to solve the site problem at that location. Thus, routes are classified according to their relation to surface configuration as follows:[2]

(1) Location along valleys - where flat grades are available, but where floods and washouts may cause difficulties and where sharp curves and bridges may be necessary if the stream is meandering (as many Michigan streams do). This is a fairly typical site for Michigan roads.

(2) Location along ridges or drainage divides - where steeper

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[1]Atwood, loc. cit., Pp. 198-205.

[2]Rubey, loc. cit., Pp. 5-7.

grades may be necessary, but where drainage and horizontal alinement problems are usually minimized. Such sites are also fairly common in Michigan.

(3) Location across the grain of drainage - where the route crosses streams and valleys approximately at right angles. Grades become fairly steep depending on shape of valley and amount of fill material which can be economically used. Expensive structures may be required at stream crossings. Most Michigan rivers and streams, however, are not wide and valleys are not deeply incised.

(4) Location along hillsides - where the route gradient can be controlled rather easily, but which necessitates following the hillside curve with consequent frequent changes in the horizontal alinement. This type of site condition is not typical for most of Michigan because of the general lack of hilly land.

(5) Location which traverses comparatively level terrain - where little difficulty in gradient is encountered, but where drainage problems may occur. Routes traversing level terrain may be straight for long distances. This site condition is typical for Michigan roads, many of which follow arbitrary section or township lines.

(6) Location with relative disregard for topography - generally found only in relatively level country where heavy and important construction is involved and modern earth moving equipment is available.

Many of the sections on the Interstate network in Michigan will be placed on sites chosen with little regard for topography in the manner described in (6) above. However, surface configuration in many areas of the state exercise only secondary control over the location of highways, and the construction work is on such a large scale that very heavy earthmoving equipment will be used.

Another factor in the physical environment of Michigan that is an important site control is earth material, including bedrock, glacial drift, and soil. However, because Michigan bedrock is deeply buried by glacial drift throughout most of the state, especially the part where Interstate routes are concentrated, it can be discounted as a major site control.

Michigan soils are derived from glacial drift which has been acted on by climate, vegetation, and time to produce the inorganic-organic substance called soil. Beneath the soil, which does not extend far beneath the land surface, is found the glacial drift, or soil parent material. This is composed of unconsolidated sand, silt, and clay particles of various sizes, and is characterized by lithological heterogeneity.[1] However, for purposes of this discussion, both soil and parent material are called soil.

Soils are important in highway construction because they are the bed over which the pavement is laid, and in many respects this bed is more important than the surface itself. The material underlying the pavement consists of two parts. These are: (1) the base course, which is immediately under the pavement and is usually, but not always,

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[1] Atwood, loc. cit., Pp. 198-200.

composed of material other than soil; and (2) the subgrade, which underlies the base course and is always composed of soil.[1]

For purposes of highway construction the physical properties of soil are the basis for classification. These properties which are of interest in highway site problems are cohesion, internal friction, compressibility, plasticity, capillarity, stability, and drainage. These physical characteristics control the performance of soil with regard to shrinkage, expansion, frost heave, settlement, sliding, and lateral flow.[2]

Soil properties, and consequent performance qualities, vary considerably in Michigan. The variances in these qualities result primarily from textural differences rather than lithological contrasts. Therefore, in classifying material as to desirability for highway subgrades, a textural approach is used. Soil is thus classed according to size of particles as follows:

(1) coarse sand - diameter from 2.0 to 0.25 mm.

(2) fine sand - " " 0.25 to 0.05 mm.

(3) silt - " " 0.05 to 0.005 mm.

(4) clay - " less than 0.005 mm.

Soil is commonly a mixture of various proportions of some, or all, of these particles. Depending on the proportion of each type particle found in the soil, it may be called sand, sandy loam, silty loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, or clay.[3]

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[1] Bruce and Clarkeson, loc. cit., Pp. 276 and 294.

[2] Ibid., P. 277.

[3] Ibid., Pp. 279-280.

Soils which contain significant proportions of organic materials, in addition to the inorganic particles, are called peat or muck.[1]

Based on the above textural and physical performance characteristics, a soil quality classification has been evolved for highway construction purposes. Each soil may be classed in one of eight different groups which are numbered from A-1 through A-8. A-1 is the best soil for highway use, and A-8 is the poorest. The others are intermediate, with the lower numbers being more satisfactory than the high. In general, the low numbered soils consist of sandy material which has just enough silt and clay to act as a binder. Clay and organics make the poorest road foundations, while silts are intermediate in quality. For example, A-1 soil is a uniformly graded material with both coarse and fine sand, and is well bound. It contains 70-85 per cent sand, 10-20 per cent silt, and 5-10 per cent clay. A-1 is highly stable under all conditions, and drainage problems are negligible. At the other extreme, A-8 consists of peats and mucks which contain 55 per cent, or less, sand constituent, are poorly drained, and are incapable of offering support for any modern type highway.[2]

In Michigan soils of all eight types are found scattered throughout the state. Many areas of A-8 (muck and peat) are found in association with former glacial lakes or swamps. However, there are also extensive deposits of coarse and fine grained sands distributed throughout the state, in association with moraines, outwash plains, kames, and eskers.

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[1]Organic soils are formed as a result of vegetation growing under very moist conditions such as shallow lakes or swamps.

[2]Lawrence I. Hewes. American Highway Practice. Vol. I, (New York: J. Wiley and Sons, Inc., 1942) Pp. 433-439.

For example, in 1955, 80 of the 83 counties in Michigan reported some production of sand or gravel. When it is necessary to use soil for fill material, or to replace an undesirable soil with a more satisfactory one, the haul distance is usually not great.[1]

Drainage characteristics of the land is another factor in the physical environment which influences site considerations. Like surface configuration, drainage patterns in Michigan are basically the result of continental glaciation.[2] Without going into the processes by which the glaciers accomplished this feat, it can be said that drainage in Michigan was completely disrupted and changed by the advances and retreats of the ice lobes. When the glaciers retreated for the last time, they left behind an immature, unadjusted drainage pattern with a plethora of lakes and swamps. The many lakes, although certainly a modern-day boon to the tourist and resort industry, have acted as obstacles to the road builders. Swamps have likewise acted as barriers[3] to highway construction, although most of them can be drained more easily than lakes. However, even when swamps are drained they are not good sites for roads because of the soil (muck and peat).

Natural vegetation.- Natural vegetation is not as important a site control as it once was. The location of heavily forested areas has controlled highway sites in the past, but the virgin forests are largely gone now. Although second growth has occurred in some of these areas,

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[1]Harry O. Sorenson and Emery T. Carlson, Michigan Mineral Industries, 1955, State of Michigan, Dept. of Conservation, April 1957, P. 17.

[2]Hudgins, loc. cit., Pp. 17-25.

[3]The Black Swamp between Detroit and Toledo, mentioned previously in this chapter as a deterrent to settlement, was formed by a glacial lake.

particularly the north, much of it is now devoid of trees and used for agricultural or other purposes. The significance of natural vegetation, for this reason, is not great, except perhaps in the northern parts of the state. But even in the south, in those areas where woodlots still exist, trees may have a decided bearing on site considerations.

Cultural environment.

Cultural elements of the environment which may be important site controls are as follows:

(1) motor-vehicle traffic flow - including actual movements and traffic-desire lines of movement, and

(2) land use - broadly differentiated as urban and rural, and including features associated with man's occupance of the land.

Motor-vehicle traffic flow.- Motor-vehicle traffic flow, both actual and potential, is an extremely important site control in determining the location of the Interstate routes in Michigan. The locus of traffic-desire movements is particularly important as a site control. Traffic-desire movements are the lines which vehicles would take between origin and destination if they could go by the most direct route; or, stated differently, they are the major paths that motor vehicles would take if they were unimpeded by obstacles and did not have to follow the existing road system.

