THE MODULAR LOOP SYSTEM
AN AUTOMOBILE TRAFFIC NETWORK

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Bruce Torrey Bartlett

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ABSTRACT

THE MODULAR LOOP SYSTEM

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BY

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The congestion of urban transportation has made very difficult the flow of individuals, goods and services during peak traffic hours. While other modes of transportation should be explored and initiated to relieve such congestion, short-term and long range planning must continue to develop an efficient use of the automobile.

The existing situations of dispersed, low-density land use may ultimately be modified so that different modes of transportation will become more economically feasible. Indeed, technology may yet develop an ideal mode of transportation in which the automobile is dysfunctional. Yet, to believe that the urban transportation solution lies in mass transit may be unreasonable at this time in history. Concurrent with the search for alternatives to the automobile, testing and developing ways of making the automobile more efficient should be undertaken.

Within the framework of the urban transportation planning process, this thesis has attempted the development of

a proposed alternative transportation network to make automobile modes of transportation more efficient. The concept involved was concerned with developing a regional circulation system that would utilize a motor vehicle oriented transportation system conveniently and effectively in the urbanized regions. Origin and destination studies as well as desire lines played a large role in developing a design concept of hexagonal patterns as a spatial framework for an urban transportation system.

Once the goals and concepts were formulated, the network was tested by coding locations and type of links involved in the regional circulation system on a simulated model of an existing street network. The street network used was Genesee County, Michigan. By loading the proposed network onto the existing network, volumes of traffic were assigned. Several programs, such as network build/updates, tree builders, skim trees program and assignment programs were used to get a clear picture of the impact and effect of the proposed network. Skim trees were used on the computer to isolate destination and distance traveled on each link of the network. The network was plotted graphically to view the links of the proposed network.

The results of the test revealed that it is possible to make the automobile more efficient and convenient as a means of transportation by developing a regionally oriented street network based on a theory of hexagon patterns, which has been designated by the author as the Modular Loop System.

Bruce Torrey Bartlett

It has been shown that it is possible to separate trips by length and purpose and by doing so produce benefits for the existing network. These benefits range from a reduction in the amount of time spent in transit, to an increased environmental quality, to a reduction of economic costs. It may also affect the existing network adversely in that the vehicle miles traveled increases and the links of the proposed network create physical boundaries which can create islands in the urban area.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (CONT'D.)

LIST OF TABLES

CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

A. FOCUS OF THESIS

The problems related to the use of the automobile are well known. Pollution, congestion and disruption of land use are serious auto-related problems which must somehow be solved unless society intends to abandon the considerable investment in roadways, automobiles, etc. Governments in particular must come to grips with the problems created by the automobile and strive to make it more efficient.

The dominance of the private automobile can be attributed to the deterioration of public transit after World War II. "Throughout the postwar period...the quality of public transit has declined, at least as measured by the frequency of service. This decline is heavily attributable to the negative interaction between public transit and private transport, transit services were curtailed for economy reasons. This was particularly true for non rush-hour periods, because the abandonment of public transportation for non-commuter purposes was much greater than for trips to and from work. The increased specialization of public transit in commuter work trips mainly reflects its disadvantages for shopping, social and recreational trips in comparison with the private automobile. In fact, an outstanding feature of urban passenger travel demands is a strong preference for the private automobile for virtually all non-commuter trips"[1].

This is further supported by inadequate development in response to changing conditions. "Routes have tended to remain constant despite large population shifts and important changes in land use. Central city mass transit service often stops for no valid reason other than the central city political boundaries. When transit lines were first established, few people lived outside of the city. Transit charters and legal restraints further limited expansion that could have responded to suburban growth"[2] (see Figure 1).

At the same time automobile usage has drastically increased (see Figure 2). In 1966 an incredible 80% of all American families owned automobiles. This represents 98 million car owners, a 31% increase over the 59% of all Americans who owned automobiles in 1950[3]. While the dependence on the automobile grows, it is fueled by the investment of money into the development of urban highways. About 45% of all monies granted by the Interstate Highway Act are being diverted to urban areas, which represent only 2% of the total land mass of the country[4].

Public transit, once a very important factor for the work trips and commuters, has now been taken over by the

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[1]The Urban Transportation Problem, J.R. Meyer, J.F. Kain, M. Wohl, Harvard University Press, Cambridge, Mass., 1965, p. 361.
[2]Tomorrow's Transportation, U.S. Department of Housing and Urban Development, Washington, D.C., 1968, p. 9.
[3]Ibid, p. 13.
[4]Ibid, p. 13.