The principal direct factors affecting traffic-desire lines are the volume and distribution of motor vehicle ownership. In common with many other situation factors, distribution of vehicle ownership is very uneven throughout the state. In 1948 two-thirds of all motor-vehicle registrations were in the 12 leading manufacturing counties in the southern

part of the state. Less than 14 per cent of the total registered vehicles were found in the northern part of the Lower Peninsula and the Upper Peninsula.[1]

The importance of the distribution of motor vehicle ownership is related to the direct influence which it exerts on the volume of traffic flow. Areas with large numbers of vehicle registrations coincide almost exactly with areas of maximum traffic flow. And lines of maximum traffic flow in rural areas are invariably between places which have a high density and volume of vehicle ownership (principally urban areas). As should be expected the most heavily traveled routes in Michigan are found in the southern part of the state, particularly in, near, or on highways leading between the larger cities. This is clearly indicated by the traffic flow bands shown in Figure 5.[2]

Land use.- Land use is the second of the cultural factors which influence site considerations. As was previously mentioned in Chapter II, land use may be broadly classified as either urban or rural. A large percentage of the urban land-use associations in the state are found in the southern half of the Lower Peninsula, and especially along the lines indicated in Figure 4. Because highway-location problems reach their maximum difficulties in urban areas, it is to be expected that Interstate problems will be more difficult in the southern, urbanized areas of the state.

The southern portion of Michigan also has a high percentage of the valuable agricultural land. Where productive land is widespread, highway

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[1]Michigan State Highway Dept., Highway Needs in Michigan, op. cit., Pp. 63-64.

[2]Michigan State Highway Dept., Average 24 Hour Traffic Flow on the Trunkline System, 1957, (Map).

location problems may become difficult and expensive to solve. The northern areas, in contrast, have a higher percentage of land devoted to such uses as forests, mining, recreation, and idle categories than do the southern.

To illustrate the differences between urban and rural sections of the Interstate System in both the north and the south, consider the estimated costs per mile for the completion of the System. Current estimates indicate that urban portions of the System will average $5,985,000 per mile of which about 29 per cent will be for right-of-way. This average is composed of costs ranging from $525,000 per mile in St. Ignace (Upper Peninsula) to over $12 million per mile on some Detroit sections where expensive right-of-way, eight traffic lanes, and many structures are involved.[1]

In rural areas present estimates are that cost per mile will average $449,000. Most rural sections of the Interstate System require only four traffic lanes, need fewer structures per mile, and right-of-way is not so expensive as in urban areas. However, there is considerable differentiation from place to place in the state. For example, costs will range from $300,000 per mile in the Upper Peninsula to over $1 million in rural areas adjacent to Detroit.[2]

Numerous traffic surveys in various cities have led to the general hypothesis that traffic loci and flow patterns are dictated by the spatial arrangement of land uses and the associated population distribution. From this hypothesis, two important corollaries have been deduced: (1) that

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[1] Michigan State Highway Dept., Modern Highways for Michigan, op. cit., P. 70.

[2] Ibid.

the number of vehicles entering and leaving a given unit of land in a specific use can be reliably predicted; and (2) that the traffic flows between land areas with a multitude of land uses can be estimated by successive additions of trip-generating capacity of individual land uses.[1]

From these studies it has been determined that commercial land-use types are the most intense generators of traffic. In Detroit a recent survey showed that daily motor-vehicle trips to commercial land averaged 269 per acre as compared to 37 per acre for industrial uses and 29 per acre for residential land. Although 80 per cent of all trips have either an origin or destination in residential land, this land is more widely dispersed than commercial or industrial uses and does not have the traffic generating power per acre that these other uses have. The traffic generating power of commercial-land uses is the basic reason why these developments are usually found along the through roads because this type highway offers the best access for the greatest number of vehicles. However, commercial development along through routes tends to destroy the original function for which these highways were constructed, namely, furnishing through transportation service to large numbers of vehicles.[2]

Relocation of Interstate Routes.

Site controls are given primary attention when the Interstate routes in Michigan are relocated. Originally, when the Interstate routes were selected by the State Highway Department and the Bureau of Public Roads (acting on the recommendations of the Interregional Highway Committee)

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[1]Michigan State Highway Dept., Report on the Detroit Metropolitan Area Traffic Study, Vol. I, Lansing, 1955, Pp. 38-41.

[2]Ibid.

the locations coincided with existing state trunklines. For example, U. S. 12 from Detroit to the Indiana state line, U. S. 10 from Detroit to Saginaw, and U. S. 16 from Detroit to the Muskegon area were both state trunklines and Interstate routes.

However, the design standards (especially control of access and wide right-of-way) established for the Interstate System render the present routes functionally obsolete. It is necessary to relocate nearly all sections of the System, because most of these routes lie in the populous southern half of Michigan and have been subjected to considerable commercial, industrial, and residential roadside development; consequently, it would be too expensive to construct the new highways on the old sites. Many of the relocated routes will closely parallel the old highways. If, however, traffic-desire lines, surface configuration, soil conditions, or other site factors indicate locations farther removed, the new highways will be so positioned.[1]

Spatial Arrangement of Interstate Highways in Michigan

The Interstate System, for the nation as a whole, was originally limited by law to 40,000 miles, and is now set at 41,000 miles. Of this total allowable mileage, 38,548 had been actually selected as of September 1957. Michigan has been assigned approximately 1,038 miles of this total, or a little less than 2.5 per cent of the national figure. Of this mileage 864 will be in rural freeways[2] and 174 will be in urban expressways.[3]

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[1]Michigan State Highway Dept., Modern Highways for Michigan, op. cit., P. 68.

[2]Includes all mileage outside of cities above 5,000 population or urban areas adjacent thereto.

[3]Interview with H. S. Bengry, Michigan State Highway Dept., Planning Coordinator, May 20, 1958.

These figures may be changed slightly when the final apportionments of the 2,200 remaining miles allotted for Interstate circumferential routes are made.

For the nation as a whole the System is expected to serve 20 per cent of all motor vehicle traffic, although it includes only a little more than one per cent of the total mileage of all public highways. The Michigan portion of the System corresponds to these national averages almost exactly.[1]

The locations of the proposed Interstate routes in Michigan are indicated in Figure 5. Examination of this map reveals a fundamental spatial arrangement which is related to the areal differentiation of the various situation and site factors which comprise the physical and cultural environment of Michigan.

The spatial arrangement of the Michigan routes is characterized by two interrelated facts: (1) the concentration of mileage in the southern part of the Lower Peninsula, and (2) the focal position of Detroit as the hub of radiating Interstate routes. The bulk of Michigan's Interstate mileage lies south of the Muskegon-Bay City line; only a single tentacle traverses the northern Lower Peninsula between Bay City and Mackinac City, and the Upper Peninsula has only a short stretch from St. Ignace to Sault Ste. Marie. Nearly all of the routes concentrated in the southern part of the state have one of their termini in Detroit (five out of seven of the rural trans-city routes are so located). These routes radiate out of Detroit in each direction except east, which eventuality is precluded by the political difference encountered by crossing the Detroit River.

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[1]Michigan State Highway Dept., Modern Highways for Michigan, op. cit., P. 66.

The reasons for this unique spatial arrangement have been alluded to previously. The southern part of the state is the most heavily populated section in both urban and rural areas. All of the metropolitan areas of Michigan are found south of Bay City, all the cities of 25,000 or more population, and the densest concentrations of rural population in the state.[1]

The southern half of Michigan also includes the main manufacturing centers, the principal agricultural areas as measured by value of crops produced per county,[2] and all the counties which have high motor-vehicle ownership totals.[3] To illustrate, in 1941 the density of motor-vehicle ownership in vehicles per square mile was 62.1 in counties traversed by the Interstate routes. In counties not traversed by these routes, the density was only 10.3 per square mile.[4]

Analysis of the reasons for the focal position of Detroit as the hub of Interstate routes in Michigan indicates three interrelated factors to be primarily responsible. First, Detroit represents the major concentration of population in the state, with nearly a third of all inhabitants. Second, Detroit is the major manufacturing center of Michigan, and its principal product, motor vehicles, not only dominates the state's economy but is extremely dependent on truck transportation for productive operations. Third, and partially indicative of the other two factors, is

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[1]U.S., Bureau of the Census, Statistical Abstract of the U.S., 1957, op. cit.