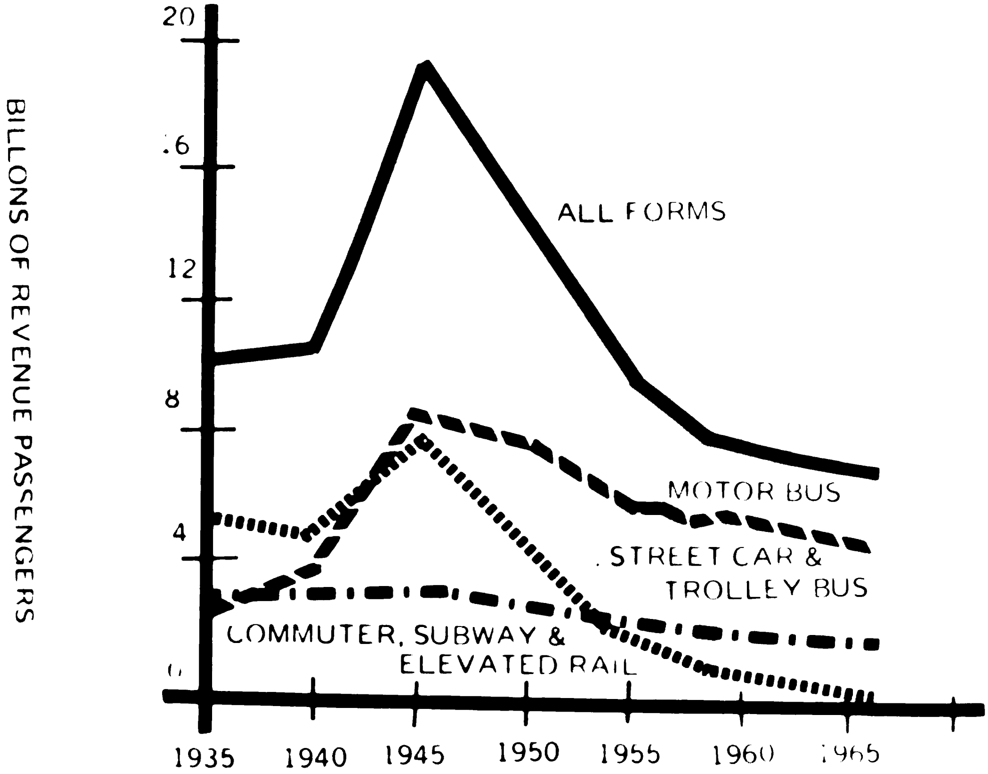

FIGURE 1
TRENDS IN REVENUE PASSENGERS OF URBAN PUBLIC TRANSPORTATION

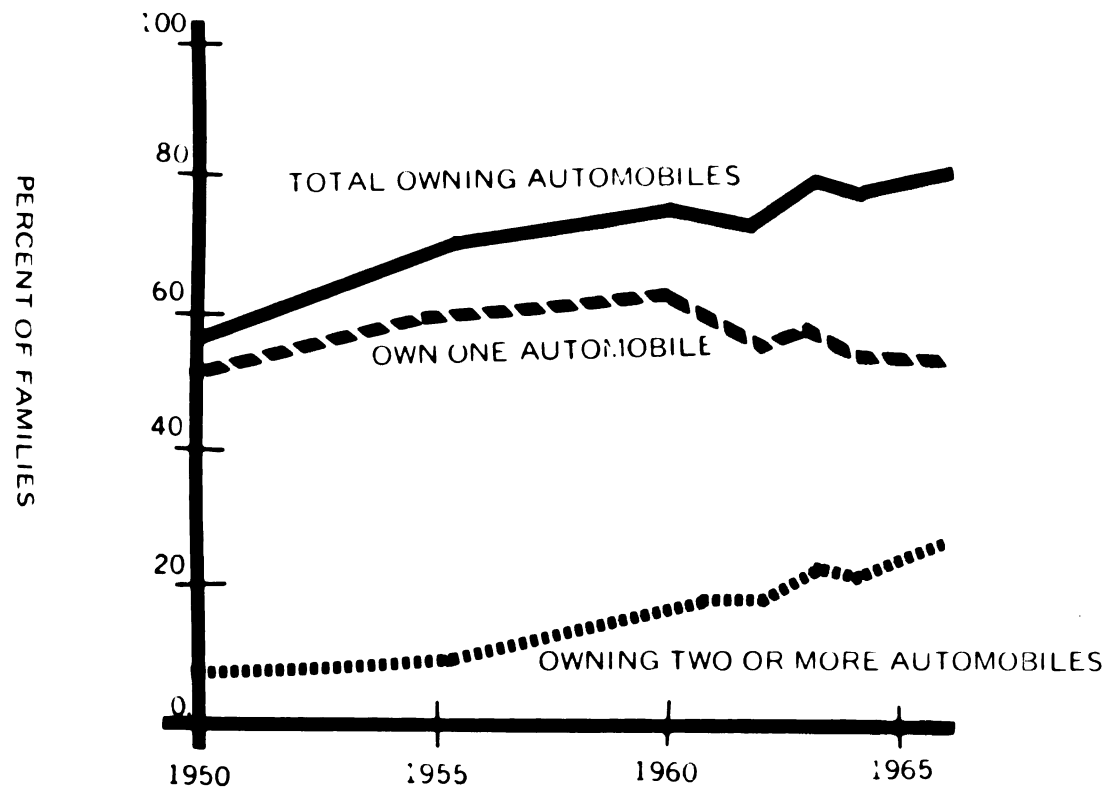

FIGURE 2
AUTOMOBILE OWNERSHIP

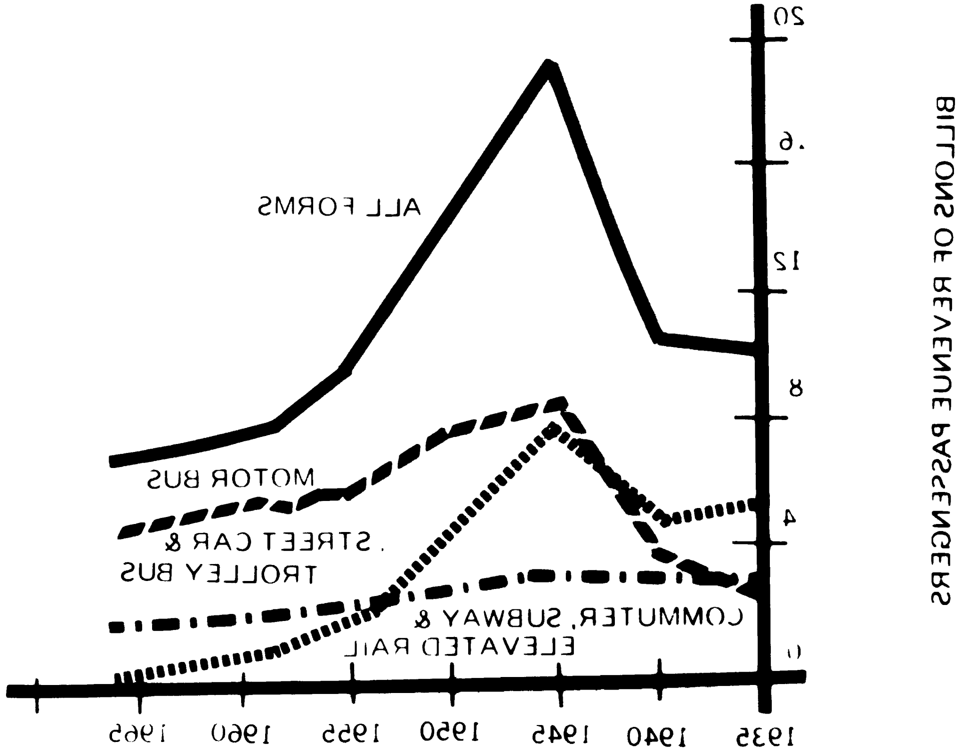

FIGURE 2
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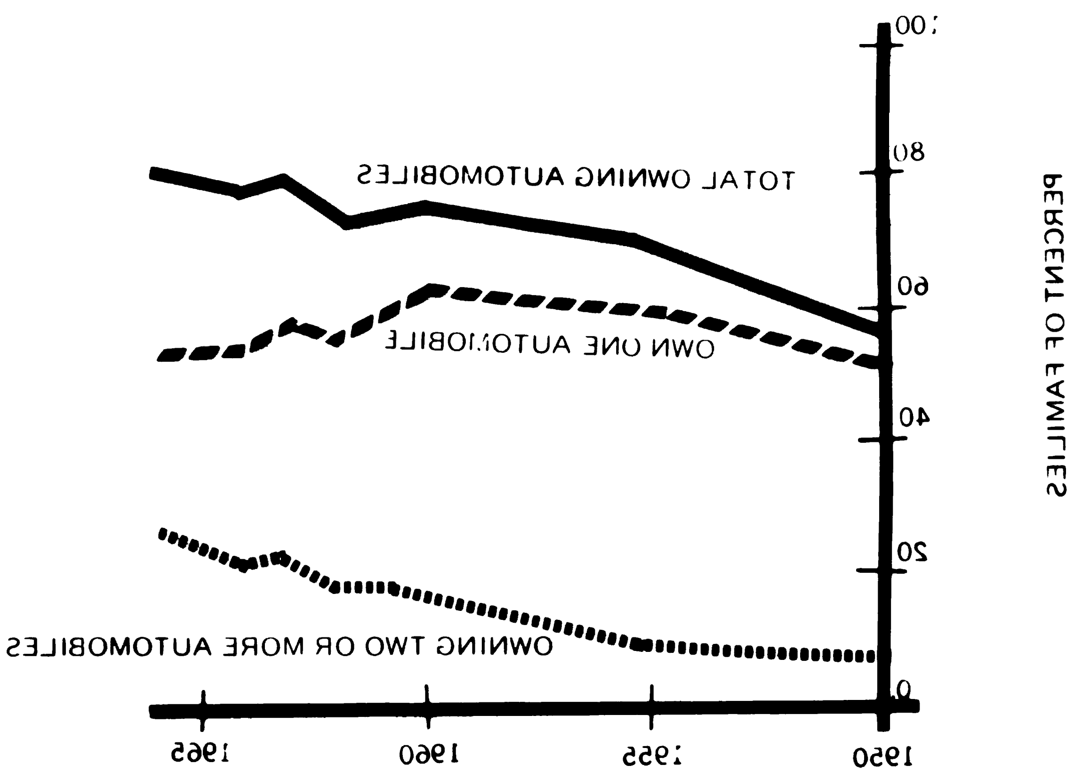

FIGURE 3
AUTOMOBILE OWNERSHIP

automobile. "According to the 1960 census, 67% of all employed persons living in the nations metropolitan regions traveled to work in automobiles"[5]. This figure is somewhat higher in the 1970 census. The dominance of the automobile, even for the commuter could be attributed to the convenience factor. "Eliminating transfers and supplying greater privacy and schedule flexibility (where car-pooling is limited), is unquestionably a superior economic good in the minds of many urban commuters"[6]. In fact, "There is considerable evidence that consumers may prefer an 'automobile' solution to the urban transportation needs, even if it is a costly solution"[7]. The cause of this ever increasing dependence is hard to determine. One can only assume that the cause and effects are very complex and intertwined with occurrences such as scattered low-density urban development. "The automobile made possible widespread and rapid suburban growth; in turn, low density communities away from central cities fostered increasing dependence on the automobile"[8].

This reliance on the automobile should not be allowed to continue to grow at such an accelerated rate. The automobile is rapidly becoming the only means of urban transportation. An example is the crisis that arose in the winter of

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[5] Ibid, p. 13.
[6] The Urban Transportation Problem, J.R. Meyer, J.F. Kain, M. Wohl, Harvard University Press, Cambridge, Mass., 1965, p. 361.
[7] Ibid, p. 361.
[8] Tomorrow's Transportation, U.S. Department of Housing and Urban Development, Washington D.C., 1968, p. 13.

1973 when the gasoline supply was scarce. Transportation was curtailed because of the dependence on the relatively inefficient automobile. There is the economic and social costs to be considered as well. Increasing air pollution, the use of needed land for highways and parking and the detrimental aesthetic effects must be kept in mind in transportation planning.

The automobile, therefore, should play a significant role in the formation of the urban transportation network, but should not be considered as the only possible mode of transportation in the network. The development of a regional circulation system should attempt to seek a more efficient use of the automobile in reference to the metropolitan region. "The most urgent policy question seems to be whether cities will choose to solve any short-run transportation problems they face by using blunt and unsophisticated methods (in the form of heavy capital investments in immobile and inflexible rail transit used on a stand-by or part-time basis for a few hours a day) or whether the self-discipline can be mustered to organize the extensive urban street and highway capacity already in place to better serve todays needs. Remembering that over 70% of public transit is now performed on highways, the possibilities for immediate gain from such discipline would appear quite promising"[9].

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[9] The Metropolitan Enigma, James Q. Wilson, Editor, Doubleday Books, Garden City, New York, 1970, p. 75.

The arguments against the dominance of the automobile while valid, may be academic. It exists, and a good problem solver or planner should search for immediate solutions to reduce the detrimental effects of this mode of transportation and make it more efficient and convenient. Long term solutions and experiments that further develop better modes of transportation should, of course, also have high priority but not at the expense of neglecting the automobile as a viable part of a more "balanced" transportation system to serve the needs of urban areas.

This thesis postulates that it may be possible to reduce the effects of the over extended use of the automobile by designing and developing a network of corridors which would provide a more efficient system for the operation of the automobile. The goals of such a network are obvious:

1. To reduce pollution, congestion, disruption of land use and other adverse effects of the automobile.

2. To support the desirable qualities of the automobile such as convenience, time saved, and efficiency.

These two very basic goals for the use of the automobile cover the entire spectrum of goals sought in developing better transportation. To develop a network which would operate in a manner necessary to achieve the goals set forth, four basic criteria for the network were formulated.

1. To establish a redesigned regional circulation system.

2. To allow for a constant and unencumbered flow of traffic.

3. To provide for the separation of trips by type and purpose.

4. To use existing roadways as a basis for the system.

It was hypothesized that if a network of interconnected hexagonal links could be designed in some form of regionally oriented circulation system that would allow constant flow of traffic, congestion could in fact be reduced. It was also felt that trips of a certain length and purpose should be attracted to such a network while other types of trips were not. In this fashion the circulation system could function properly by encouraging the "natural" separation of through or regionally oriented trips from purely locally-oriented traffic.

The physical placement of such a network utilized the Genesee County, Michigan urban area as a base. It was conceived to avoid land use allocation, displacement and deterioration. Existing streets in Flint and the surrounding Genesee County area were used as the base for the network and a new Modular Loop System was simply superimposed onto it. It primarily made use of major and minor arterials which service the region presently and could be upgraded. All of these factors are essential component parts of what has been designated in this thesis as the Modular Loop System[10].

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[10]The term "Modular Loop System" is reviewed in detail further on in this chapter and also in Chapter II.

B. URBAN TRANSPORTATION PLANNING PROCESS

Ever since 1909 when Mr. Daniel Burnham, leading architect of the time, "superimposed a system of diagonal avenues onto the prevailing grid system"[11] for the purpose of shortening travel time, planning for transportation corridors and systems has been constantly evolving. From the standpoint of transportation, his plans were not outstanding because of the problems created by the superimposition of these avenues. He failed to realize the coming tremendous growth in the use of the automobile. "There were 8,000 motor vehicles registered in the United States in 1900 and over 32 million in 1940. Of these, over 27 million were passenger cars"[12]. The automobile was in the process of evolving from a sports item for the rich to a means of transportation for the masses. However, by presenting it as a total concept, Burnham set in motion the development of transportation planning.

The Federal Aid Road Act of 1916 started a federal policy for the betterment of the roads and highways. The act dictated $75 million to be spent over a five year period for the improvement of "rural and post roads"[13]. Soon it was found that improving the post roads was not enough and the Federal

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[11] Urban Transportation Planning, Roger L. Creighton, University of Illinois Press, Urbana, 1970, p. 127.
[12] The Road and the Car in American Life, John B. Rae, M.I.T. Press, Cambridge, 1971, p. 49.
[13] Ibid, p. 37.

Highways Act of 1921 was enacted. This brought about the development of a main system of interstate and inter-county highways[14].

The birth of transportation planning came in 1934 in the form of Hayden-Cartwright Act of 1934[15]. "Up to 1.5% of Federal Highway funds given to each state could be spent for research and planning purposes"[16]. With these monies most state highway departments undertook statewide traffic counting, road inventories and mapping programs. However, this was centered primarily in the rural areas and urban studies were virtually ignored[17].

During World War II the scope of road planning changed. The cities which generated most of the traffic and congestion were finally allowed state and federal funds for improvements to the street systems in the urban areas. This was embodied in the Federal Aid Highway Act of 1944[18].

The Highway Act of 1956 could be considered a setback to the development of an urban transportation planning process. In this Act the Interstate Highway System was established with 90% of the funding coming from Federal sources. However, planning procedures and allocated funds were omitted. There was no requirement in the 1956 Act for the interstate system to be integrated or harmonized with comprehensive plans

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[14]Ibid, Creighton, p. 126.
[15]Ibid, p. 128.
[16]Ibid, p. 128.
[17]Ibid, p. 128.
[18]Ibid, p. 129.

of local, city, county, or regional planning commissions. Nor was any transportation planning process involving local units of government provided for in the Act.

The Highway Act of 1962 represents the culmination of urban transportation planning[19]. This act "set a deadline of July 1, 1965 by which time all metropolitan regions with central cities having more than 500,000 persons were required to have a completed comprehensive transportation plan embracing all modes of travel and taking land use into consideration"[20].

The Highway Act of 1962 can be attributed to four major Ad Hoc transportation studies. These are the Detroit Metropolitan Area Traffic Study, done in 1953-55, the Chicago study of 1955, the Pittsburgh Study of 1958, and the Penn-Jersey Study in 1959[21]. The Highway Act of 1962 was not the only outgrowth of these studies. These and other studies in the 1950's were instrumental in the development of the basic six step process for transportation planning. The studies, particularly those in Chicago and Detroit were landmarks in formulating procedures for inventories and forecasts. The form of the networks which were developed have been proven to be inadequate given theeexisting situation on the transportation corridors. This is further explained in Part C, "Development of Terms Used and Network Form".

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[19] Urban Transportation Planning, Roger L. Creighton, University of Illinois Press, Urbana, 1970, p. 131.
[20] Ibid, p. 131
[21] Ibid, p. 132.