[2]Michigan, Dept. of Agriculture, Michigan Agricultural Station, June 1957, Pp. 14-15.

[3]These are: Wayne, Oakland, Genesee, Kent, Ingham, Saginaw, Macomb, Kalamazoo, Muskegon, Berrien, Calhoun, Jackson, Washtenaw, St. Clair, and Monroe.

[4]U.S., Congress, House, Interregional Highways, op. cit., P. 29.

the history of Detroit and its influence on Michigan settlement patterns. The city was the first Michigan settlement, and it has retained number-one ranking by a combination of natural advantages and good fortune. The earliest roads in Michigan had one terminus in Detroit, and settlement waves pushed out along these paths. This, in large part, is responsible for Michigan's unique urban-settlement pattern in which the large cities of the state all lie on relatively straight lines focusing on Detroit.

This Detroit-oriented, straight-line urban settlement design is economical, based on the amount of Interstate mileage needed to connect major urban centers. The truth of this statement is indicated by estimates that the average-daily traffic volume on rural sections of the Michigan Interstate routes will be the third highest in the nation, being exceeded only by traffic on rural sections in New Jersey and Delaware.[1]

The single tentacle to Mackinac Straits and northward to Sault Ste. Marie merits special comment. Certainly, urban population centers, manufacturing activity, and traffic flow are not sufficient in this area, compared with the southern part of the state, to merit the Interstate emblem. This route is justified, however, on the basis of: (1) connection with a Canadian route at Sault Ste. Marie, (2) the strategic importance of the locks at Sault Ste. Marie, (3) service to the tourist and resort industry (the second-ranking economic base of Michigan), and (4) provision of minimum service to the Upper Peninsula which would otherwise be without an Interstate connection.

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[1] Michigan State Highway Dept., Highway Needs in Michigan, op. cit., P. 80.

CHAPTER IV

THE INTERSTATE SYSTEM IN ITS LOCAL SETTING: CASE STUDIES OF MICHIGAN URBAN AREAS

Cities, in the modern exchange economy, are the focus of activity in the areas which are tributary to them. In like manner, highway problems come to a focus in the city. In Michigan, where about three-quarters of the people live in incorporated places, over half of all mileage driven in the state is on urban roads. The concentration of motor-vehicle traffic on urban roads is further demonstrated by the fact that there are only 15,621 miles of urban roads in the state compared with 93,998 miles of rural roads.[1]

Not only is motor-vehicle traffic heavily concentrated in urban areas, thus indicating a need for more rapid implementation of an improvement program, but the problems involved in providing adequate locations for the proper facilities are often very difficult and expensive to solve. This is especially true of the Interstate highways in urban areas. These highways will be constructed with controlled-access features and on wide right-of-way; they will be, with some exceptions such as more closely spaced interchanges, the same as the rural freeways. In urban areas they are commonly referred to as expressways.

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[1] Michigan State Highway Dept., Modern Highways in Michigan, op. cit., Pp. 66-67.

In Chapter III the urban-rural differentiation of highway location problems in Michigan was discussed in general terms. This chapter is primarily concerned with the urban-location problem. The approach used is to outline general principles and to present case studies of three Michigan cities to illustrate actual Interstate-highway situations in their local settings.

General Principles

Highway location in any urban area should be based on cooperative planning by highway-location engineers and local-planning authorities. This is especially true of Interstate routes because of their importance to the basic road framework of the city in which they are located. However, plans for a logical and efficient arrangement of highways within the urban area are becoming increasingly difficult to carry out for a variety of reasons. The large and expensive fringe developments around most large cities have added to already serious problems of finding adequate sites for new highways. On the Interstate expressways the necessity for high design standards, including such factors as control of access, bridging or closing of intersecting roads, interchange location, frontage road (service roads which parallel the main highway) location, and the possible abandonment of existing routes further complicate the studies.[1]

Before the route location problem can be solved, it is necessary to understand the morphology and functions of the American city. American cities, including those of Michigan, are surprisingly uniform in the morphological arrangement of their principal sections. Although size, type

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[1]Michigan State Highway Dept., 26th Biennial Report of the State Highway Commission, Lansing, 1958, P. 32.

of economic activity, physical site, and that intangible, "personality," may vary from place to place, a description of the zones of one city will suffice for nearly all.

The focal point for the average city is the Central Business District (CBD). This district contains the large stores, office buildings, and governmental functions, and is usually the cultural center for the adjacent area. The CBD merges gradually into a secondary business area which fringes the core. The secondary business district in turn blends into a large area of mixed land uses and run-down buildings; this is usually the slum area of the city. Surrounding the slum area is an even wider area of residential property in various stages of depreciation. This is the so-called "blighted area." Beyond the blighted area lies the newer residential developments which extend far out past the city limits in the form of subdivisions. These subdivisions merge gradually into farm land.[1]

Traversing all of these zones, arterial roads focus on the heart of the city. Various road patterns connect these arteries and provide access to local property. If the city is engaged in manufacturing or wholesaling, much of this activity will be found along railroads which penetrate the urban area. Although the CBD is the center of commercial activity, the arterial roads have attracted many commercial establishments. Thus, tentacles of roadside commercial developments are characteristic of the urban area.[2]

The Bureau of Public Roads, in recommending criteria for the selection of Interstate routes in, or near, urban areas, was cognizant of the

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[1]U.S., Congress, House, Interregional Highways, op. cit., P. 53.

[2]Ibid.

fact that the precise location of such routes should be decided by local study to fit the needs of the particular community. However, in accordance with the general morphological similarities of most American cities, it was also realized that certain principles should be considered if the routes were to provide a uniform, integrated system.

The principles which were evolved by the Bureau of Public Roads relate to: (1) the situation of the highway within the urban matrix, and (2) the specific site of the highway. The following principles are related to the situation of the highway:[1]

(1) Connection with city-approach rural routes — Interstate routes in urban areas should provide adequate and safe connections with the city-approach rural routes of the System in order to provide through service for motor-vehicle traffic moving in and out of the city to and from exterior points.

(2) Circumferential, or by-pass, routes — Highways which avoid the intensively developed areas of the city are needed to serve motor-vehicle traffic that does not have an origin or destination in, or near, the CBD. Such routes usually parallel the fringe of the urban area and may serve as arteries for through traffic by-passing the city, as distributors for the traffic movements between city-approach routes, and to accomodate traffic with local origins and destinations on the fringes of the urban area.

(3) Service to core of the city — In the larger cities the Interstate highways should penetrate the city to the CBD,

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[1]U.S., Dept. of Commerce, Bureau of Public Roads, Criteria for Selection of Interstate System, op. cit., Pp. 5-6.

because a very large proportion of motor-vehicle traffic on such routes originates in or is destined to that quarter of the city.

(4) Service to major traffic-generating focal points such as transportation terminals — Railroad terminals, wharves, docks, and airports generate large volumes of traffic associated with the essential interchanges between the various media of transportation. Interstate routes should be so located as to give convenient express service to these major traffic-generating terminals within, and in the vicinity, of cities.

(5) Relation to urban planning — Interstate routes are only one element in the total transportation system for any city; they should, therefore, be located and designed in accordance with official urban-transportation plans.

General principles for site considerations which would include all cities are difficult to establish, because site conditions and consequent problems vary greatly from city to city. However, it is recognized that in many cities wedges of undeveloped land exist between the flanking developments along the present major arterial roads. Wherever such areas are available, and consistent with other site requirements, they offer the best possible sites for routes entering a city.[1]

In addition to these general principles which were to apply to all urban places, the original Interregional Highway Report considered urban location problems as falling into one of three separate categories depending on the size and situation of the city. These three general classes,

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[1] Ibid.

each of which exhibits a different Interstate route pattern, are: (1) the small city; (2) the medium city; and (3) the large city. No definite size limitations were placed on these classes, for it was realized that relative position in respect to other urban places and the regional significance of a city might cause it to be either less or more important than size alone would indicate. Thus, these classes were established only as broad guides, and to indicate how the typical city of each class would be effected by Interstate routes. In the following case studies, one Michigan city in each of these classes is examined and related to these national recommendations. In considering each of these places, situation and site factors are examined on the largest practical scale, and the approximate location of the Interstate routes passing through these urban areas is indicated.

The Small City — Howell

Most small cities in the United States are not purposely connected by Interstate routes. However, many small cities happen to lie along important routes, and are served by an Interstate highway which usually passes directly through the core of the city. The Interregional Highway Committee's recommendations for the location of an Interstate route in a small urban place call for the new facility to be wholly outside of the city, or, in other words, to by-pass it. The former main highway could be converted into a connecting road and would interchange with the Interstate route at points several miles on each side of the city. The major reason for by-passing small cities is that most motor-vehicle operators driving through them have little desire to stop, and thus these vehicles

add to the congestion on the main street without contributing substantially to the city's economy.[1]

There are numerous small cities in Michigan which lie on routes designated as part of the Interstate System. Most of these cities will be by-passed when the relocations for the System are constructed. Typical of the small city which is to be by-passed by such a route is Howell, Michigan.

The city of Howell, consisting of approximately 4,500 people, is situated on the northern edge of a recessional moraine and has a north-south esker passing through it. To the north of the city the landscape is gently rolling till plain; to the south the moraine becomes more rugged and contains numerous lakes. The major functions of this city are: (1) manufacturing and (2) service as a trade center to the surrounding area. Although there are several small manufacturing establishments in the city, the only large one is Howell Electric Motors Corporation which employs about 450 people.[2]

The trade area of Howell for most goods and services coincides roughly with Livingston County, for which Howell is the county seat and largest city. Except for the limited amount of manufacturing concentrated principally in Howell, Livingston County is an agricultural area, with dairying and general farming being most important. Sandy soils, the presence of hilly moraines, and numerous lakes in the southern part keep Livingston County from being a first rate county in value of agricultural production; nevertheless, it ranks higher than most counties in

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[1] Ibid., P. 71.

[2] Howell, Mich., Chamber of Commerce, Existing Industries - Howell, Michigan, (Mimeographed distribution sheet).

the northern part of the state.[1] In addition, the hills and lakes add to the recreational value of this area.

The Interstate highway presently traversing Howell is U. S. 16. This highway is one of the main roads in Howell and passes through the CBD. Howell is situated about half way between Lansing and the outskirts of the Detroit Metropolitan Area, and is, thus, subjected to considerable through traffic movements. State Highway Department plans call for the construction of a new route on a different site than presently occupied by U. S. 16 to serve as the new Interstate route in the Howell area. The new facility, when constructed, will by-pass Howell to the north, and will, thus, have its site on the till plain in that area. This will negate topographic factors as a major site consideration, although in some areas drainage may be a slight problem. If the till plain soils are not satisfactory sites for the highway, the sandy materials from the nearby eskers and moraines should be available for use.

The relationships between the new and old routes are indicated in Figure 6. Observation of this map indicates that the new Interstate facility will pass fairly close to the city but will be wholly outside of the city limits; that all cross roads will have grade separations or will be terminated; and that the Interstate highway will be connected by modern interchanges with major through and community roads at close intervals near the city and at greater intervals farther from the urban area. It should also be noted that U. S. 16 will continue to function as a service road into Howell; however, it will not be part of the Interstate System.

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[1]Hill and Mawby, Types of Farming in Michigan, loc. cit., Pp. 5-7.

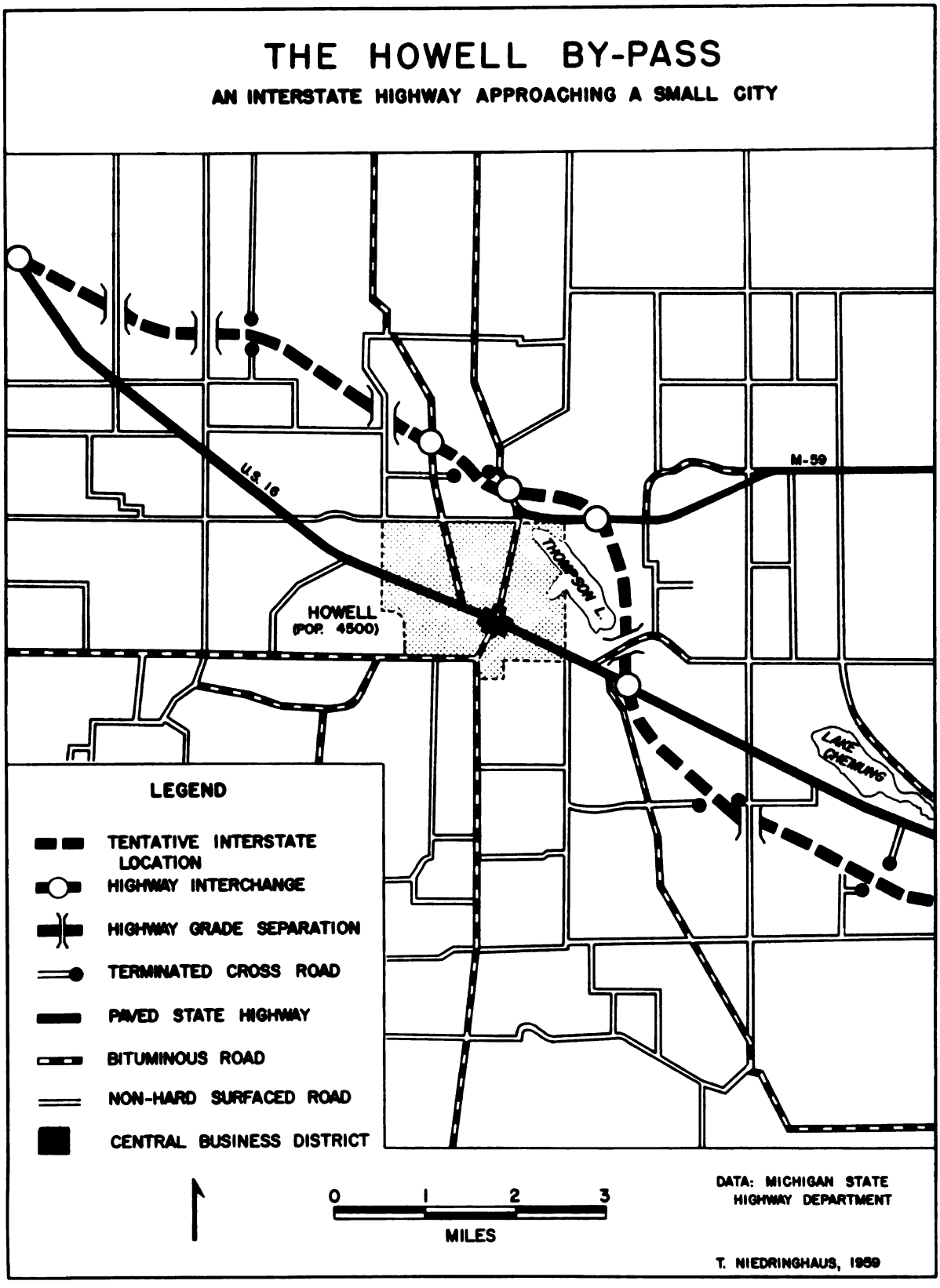
THE HOWELL BY-PASS
AN INTERSTATE HIGHWAY APPROACHING A SMALL CITY
U.S. 16
M-59
THOMPSON L.
HOWELL
(POP. 4500)
LAKE CHEMUNG
LEGEND
TENTATIVE INTERSTATE LOCATION
HIGHWAY INTERCHANGE
HIGHWAY GRADE SEPARATION
TERMINATED CROSS ROAD
PAVED STATE HIGHWAY
BITUMINOUS ROAD
NON-HARD SURFACED ROAD
CENTRAL BUSINESS DISTRICT
0 1 2 3
MILES
DATA: MICHIGAN STATE HIGHWAY DEPARTMENT
T. NIEDRINGHAUS, 1959