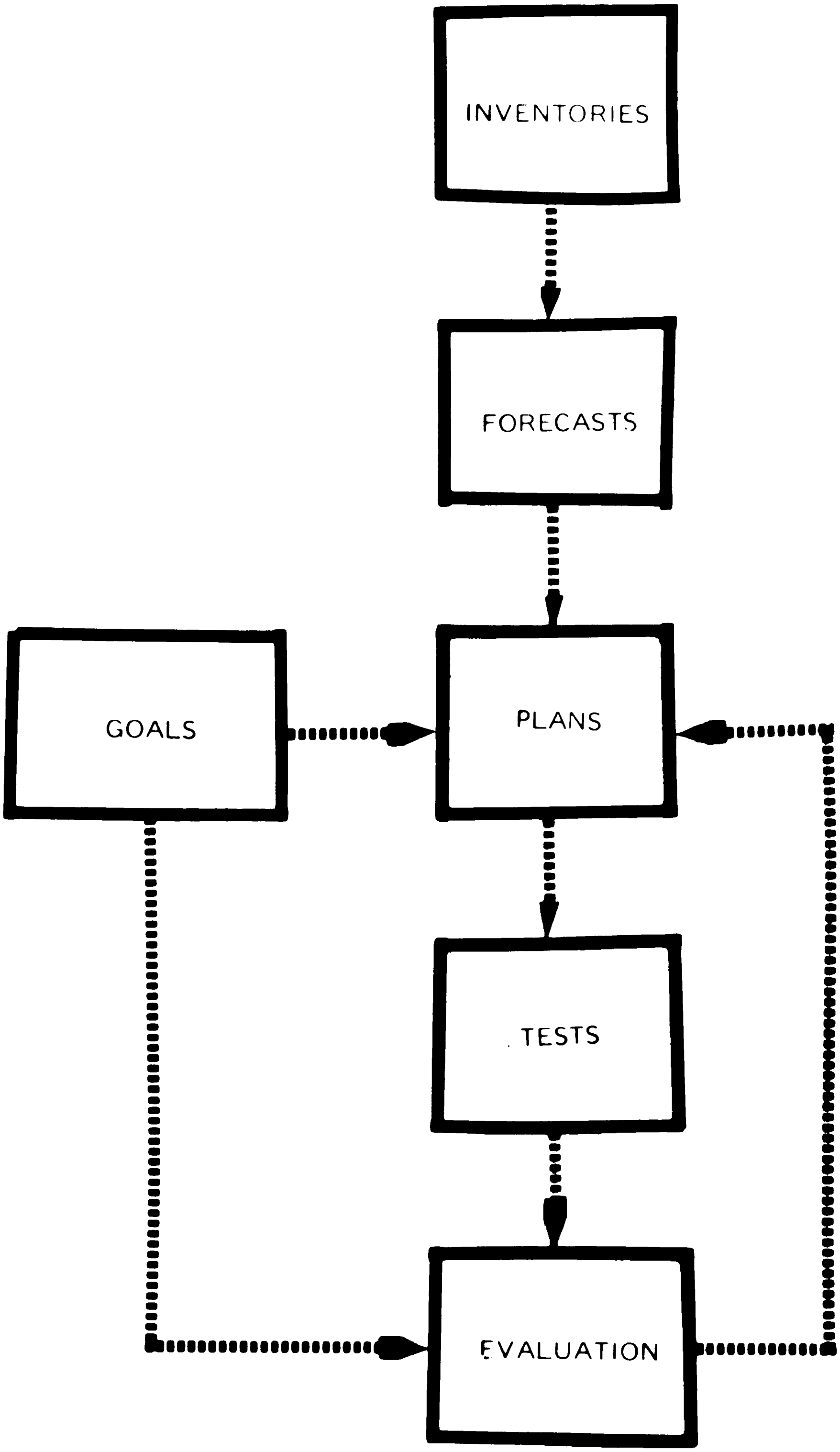

FIGURE 3
THE METROPOLITAN TRANSPORTATION PLANNING PROCESS

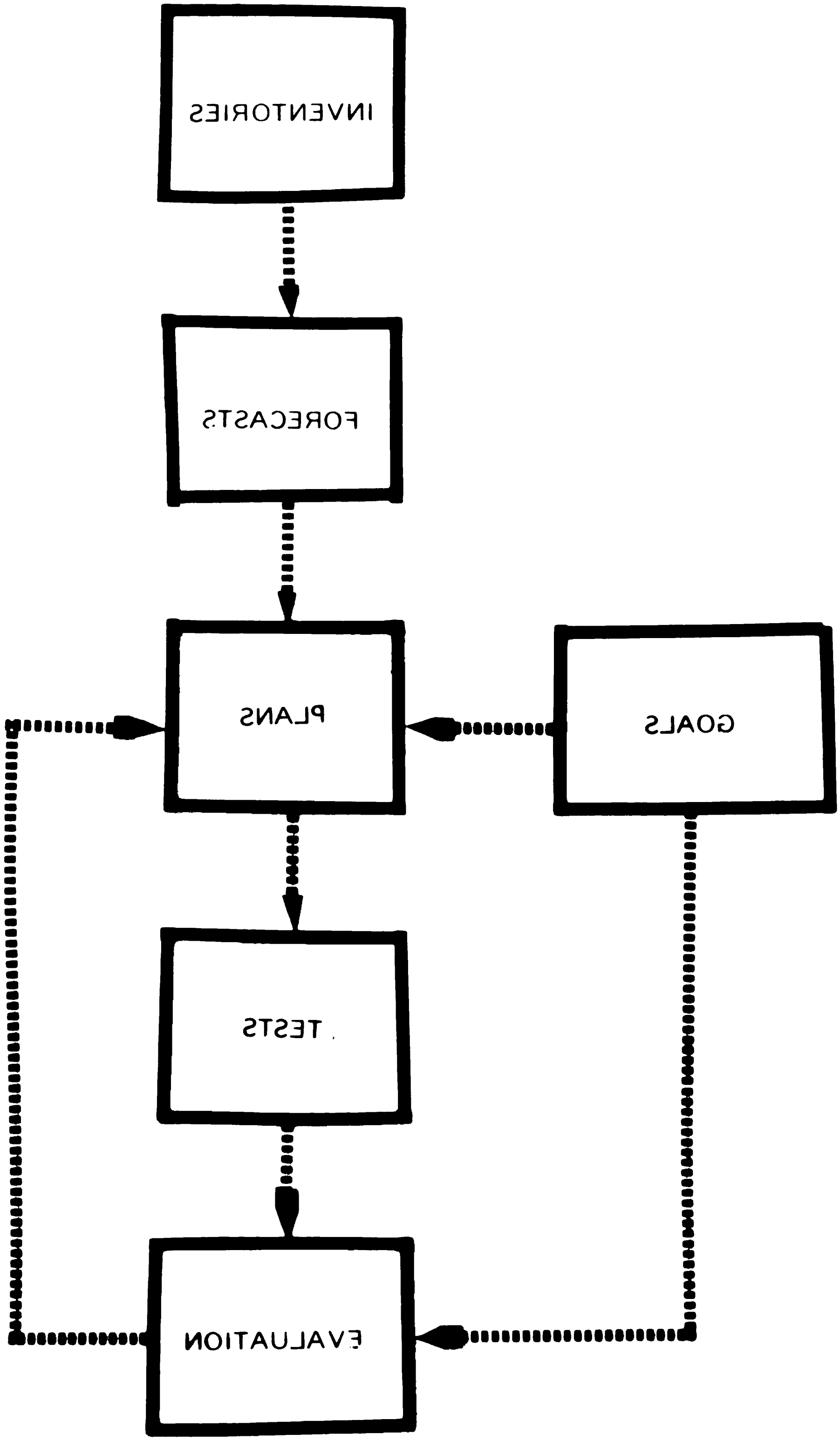

FIGURE 1

THE METROPOLITAN TRANSPORTATION PLANNING PROCESS

The basic six steps are illustrated in their proper relationships in Figure 3. Following is a detailed explanation of each step:

Inventories

Any planning which concludes with recommendations for the expenditure of public funds must obviously be based upon fact. To obtain a measured understanding of the subject, inventories are taken as the first operation in the transportation planning process.

Three major inventories are generally undertaken, plus a number of minor ones. The major inventories cover travel (trips made wholly or partially within an urban area), land uses, and the transportation facilities over which vehicles, people or goods must move. (The travel inventory in a metropolitan area is actually a special kind of census, since interviews conducted in the home collect population and employment data as well as data on trips by all modes of travel.) The minor inventories vary in number, but may include speed-volume-density studies of travel behavior on the streets, traffic volume counts, transit passenger volume counts, parking surveys, a central business district floor area survey and similar studies.

Data obtained in these surveys are reduced to numeric form and constitute a complete representation-even if only on a sampled basis-of the major transportation related aspects of the city. The surveys are selected to provide those particular kinds of information which are essential for carrying out the planning process.

Forecasts

While inventories describe a city as it is, forecasts are needed to estimate what it will be like in the future, since plans are intended to meet future as well as present problems. There are two types of such forecasts: Aggregate and distributed.

The aggregate forecasts are estimates, based on historical data, of what certain totals will be for a particular urban area. Population forecasts are examples of aggregate forecasts, as are economic projections. All the forecaster is interested in doing in such cases is to establish how may people and jobs, and how much income and consumption, will exist within an entire metropolitan area.

These totals must then be distributed geographically; that is, location within the metropolitan area must be estimated. There are two ways to make these distributions: One is by planning, in which values are imposed to indicate a desired pattern of location; the other is by forecasting, which assumes that at least some of the items being distributed behave in an orderly or at least predictable fashion.

Based on the distributed forecasts of population, other forecasts-both distributed and aggregate-can be made. The automobile ownership forecast, for example, can only be made sensible when the location of the population is known.

Similarly, forecasts of tripmaking (which are the principal output of the forecasting operation and the principal input to the testing stage) depend upon a distributed population.

Goals

In a systematic planning process, stating objectives is an essential step. The objectives become the criteria against which all plans are measured. An explicit statement is made and formal procedures are created to connect the plan with these goals and objectives. In a democracy the objectives used in government planning must be those of the people.

The objectives may fall into several groups. Some are quantifiable; others have to be related to the plan subjectively. Some objectives can be measured in the same units as others, and consequently the trade offs between opposing objectives can be estimated. Some objectives relate to things at the regional scale in the transportation planning process, while others relate to things which can only be accomplished through detailed design after the general location of a new transportation facility has been settled.

Whatever plan is selected must be demonstrated as being best in the light of the explicitly stated objectives. How such a demonstration can be made is described in step six.

Preparing Network Proposals

The fourth step in the transportation planning process is the preparation of a number of network proposals. In an urban area these should include proposals for transit as well as highway facilities. The proposals must be for complete systems, not increments of one or two facilities, but complete systems serving an entire urban area at its expected size at the time of the target year. Target years for transportation planning are generally twenty to twenty-five years for the year of the survey work.

The preparation of network proposals will involve consideration of trip density, trip length, land use, network planning principles, investment cost, and network characteristics among other things. A methodical procedure is used to bring these factors together, and a number of network proposals are prepared for testing purposes. Always in the background, as proposals are prepared, are the goals which the plan is expected to achieve.

Testing

The purpose of the testing phase in the planning process is to determine how well any given network proposal will perform at some prescribed time in the future.

It is impossible for an individual to appraise correctly how well a transportation system consisting of hundreds of different segments of streets and transit lines will perform under either present or future conditions. Therefore the testing must be done by a computer. The essence of the testing process is the representation of trips and networks by the use of numbers within the computer and the use of the computer to estimate where the trips will go, what kinds of transportation facilities will be used and what path each trip will take through the network. This is all done by rules prescribed to the computer, rules whose results are verified by comparing simulated with actual volumes of travel on the links of the present system.

Evaluation

The results of each test of a separate transportation network are evaluated in terms of the objectives which have previously been specified. If the objectives are primarily economic ones, direct output from the computer can give the time, accident, and travel costs associated with each network plan. The capital costs of the plan are also known. These two sets of costs can be accumulated to give the total transportation cost of the plan.

By comparing the test results of different plans, it is possible to determine which types, configurations, and quantities of transportation facilities provide greater reductions of the costs of transportation in return for additional investment. A series of tests and evaluations gradually permits planners to "zero in" upon a best plan, or at least a plan which cannot reasonably be bettered. This plan is then recommended for adoption[22].

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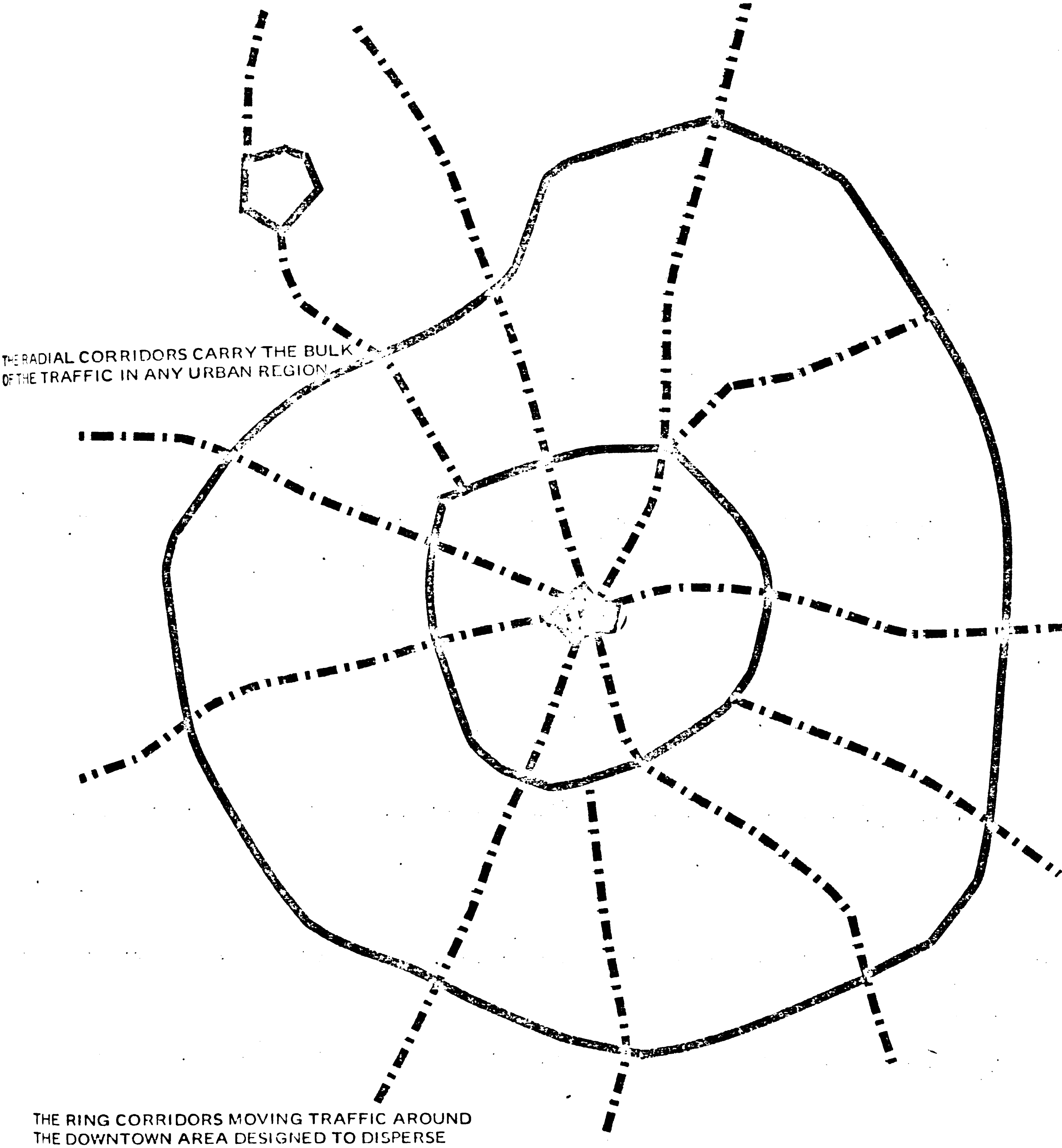
[22] Urban Transportation Planning, Roger L. Creighton, University of Illinois Press, Urbana, 1970, pps. 137-140.

C. DEVELOPMENT OF TERMS USED AND NETWORK FORM

The term that portrays the proposed alternative network merely indicates this particular alternative. "Modular Loop System" refers to the pattern of corridors which would be established if the alternative were to be implemented. The term "module" was used to indicate the component parts found in the alternative. The term "loop" was used to represent the fact that each module, while part of the network, is also a separate entity. That is to say that each module functions as an integral part of the traffic network while at the same time acting as a circumfrential access route. The meaning of Modular Loop System will become more evident when the network is more thoroughly developed in Chapter II, "Proposed Alternative Network Pattern".

The form of the proposed network is a major factor in the effectiveness of the network. The Modular Loop System is explained in detail in Chapter II but it should be pointed out here that it differs from the existing pattern of corridors which is found in most urban regions in the United States.

The most common pattern of automobile corridors is the ring-radial pattern (see Figure 4a). These corridors radiate from one designated point, usually the largest Central Business District (CBD). They provide quick, convenient access to the CBD but seriously neglect access to other major attractors in the urban area. The Modular Loop System is developed to allow easy access to these attractors. The ring corridors were designed to circle the CBD for the purpose of through



THE RING CORRIDORS MOVING TRAFFIC AROUND
THE DOWNTOWN AREA DESIGNED TO DISPERSE
TRAFFIC FROM CONGESTED POINTS IN THE REGION
BY CREATING BY — PASSING LINKS

GIVEN THE RING — RADIAL CIRCULATION PATTERN
CLOSE PROXIMITY OF TRAFFIC TO ANY REGIONAL
ATTRACTOR IS INHIBITED

RING — RADIAL CIRCULATION PATTERN

FIGURE 4A

trips, by-passing the congestion of corridors emanating from the CBD.

The ring-radial system has been effective in many large metropolitan areas but congestion still occurs. This is due primarily to trips of all lengths and types using the same corridors. The Modular Loop System tries to deal with this problem.

An urban area must be very large in order to absorb the costs involved in a ring-radial network. Most cities with a medium sized urban area can afford neither the money nor the space needed for this form of network. In these areas the ring-radial system usually consists of a business loop which supplies the necessary corridors for the congestion on the network. Therefore, the size and scale of the form becomes a factor as well.

The Modular Loop System was designed to supply all the necessary corridors for an urban area, be it quite large or quite small.

The proposed network is the author's own original design concept. However, further research uncovered the fact that in Traffic In Towns, a report by the Steering Group for Her Majesty's Stationary Office in London, England in 1963, there are three principles employed in the development of their system which parallel three concepts used in the Modular Loop System (M.L.S.).

The first is not really a concept; it is an adoption of the term "environmental area"[23]. In adopting the term, the definition becomes realigned. Traffic in Towns considers environmental area in terms of traffic being generated. "The concept is no more and no less than a method of arranging buildings for motor traffic"[24]. Through the development of the M.L.S. an environmental area becomes that area for which the M.L.S. creates boundaries. The effects on these areas and their characteristics will be discussed later. The size of the environmental area as used in Traffic in Towns and the size as it is used in this thesis is based on two different concepts. "The maximum size of an environmental area is governed by the need to prevent its own traffic building up to a volume that in effect necessitates subdivision by the insertion of a further distributory link in the network...It should be said here that no sociological content is implied by our concept of environmental areas. There is no connection for example with the idea of 'neighborhoods'"[25]. In the M.L.S. as used herein, the size and shape of the environmental areas are determined by the regional oriented trips and regional oriented attraction points. (This concept is developed more completely in Chapter II. Because of the

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[23]Traffic In Towns, Reports of the Steering Group and Working Group appointed by the Minister of Transport, London, Her Majesty's Stationary Office, 1963, p. 44.
[24]Ibid, p. 45.
[25]Ibid, p. 45.

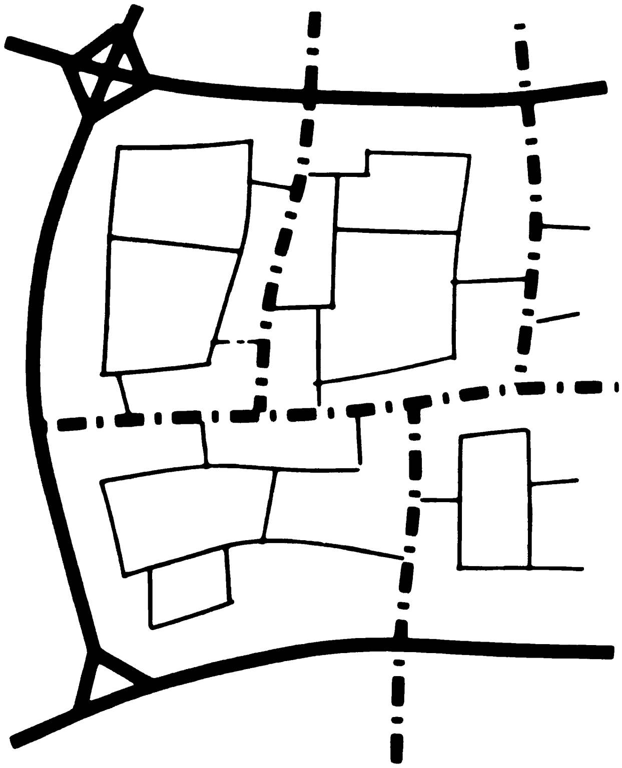


FIGURE 4

THE PRINCIPLE OF THE HIERARCHY OF DISTRIBUTORS

PRIMARY DISTRIBUTORS
DISTRICT DISTRIBUTORS
LOCAL DISTRIBUTORS

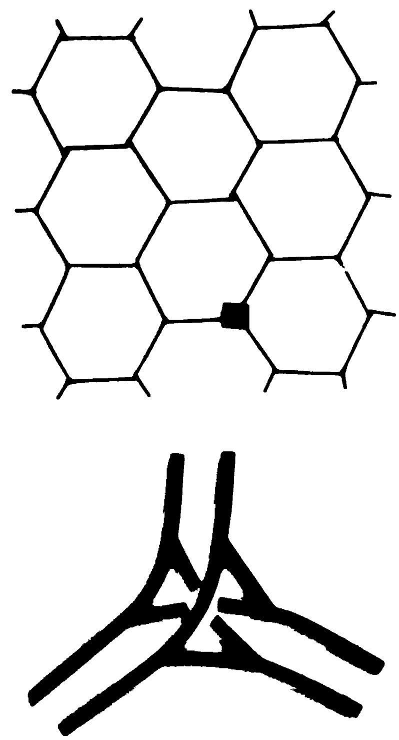
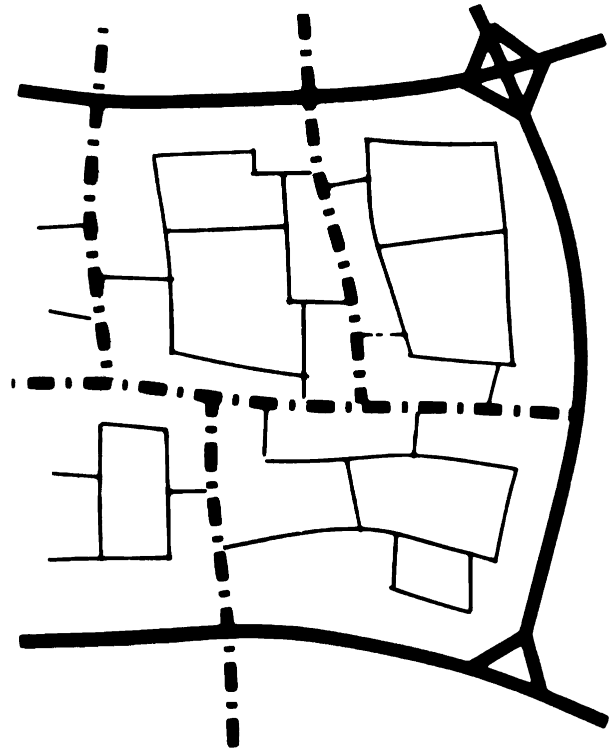