Figure 6

When a city such as Howell is to be by-passed by an Interstate highway, or the route is to be relocated, Federal law requires the State Highway Department to hold a hearing for the purpose of considering the economic and social consequences on the community, or area, in question. Any individual or group may express their objections to the proposed relocation at this time. A public hearing, for the above purpose, was held at Howell on July 16, 1958.[1]

The official transcript of this hearing indicates that it consisted of two general phases; in the first phase the State Highway Department attempted to justify its selection of the proposed location, and the second phase consisted of objections or statements of agreement by interested individuals and organizations.

The State Highway Department representative presented the state's case in brief, nontechnical form. It was pointed out that the present location of U. S. 16 marked the principal east-west route across central Michigan. Because of the importance of this route it is imperative that the new Interstate highway, which will replace old U. S. 16, be located in such position that it could serve for many years. In arriving at the tentative location, the State Highway Department considered the factors of land conservation and least possible disturbance of present economic, residential, or other developments. This latter factor ruled out any possible expansion of the present route by widening the right-of-way of U. S. 16, because of the economic costs and damages which would be incurred by such action. The proposed route was one of several studied by the State Highway Department; and location engineers concluded that it

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[1]Michigan State Highway Dept., "In the Matter of the Proposed Relocation of U. S. 16 from Brighton to the West Livingston County Line," Public Hearing held at Howell, Mich., July, 1958 (Typewritten).

would satisfactorily service the needs of Livingston County, and Howell, for many years, and materially aid in the future industrial and population growth of the area.[1]

It was further emphasized that the controlled access features to be used on the new highway would stabilize local development plans, and would prevent many accidents. Statistics for 1957 were presented which indicated that an average of 16 vehicles per minute were passing a point just to the west of Howell, on U. S. 16. Projections indicated that this figure would jump to 33 vehicles per minute by 1978. These statistics were presented to the citizens of Howell, and the surrounding area, as primary reasons why a radically new type of highway facility was needed in their area. As a final argument in favor of the proposed location, several studies were cited which indicated that the total business activity of a community rises when it is by-passed by a freeway.[2]

After the State Highway Department's arguments were presented, the hearing was thrown open to discussion. No serious disagreements with the proposed location were voiced at this particular hearing. Occasionally, however, real objections are offered. These objections may be by individuals whose businesses might be adversely effected by the relocation (such as gasoline stations along the highway), and/or by civic groups who feel that the proposed location will damage plans for the future growth of their community or will remove valuable property for the highway site. It may happen that certain information is brought to

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[1] See James H. Lemly, Economic Consequences of Highways By-Passing Urban Communities, Research Paper No. 1, Georgia State College of Business Administration, Sept., 1956.

light at a hearing which will cause a re-evaluation of the proposed location.[1]

The Medium City -- Lansing

Recommendations for the medium-size city, served by only one Interstate route, were somewhat different than those for the small city. In most medium-size cities, a substantial portion of the traffic in or near the city has an origin and/or destination in the urban area, and particularly in the CBD. Therefore, the Interstate route, instead of simply by-passing the community, will pass through the built-up area closely adjacent to the CBD to provide access to that place for the large numbers of motor vehicles wishing to enter it.

In a city of this size, the larger proportion of traffic has either an origin or destination in the city and does, therefore, not normally wish to by-pass the city. But because of the relatively high absolute volumes of motor-vehicle traffic present in and near these centers, a considerable number of vehicles wish to pass through the city without stopping. For this reason, it is recommended that an Interstate circumferential route diverge from the main route outside the built-up area, skirt the city limits on one side of town, and rejoin the main route when the city has been passed. Depending on the size and situation of the particular city, another, or secondary, circumferential route may be located on the opposite side of town from the first circumferential.[2]

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[1]U.S., Congress, House, Operations of the Federal Bureau of Public Roads, (Federal-Aid Highways in Michigan), House Report No. 2953, 84th Cong., 2d Sess., 1956.

[2]U.S., Congress, House, Interregional Highways, op. cit., P. 73.

The city of medium size, then, is similar to the small city in that it is serviced by only one Interstate route. It differs in that it has both a circumferential by-pass and an urban penetrator as part of the Interstate System. In Michigan there are several medium-size cities which illustrate this arrangement. The city chosen for this study is Lansing. Although Lansing is the state capital, and in this respect is not typical of the average city of its same approximate size, it is also an important manufacturing and trade center.

Lansing is situated in the northwest corner of Ingham County at the junction of the Grand and Red Cedar Rivers. Most of the city is located on a till plain which is trapped between two relatively undeveloped recessional moraines. In the year 1847, although the town of Lansing was nonexistent, the capital of Michigan was moved from Detroit to the virtual wilderness known as Lansing Township. From this time, the town experienced very rapid growth. Upon the city's final incorporation in 1859, it had a population of almost 4,000, and by 1900 it had reached 16,000.[1]

At the turn of the century automotive manufacturing was begun in Lansing, and its rapid expansion opened the way for significant industrial development. This resulted in another influx of people who brought the population to 32,000 by 1910, and nearly 80,000 by 1930. In 1955 there were an estimated 107,050 people in the city proper, and over 180,000 in the Lansing-East Lansing metropolitan area. This represents one of the most significant clusters of population in Michigan, outside of the Detroit area.

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[1]Michigan State Highway Dept., Lansing-East Lansing Metropolitan Area Traffic Study, Lansing, 1948, P. 8.

The importance of Lansing as an industrial center has continued to grow. This is illustrated by the fact that Ingham County is the fifth most important county in the state according to value added by manufacture. The leading manufactures of the Lansing area are transportation equipment, machinery, primary metals, and fabricated metal products. Of these various manufactures, however, the concentration on transportation equipment (motor vehicle units and parts) is marked.[1]

The city has also assumed importance as a major wholesale, retail, and service center for central Michigan. For most products and services its trade influence area extends for a radius of 25 miles, except in the north where the radius extends for 40 miles because of the absence of cities of comparable size in that direction.[2]

Lansing is situated on U. S. 16 (an Interstate highway) approximately 84 miles from Detroit and 63 miles from Grand Rapids. The city lies nearly at the midpoint of the busiest cross-state route in central Michigan, with heavy motor-vehicle traffic flows being generated in Detroit, Grand Rapids, Lansing, and Muskegon. In 1955 there was a total of 102,826 motor-vehicle registrations (private, corporate, and public) in Lansing city. And a recent traffic count completed by the State Highway Department showed 135,900 vehicles entering and leaving the Lansing area every 24 hours on an average day.[3] This represents considerable movement in a fairly restricted area.

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[1]U.S., Dept. of Commerce, Bureau of the Census, U.S. Census of Manufactures: 1954, op. cit., Pp. 12-15.

[2]Michigan State Highway Dept., Lansing-East Lansing Metropolitan Area Traffic Study, op. cit.

[3]Michigan State Highway Dept., Average 24 Hour Traffic Flow on State Trunklines, op. cit.

A large percentage of the traffic moving along U. S. 16 near Lansing has either its origin or destination in the metropolitan area, and only a relatively small proportion of the total traffic approaching the city intends to pass through without making an intermediate stop.[1] Although this is a relatively small proportion, in absolute volume it is significant, and would add to the otherwise already congested roads in Lansing. If the figure of 135,900 motor vehicles entering and leaving Lansing on an average day is considered, and if it is estimated that 20 per cent of these vehicles would by-pass Lansing if they could do so without inconvenience, it is evident that approximately 27,000 vehicles moving through the Lansing area would by-pass the built-up area on any average day. Not all of these potential through-vehicles travel on the Interstate route (U. S. 16) entering the area, but many of them do. Because of its position between Detroit and Grand Rapids, Lansing has a higher percentage of by-pass traffic approaching the city along U. S. 16 than would normally be expected for a city of its size.

For the above reasons it was decided by the Michigan State Highway Department and the local planning authorities, with the approval of the Bureau of Public Roads, to provide both a circumferential route and an urban penetrator for the Lansing area. The approximate, tentative position of these routes is indicated in Figure 7. As shown on this map, the circumferential route will pass to the south of the city, and the penetrator will enter the city on the east and west and pass close to the CBD and the south-side industrial concentration along the Grand River. The

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[1]For a city of Lansing's size, the average percentage for traffic which wishes to stop in the city is 80, leaving 20 per cent which by-pass the city if it could.

traffic flow bands on this map indicate a heavy concentration of motor vehicles moving east-west through the Lansing area, but north-south movements are also heavy. U. S. 127 is a major state trunkline, and one of the most important north-south routes in the state. Althouth it is not a part of the Interstate System (in the Lansing area) it is being constructed to standards approximately commensurate with Interstate highways in the state. The extremely heavy volumes in the East Lansing area may be attributed to the fact that U. S. 16 and M-78 are the only major routes entering Lansing from the east, and the traffic-generating power of a large educational institution, Michigan State University.

The Large City -- Detroit

Situation and site considerations are more complex in the large city than is the small city or medium-size city. The large city, because of its regional importance, is usually the hub of several Interstate routes. The main routes enter the city and converge on the CBD. They may, in effect, form a loop around the core, separating it from the remainder of the city, but offering good express service to it. A number of circumferential routes may be necessary, depending on the particular size and situation of the city, to distribute traffic to the several parts of the city, and to transfer through-vehicles from one main route to another. It is possible in some of the larger cities that both inner and outer belts of circumferential routes will be needed.[1]

The complexity of the Interstate network within the vicinity of the large city leads to greater location difficulties than are found

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[1]U.S., Congress, House, Interregional Highways, op. cit., P. 73.

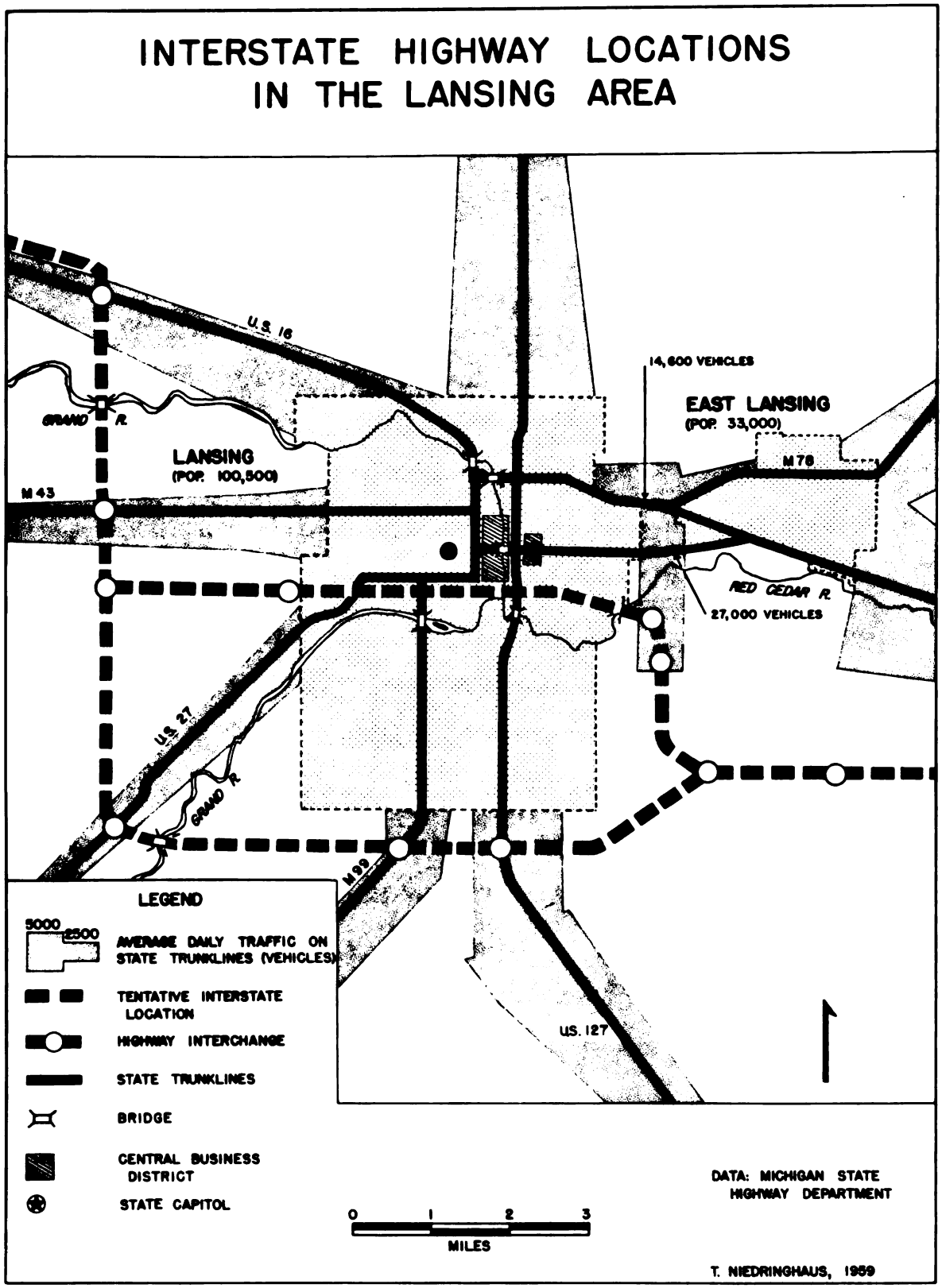
INTERSTATE HIGHWAY LOCATIONS
IN THE LANSING AREA
U.S. 16
GRAND R.
LANSING
(POP. 100,500)
M 43
14,600 VEHICLES
EAST LANSING
(POP. 33,000)
M 78
RED CEDAR R.
27,000 VEHICLES
U.S. 27
GRAND R.
M 99
U.S. 127
LEGEND
5000
2500
AVERAGE DAILY TRAFFIC ON STATE TRUNKLINES (VEHICLES)
TENTATIVE INTERSTATE LOCATION
HIGHWAY INTERCHANGE
STATE TRUNKLINES
BRIDGE
CENTRAL BUSINESS DISTRICT
STATE CAPITOL
0 1 2 3
MILES
DATA: MICHIGAN STATE HIGHWAY DEPARTMENT
T. NIEDRINGHAUS, 1959

Figure 7

elsewhere. The great numbers of people living and working together in a limited area, the specialization and division of labor involved, the wide variety of land uses, and the rapid and relatively uncontrolled growth of the urban area all combine to accentuate these problems.