FIGURE 5

THE HEXAGONAL NETWORK PATTERN WHICH GIVES A GOOD DISTRIBUTION WITH COMPARATIVELY SIMPLE INTERSECTIONS

FIGURE 4

THE PRINCIPLE OF THE HIERARCHY OF DISTRIBUTORS



PRIMARY DISTRIBUTORS
DISTRICT DISTRIBUTORS
LOCAL DISTRIBUTORS

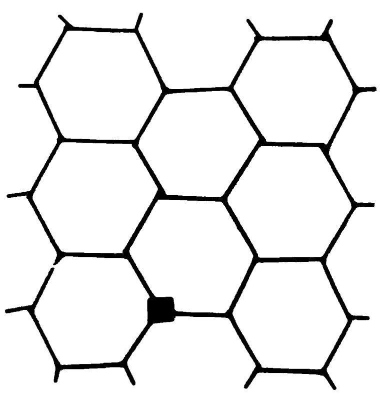
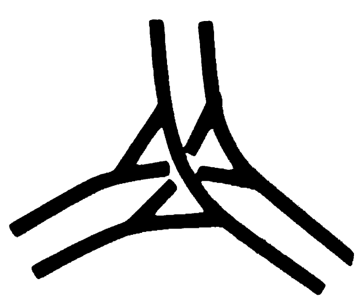


FIGURE 5

THE HEXAGONAL NETWORK PATTERN WHICH GIVES A GOOD DISTRIBUTION WITH COMPARATIVELY SIMPLE INTERSECTIONS



the difference in the two approaches, the environmental areas in the M.L.S. are usually larger and follow established land use patterns and desire lines.

The second concept is the development of a network of interconnected corridors to function as a "distributing system"[26]. While the characteristics and the formation are different, the concept of a network of corridors dispersing traffic is basic to both. "If the problem is considered in terms of a network serving environmental areas (corridor serving rooms, to use the analogy with buildings) it will be seen at once that the pattern of the network must depend on the disposition of the areas, the kinds and quantities of traffic they generate, the associations that exist between one area and another, or between areas and the outside world"[27]. While the dispersal of traffic is common to both of these alternatives, so is it common to most alternative networks. The real parallel is apparent in the fact that these alternatives are both modular in scope. "...the network would be superimposed in the manner of a 'grid' with a very definite pattern and 'module'. A hexagonal pattern which is the basic spatial arrangement used in the Modular Loop System, is very efficient with economical, three way intersections, but other polygonal patterns are possible. A rectangular pattern tends to require very complex intersections. The basic dimension or 'module' of the distributory system in such circumstances

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[26]Ibid, p. 43.
[27]Ibid, p. 43.

will broadly depend upon the kinds and intensities of land uses within the enclosed areas; the more intense the activity, the more traffic will be generated, and so the greater will be the need to insert distributors and thus the closer will need to be the mesh of the distributory system"[28].

The third concept used in Traffic in Towns which paralleled the M.L.S. was the creation of a hierarchy of corridors[29]. The development of a hierarchy of traffic facilities is not unique to either of these proposed networks. Classification of traffic facility types is common place in transportation planning and traffic engineering. Basically, there are three types of corridor facilities classified. They are: Arterial, collector and local facilities.

"The primary purpose of an arterial street or highway is to serve relatively long trips between areas of regional or traffic importance. Collector streets disperse traffic to and from the arterial, and local streets provide direct access to individual properties"[30].

The concept developed in Traffic in Towns is a methodical and well constructed network to disperse the traffic through a town or urban region. This approach follows the classic function desired in dispersion on the three facility levels using a module oriented network (see Figure 6). The

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[28] Ibid, p. 43.
[29] Ibid, p. 43.
[30] "Guidelines for right-of-way widths", Michigan Department of State Highways, Lansing, Michigan, 1969, p. 6.

Modular Loop System attempts to utilize the functional efficiency of the module and to separate the functioning of the link types (see Figure 7).

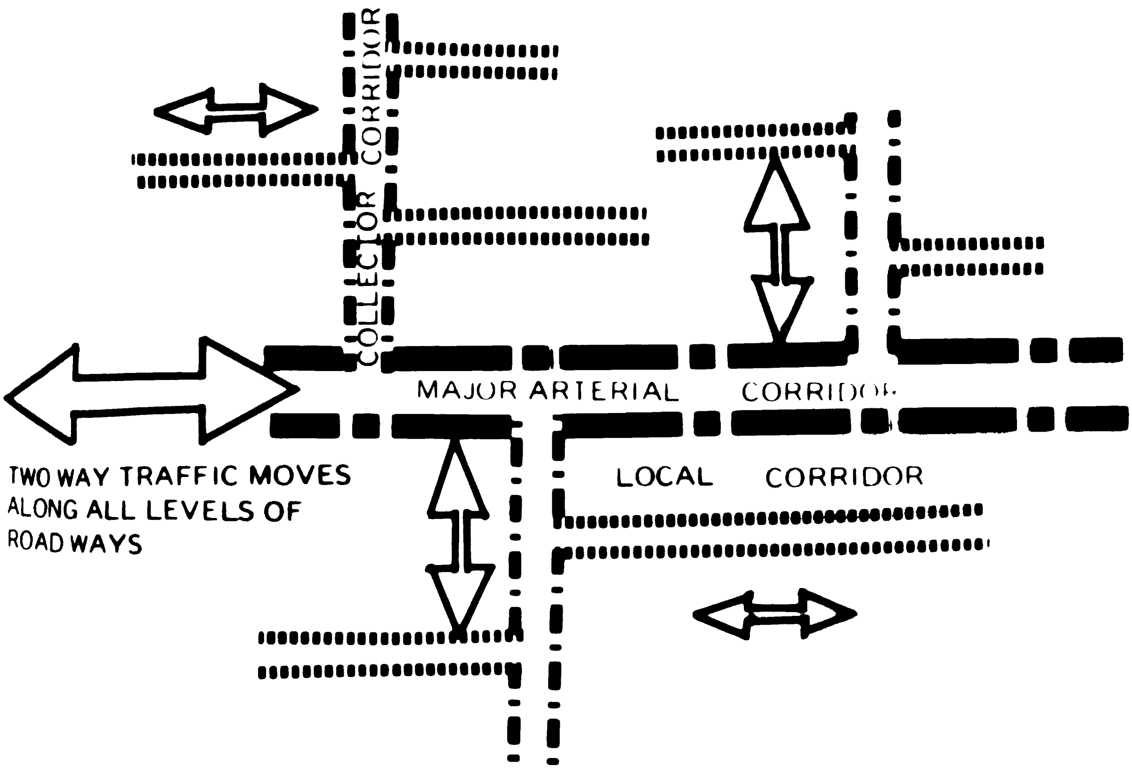
D. LIMITATIONS AND CONSTRAINTS

While it would be desirable to develop a comprehensive transportation system by researching and testing each integral part for its functioning aspect in the urban setting, it is not feasible for several reasons. First, each part of the transportation network would require extremely large amounts of data which is costly to assemble. Secondly, the resources available were not sufficiently equipped to handle such a large influx of data. For example, the simulated model of the case study area developed by the State Department of Highways and Transportation was not programmed to deal with such a large array of possibilities. Thirdly, there was not enough time allowed to develop the ultimate relationships of the modes of transportation used in the urban areas needed to complete a comprehensive transportation network.