Detroit is such a center, and consequently offers typical large-city problems. Three million people live and work in the Detroit Standard Metropolitan Area (defined by the Bureau of the Census as Wayne, Oakland, and Macomb counties), and the specialization and interchange of products involved in their activities produces a great daily movement of individuals and vehicles. A basic need for Detroit, as for other large cities, is to secure and maintain effective functioning of this movement by proper planning and expedient implementation of an efficient transportation system.[1]

The primary reason for the existence of so many people within this area is manufacturing. The city of Detroit is the focal point for a great industrial agglomeration located on the Detroit River and Lake St. Clair, the connecting waterways between Lakes Huron and Erie. The city lies at about the halfway point on the navigable Great Lakes system, and thus has access to the natural resources, agricultural products, and manufactured goods of the Great Lakes region.[2]

The industrial area of which Detroit is the focal point includes 1,965 square miles, and had, in 1950, 3,016,197 people. According to the 1954 Census of Manufactures there were 6,159 manufacturing establishments

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[1]M.S.H.D., Report on the Detroit Metropolitan Area Traffic Study, op. cit., Pp. 13-18.

[2]City of Detroit, Economic Base of Detroit, Master Plan Reports, City Plan Commission of Detroit, 1944, P. 2.

in this area (about half the state's total), 434,365 production workers, and total value added by manufacture of $4,713,167,000 (over half the state's total). This is the nation's sixth largest industrial area in terms of total population, but ranks third in terms of manufacturing labor force.[1] The focal point, Detroit, accounts for only 138 square miles of land in this area, but has 70 per cent of the population and total labor force, and 56 per cent of the manufacturing labor force.[2]

Many different types of manufacturing establishments are found in this area. The most important, based on value added by manufacture, are: (1) transportation equipment; (2) machinery, except electrical; (3) primary metals; (4) fabricated metal products; (5) chemicals and products; (6) food and kindred products. Transportation equipment, particularly motor-vehicle units and parts, dominates manufacturing with $1,915,498,000 value added by manufacture and 229,899 production workers (in 1954), although it consists of only 281 establishments.[3]

Detroit is the focus of what is known industrially as the "automobile belt." And, as was pointed out previously, the motor-vehicle industry (a sub-division of transportation equipment) is very dependent on highway facilities for its operations. It is, therefore, not difficult to judge the importance of a completed Interstate System to Detroit's future. Detroit certainly has as much to gain from rapid completion of this System as any other city in the nation.

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[1]U.S., Dept. of Commerce, Bureau of the Census, U. S. Census of Manufactures: 1954, op. cit., P. 4.

[2]City of Detroit, Economic Base of Detroit, loc. cit.

[3]U.S., Dept. of Commerce, Bureau of the Census, U. S. Census of Manufactures: 1954, op. cit., Pp. 12-13.

However, despite their great importance, the location of Interstate highways through this urban area should not be considered independently. First, Interstate routes are only one element in the transportation system of Detroit, even though, perhaps, the most important. And, second, they cannot be considered alone in the urban area because they are a part of, are effected by, and in turn influence the land use patterns of the city. It is a recognized principle that Interstate highways should be so located as to blend harmoniously with the planned land use of the urban area.

Detroit illustrates this principle admirably. A large measure of cooperation has existed between the various agencies which have jurisdiction over road and land use problems in the Detroit area. Real efforts have been made to combine highway development projects with the other important elements of urban planning. In February, 1958, an article published on highway planning in Detroit contained a statement by Glenn C. Richards, Public Works Commissioner for Detroit, in which he indicated that the new urban expressways were being used as the major structural elements of the Detroit Master Plan. It was pointed out that every mile of expressway built in Detroit since 1950 — $200 million worth — had been designed and located in accordance with the Detroit Master Plan. Highway engineers and city planners have cooperated closely in the expressway program, and strong hope exists that the highway can become a positive and creative design element in the redevelopment of Detroit.[1]

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[1] "Detroit...Where Planners and Engineers Talk to Each Other," Street Engineering, Vol. 3, No. 2, Feb., 1958, P. 4.

In Detroit it is planned for the expressways and other major roads to serve as the framework for a new urban arrangement developed along advanced land-use principles. The new city, as seen by the planners, involves three elements: (1) a central core; (2) sixteen relatively self-sufficient communities comprising the surrounding city proper; (3) 155 unit-neighborhoods which will comprise the 16 communities. Within this matrix there will be 45 major shopping centers and 27 industrial districts.[1]

The Master Plan includes a scheme involving the ringing of the core with an expressway loop, approximately one mile in diameter, from which nine ramps will descend into the CBD. This core area is to be revitalized, and highway planning has taken this into account. Five major expressways will terminate at the loop, and much blighted property around the fringe of the core will be removed to provide locations for these new routes. The razing of property for highway purposes will be accomplished in conjunction with plans for urban renewal.[2]

Outside of the CBD, the new expressways will serve as boundaries, or buffer zones, between communities or conflicting land uses, and will connect these areas with the core of the city. It is estimated that 75 of the 155 residential neighborhoods will be within 20 minutes drive of the CBD. No section of the city will be more than 30 minutes by expressway from the Detroit core area.[3]

With an urban Master Plan available and in full knowledge that Detroit was badly in need of traffic relief, the next step was to conduct

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[1] Ibid.

[2] Ibid., P. 5.

[3] Ibid.

a survey to determine what the form, amount, and location of this relief should be. The City Plan Commission had previously completed a study, but this was limited to the city proper. What was needed was a metropolitan area study. With this in mind, the city of Detroit, the Wayne County Road Commission, and Michigan State Highway Department, in cooperation with the Federal Bureau of Public Roads, undertook the Detroit Area Traffic Study. The purpose of this study was to insure effective functioning of the huge traffic movements in the Detroit area by thoroughly understanding the nature of the movement, and devising the best possible transportation system to serve it.[1]

This study was one of the most comprehensive ever made of a large city's traffic problems. Complete inventories were taken of all factors in the environment of Detroit, and area, which could be expected to influence traffic. These inventories were of two types; (1) fixed and (2) moving. They consisted of such elements as the existing road system, land use, population distribution, origin and destination of traffic, and traffic flow patterns.[2]

An origin-destination survey was employed to establish the major lines of traffic-desire movement in the Detroit area. Land use surveys were taken because traffic is influenced to a large degree by existing land use. This type inventory allows the identification of trip-generating uses, and the probable effects of area growth and future land use arrangements. The arterial road inventory was necessary to determine the adequacy, or inadequacy, of existing road networks, and to delineate

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[1]Michigan State Highway Dept., Report on the Detroit Metropolitan Area Traffic Study, op. cit., P. 13.

[2]Ibid., Pp. 17-31.

areas which were lacking in proper motor-vehicle traffic capacity.[1]

From these various inventories, and the interpretations made from them concerning future volumes and spatial distributions of traffic, it was possible to devise a rational plan for the solution of Detroit area traffic problems. The plan which was evolved called for the creation of an interconnected system of expressways including penetrators and circumferentials, along with necessary connectors. Other solutions were considered, but the expressway plan was accepted. Most of the expressways built to fulfill this plan will be part of the Interstate System.

All of the high-priority locations for this expressway system stress the importance of the completion of the Interstate routes. This is only natural because these routes will have more liberal financing available, will connect with rural Interstate routes, and in every case, it is believed their sites are fundamentally sound in terms of traffic-desire movements and planned land use. The Interstate routes radiating into Detroit and converging on the CBD will comprise the basic framework around which the remainder of the city's arterial road system will be designed.

Figure 8 shows the Interstate System network in the Detroit metropolitan area. As this map indicates, five Interstate routes enter the Detroit city limits where they eventually converge on the CBD (either directly or by connector routes) and form a loop around that area. Two Interstate routes, one north-south and the other east-west, will serve as circumferential highways connecting the penetrators on the urban periphery and providing by-pass facilities. The traffic flow bands, which parallel

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[1] Ibid., Vol. II, Pp. 92-107.

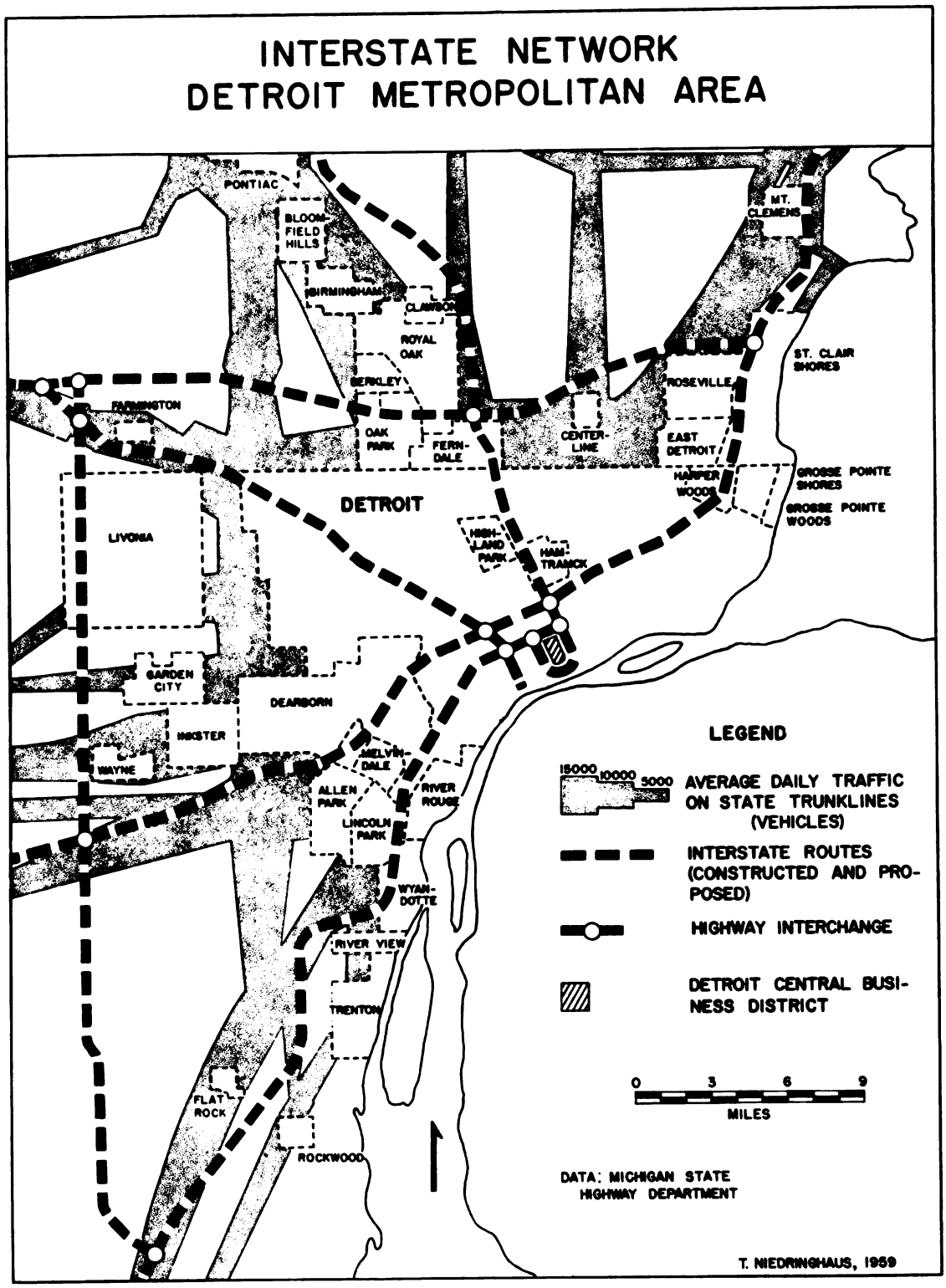
INTERSTATE NETWORK
DETROIT METROPOLITAN AREA
PONTIAC
BLOOMFIELD HILLS
BIRMINGHAM
CLAWSON
ROYAL OAK
BERKLEY
FARMINGTON
OAK PARK
FERNDALE
CENTERLINE
MT. CLEMENS
ST. CLAIR SHORES
ROSEVILLE
EAST DETROIT
HARPER WOODS
GROSSE POINTE SHORES
GROSSE POINTE WOODS
DETROIT
HIGHLAND PARK
HAMTRAMCK
LIVONIA
GARDEN CITY
DEARBORN
INKSTER
WAYNE
MELVINDALE
ALLEN PARK
LINCOLN PARK
RIVER ROUGE
WYANDOTTE
RIVER VIEW
TRENTON
FLAT ROCK
ROCKWOOD
LEGEND
15000 10000 5000
AVERAGE DAILY TRAFFIC ON STATE TRUNKLINES (VEHICLES)
INTERSTATE ROUTES (CONSTRUCTED AND PROPOSED)
HIGHWAY INTERCHANGE
DETROIT CENTRAL BUSINESS DISTRICT
0 3 6 9
MILES
DATA: MICHIGAN STATE HIGHWAY DEPARTMENT
T. NIEDRINGHAUS, 1959

Figure 8

major state trunklines, give some indication of the huge volumes of motor vehicles which enter and leave the Detroit area on an average day.

CONCLUSION

The spatial arrangement of the Interstate-System highways in the United States is strongly influenced by an areally differentiated physical and cultural environment. To the extent that these highways are in harmony with the present and future human use of this environment they should be valuable additions to the total transportation network of the nation. It is the conclusion of this thesis that, in general, the proposed locations for Interstate routes will be beneficial to the nation as a whole, will strengthen the economy of Michigan, and will improve the transportation situation in the three communities examined without having undesirable economic and social consequences.

However, it is realized that this thesis is by no means a complete analysis of the Interstate System and the associated location problem. In some areas it may well be that the Interstate locations are poorly planned, and will create more disturbances to land-use plans and community organization than is gained by the increased mobility of the people. For this reason it is considered necessary to continue public hearings so that the people most effected by the new locations will have the opportunity to voice their opinions, in the best traditions of American democracy.

The influence of the physical and cultural environment on the location of Interstate highways has received the primary attention in

this thesis. But the Interstate highways, having once been put into place, will themselves influence man's environment. Some of these effects may be very important.

One important effect will be a significant increase in the mobility of a population that already is highly mobile. This effect is worthy of study by geographers, as well as many others, because of the economic and social changes which will result.

Based on the evidence of prior studies, it also appears likely that land-use and land-value changes will be a necessary concomitant of the new Interstate highways. In the normal course of events, these changes tend to follow in the direction of substantial highway improvements. Because of the controlled-access features of these highways there is little danger that these changes will adversely effect the traffic capacity and safety advantages of the Interstate facilities. The most dramatic changes in land use and land value will be near the highway interchanges. It is reasonable to assume that these interchanges will be the new sites for considerable medium and light manufacturing, commercial, and residential developments.

Perhaps the most important effect of the new Interstate highways relates to their great power to exercise desirable or disruptive influences on regions and communities. If the highway engineers and the local and regional planners are able to meet on common ground, and if the planners have constructive ideas to offer, there is no reason why the Interstate highways cannot be strong elements in the development of better regions and communities. If the highways are improperly located with no regard for planned development or for economic and social consequences, they will add to the already serious problems of urban sprawl, poorly

planned land use, and blighted property. Detroit is a good example of a city which planned for the Interstate highways, and cooperated with highway officials in fitting them into a comprehensive Master Plan.

Because the Interstate highways will have important effects on the economic and social balance of all parts of the nation, this thesis concludes that studies and evaluations by impartial but learned investigators should be continued. Their work, along with the continuous efforts of Federal, state, and local highway authorities and regional and local planners, should help to ensure the development of highways that are not only valuable in themselves but that tend to appreciate the value of other real estate.

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