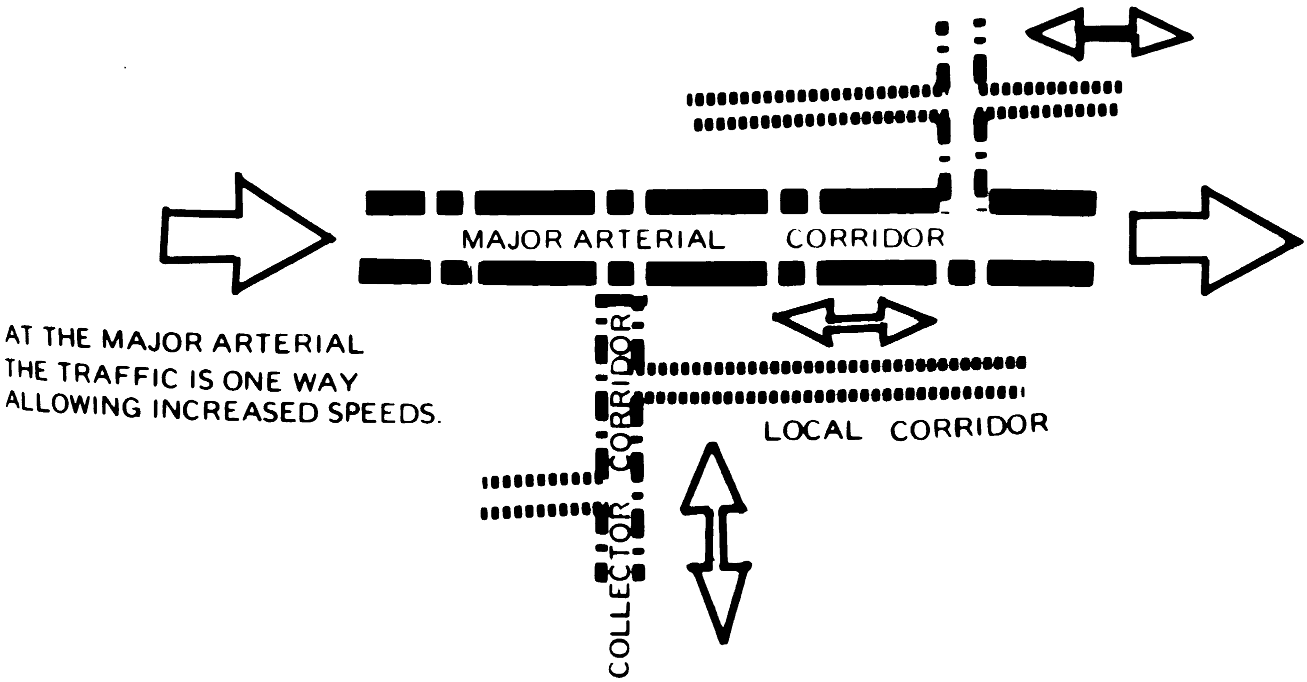
The thesis objective, therefore, is to develop a network of private motor vehicle-oriented corridors which create a regional circulation system which result in a hierarchy of circulation systems for an urban vehicle transportation system. This would appear to more adequately provide traffic movement for a large segment of the vehicular trips in urban areas. For example, 93% of all trips are private automobile oriented

FIGURE 6

SYSTEM SCHEMATIC



DISTRIBUTION OCCURS ORDERLY AND EFFECTIVELY FOR THE TRAFFIC THROUGHOUT THE NETWORK. THE HIERARCHY PRESENTED AND THE NUMBER OF INTERSECTION THERE IN COULD POSSIBLE CLOG AN ALREADY SLOW MOVING NETWORK.

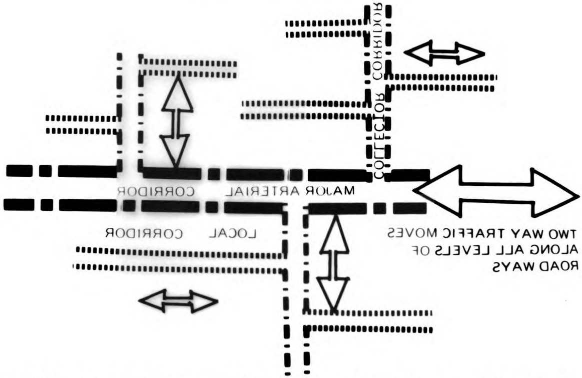


THE DISTRIBUTION OF TRAFFIC OCCUR AT RESTRICTED INTERSECTION, IN NUMBER AND DESIGN, IN ORDER THAT THE ARTERIAL NETWORK CAN FUNCTION PROPERLY, AS REGIONAL SYSTEM AND AT INCREASED SPEEDS

FIGURE 7

SYSTEM SCHEMATIC

FIGURE 6
SYSTEM SCHEMATIC



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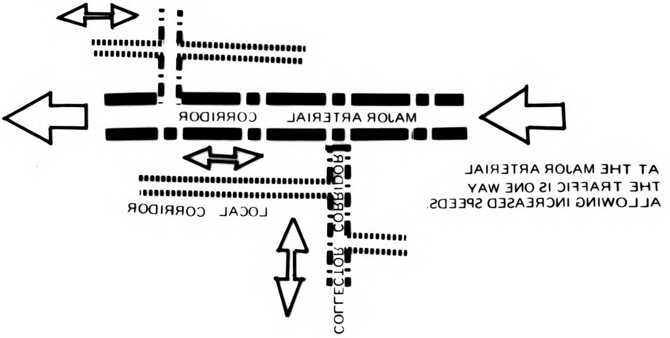

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FIGURE 7

SYSTEM SCHEMATIC

and work oriented trips alone are comprised mostly (80%) of individuals being transported by private automobile[31].

TABLE 1

ESTIMATED DISTRIBUTION OF URBAN PASSENGER MILES[32]

	Bus, Subway and Suburban Rail	Private Auto	Combined
All Types of Trips	7%	93%	100%
Journey to Work	20%	80%	100%
Other Trips	1%	99%	100%

Even in New York City where transit ridership for work oriented trips is 40%, the private automobile is still the dominant factor in the total number of trips with 80% usage[33].

Using the automobile in its most efficient manner would have ramifications in several areas. These are congestion, efficient use of the land, urban pollution, and a capacity for change[34].

> "Congestion--Congestion results in the daily loss of time to the traveler. Too often solutions are expensive in dollars and land taking, destroying the urban environment in the process.
>
> Efficient Use of the Land--Transportation functions and rights-of-way require extensive amounts of urban land, and compete with other important uses of the urban land resource. More rational urban land use made possible by new forms of transportation might help travel demands, aid in substituting

---

[31] Economic and Urban Problems, Dick Netzer, Basic Books, Inc., New York, 1970, p. 138.
[32] Economic and Urban Problems, Dick Netzer, Basic Books, Inc., New York, 1970, p. 139.
[33] Ibid, p. 140.
[34] Tomorrow's Transportation, U.S. Department of Housing and Urban Development, Washington D.C., 1968, pps. 6-7.

communications for urban transportation, and achieve greater total transportation services for the amounts of land required.

Urban Pollution--Air, noise, and aesthetic pollution from all current modes of urban transportation are far too high, degrading unnecessarily the quality of the urban environment.

Lack of Both Change and the Capacity to Change--resulting in a restricted choice of ways for people to get around the city and the metropolitan region.[35]"

The effectiveness and the validity of the proposed alternative network pattern depends on how each of these urban problems is effected. These problems, which are apparent in every urban region in the country must be kept in mind as the proposed network is developed.

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[35] Tomorrow's Transportation, U.S. Department of Housing and Urban Development, Washington, D.C., 1968, pps. 6-7.

CHAPTER II

PROPOSED ALTERNATIVE NETWORK PATTERN

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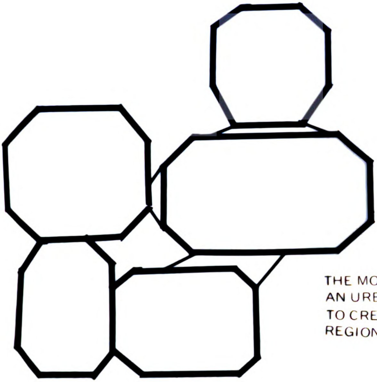
PROPOSED ALTERNATIVE NETWORK PATTERN

The Modular Loop System is a network of interconnecting roadways designed with the idea of moving vehicles to desired destinations, while relieving the problems discussed in Chapter I. It should be pointed out that the main purpose of such a network system is to move people and goods to desirable areas. The system here in question is a concept which will present a partial solution to transportation problems in urban parts of the country, but more importantly, will realign the actual goal of transportation in respect to urban life and its environment.

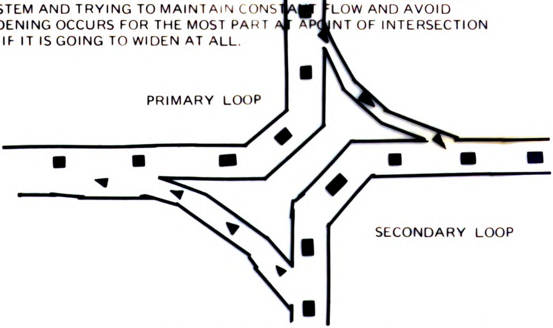
The Modular Loop System is exactly what the name implies; that is, a network of interconnected loop routes in any given urban area, designed for the movement of motor vehicles (Figure 8). The loops are designed in such a manner as to encircle any given environmental unit; that is, an extension of the neighborhood concept which encompasses the entire spectrum of social, economic and natural activities. In this way the loop is large enough to contain the traffic for which it was designed without destroying the activities, living and movement within the boundaries of the loop. The loops are connected so as to allow for the constant flow of traffic from one loop to another and so on, through the entire chain of loops in the network (Figure 9). The loop network will be spread through an urban area to provide the links necessary to insure flow of goods



THE MODULE ARE LOCATED THROUGHOUT AN URBAN REGION IN SUCH AWAY AS TO CREATE AN INTERCONNECTED REGIONALLY ORENTED NETWORK.

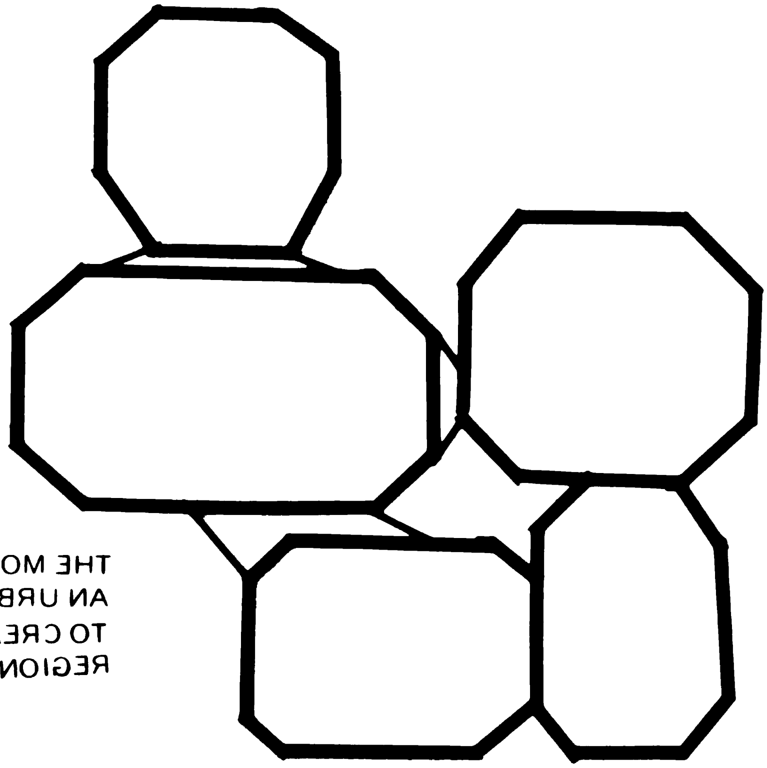
FIGURE 8
MODULAR LOOPS

PRIMARY LOOP ARE COMPRISED OF MORE LANES OF TRAFFIC THIS DO TO THEIR MAJOR ROLL IN THE LOOP SYSTEM AND TRYING TO MAINTAIN CONSTANT FLOW AND AVOID CONJESTION. THIS WIDENING OCCURS FOR THE MOST PART AT APOINT OF INTERSECTION WITH AN OTHER LOOP IF IT IS GOING TO WIDEN AT ALL.



BY DETERMINING THE FLOW OF TRAFFIC FROM ONE LOOP TO ANOTHER MAJOR OR PRIMARY LOOPS CAN BE PRESENT. THOSE LOOPS THAT HAVE A SURPORTIVE FUNCTION ARE SECONDARY THE FLOW OF TRAFFIC BACK TO THE SECONDARY MODULAR LOOP IS LESS, DO TO OFF PEAK RETURNS, DIFFERENT PATH HOME USEING A DIFFERENT SECONDARY LOOP, ETC.

FIGURE 9
INTERSECTION OF TWO MODULAR LOOPS



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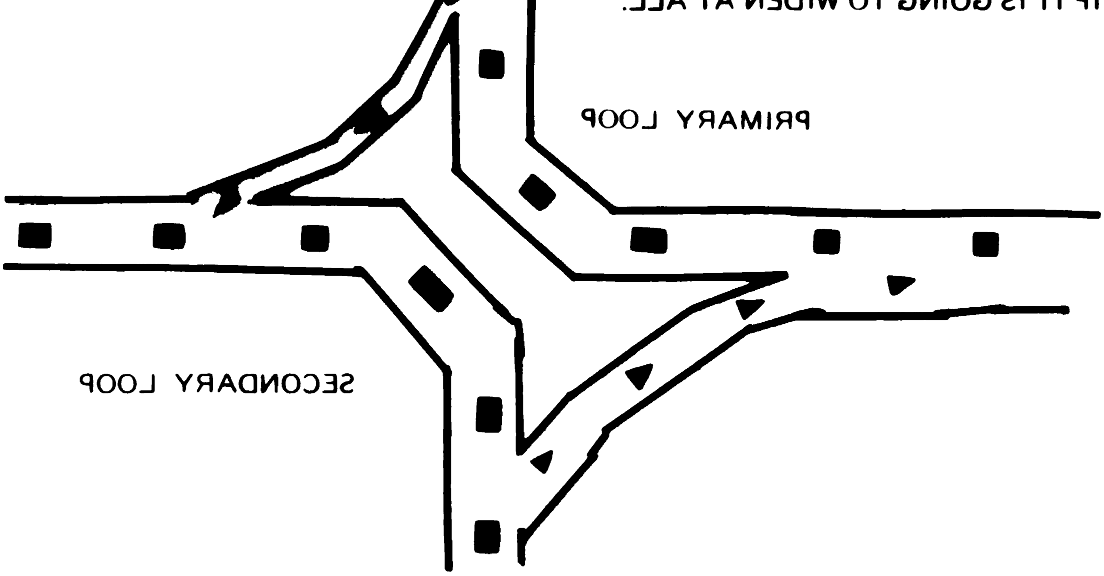

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FIGURE 9
INTERSECTION OF TWO MODULAR LOOPS

and people through the region. This network can be expanded by attaching another module to the loop network. This is in the event that land use changes due to urban expansion in certain parts of the area, or the volume of traffic is increased enough to warrant the development of a connection to the network. Removal from the network would be achieved by reversing this process. For example, a module not heavily used could be adapted into the local street system by making it an open access, two-way link. This concept of a flexible traffic network is crucial in urban areas which are prone to change. By adding more loops where needed and subtracting when necessary, the system is capable of coping with the many changes occurring in the urban area.

The concept of constant flow is not a new one. Expressways were designed for just that purpose; to move people, non-stop, from one place to another quickly, conveniently and safely. Traffic signal timing on major arterials was designed to maintain a constant flow of traffic through commercial areas, and to and from congested activity centers. Neither of these methods, however, completely solved the problem of traffic congestion. The Modular Loop System is designed to work on a third concept to allow more opportunities for constant flow. By organizing all three forms it may be possible to minimize the problem of congestion.

Like blood through a human body, the Modular Loop System strives to maintain constant flow of traffic through an urban area. The heart pulsates at a uniform speed sending blood to all parts of the body. However, when exerted, the flow becomes more active and blood is moved more quickly through the veins to the body. When this flow is speeded up to a certain extent the heart fibulates and finally ceases to function. The same is true in an urban area. When the traffic flow is greater than the corridor can handle, congestion occurs and the system ceases to function. If a system is created to absorb certain amounts of traffic from the other corridors without getting congested itself, then all the levels can operate as designed. It is best to keep in mind that the flow of blood from the heart and the flow of traffic are functions in their respective elements, but are not the ultimate goal.

The constant flow of traffic along the Modular Loop System operates on three basic principles. These principles are (1) the function of the Loop System, (2) form of the Loop System, and (3) movement on the Loop System. Through these basic principles it becomes clear how the Modular Loop System is set up.

A. FUNCTION OF THE MODULAR LOOP SYSTEM

The system is designed to perform certain functions in the urban setting. A hierarchy of transportation corridors for motor vehicles exists in any regional transportation network. These range from local streets to expressways. The expressways, which are limited access roadways are designed for long distance travel around and through a region, bypassing congestion within the region. These corridors do

serve a purpose. For example, they are used in traveling from one end of the region to another and also to bring the people from the outskirts of the region into the central trip generator, usually the Central Business District. Far too often expressways which have corridors in close proximity to important activity centers attract more trips of a shorter length than those for which they were designed. This is understandable if the expressway lessens the time required or has a more direct access for the shorter trips as well as for the long distance trips. This puts a strain on the expressway system, however, in the form of an excess of entering and exiting, high speeds, confusion and congestion.

Moving one step down from the expressways we come to the major corridors. These were designed to take trips throughout the region or urban area itself, excepting extremely short trips which should ideally take place on the local streets. However, the development of commercial strips along these arteries has increased movement and traffic and thus these arteries have not been able to perform their function. Alternative routes such as expressways, have been used in place of these major corridors. The expressways then become congested and in turn defeat their purpose.

It is to this problem that the Modular Loop System addresses itself. It has been pointed out that the cities were not designed for the onslaught of the automobile. However, that is not to say that it is inconceivable that a system of roads can not emerge in the cities that is compatible with the automobile concept. The Modular Loop System is designed to establish a clear alternative for the people of an urbanized region in their travel through the urban area without relying on the expressways or mass transit for rapid movement. The system is designed for intermediate trips, given a point of origin and a specific point of destination or purpose, such as home to shopping, or work to home.

Intermediate Trips

The dictionary defines the term "intermediate" as "Being or happening between". Therefore, an intermediate trip is one which is between long trips using the expressways, and short interval trips using the local streets.

To isolate and develop networks to be used for specific purposes and trips of a certain length, the desired trips can be broken down into facilities used. This can be achieved in several ways. One is to rival the speed and accessibility of the expressways, thus drawing the through trips which should be a lower level of movement than the expressways. The second is to restrict the amount of access to the system so that short trips will have less access to the higher level of movement. There would not be access points at every major street. Thus, it is possible to isolate certain types of trips on the appropriate level of movement. Once this can be determined, an indepth study of each level of movement should be considered in terms of the most efficient, convenient and accessible forms of transportation.

However, it is not a simple task to determine what an intermediate trip consists of. Are they home base to work, home base to shopping, home base to recreation, or non-home base trips? This would depend on the scale of urban area involved and the geographic placement of major attractors. Thus, the reason for the trip becomes incidental other than the fact that it generates movement through the network to a destination. It is equally as hard to set perimeters on the development of an intermediate trip system which is discussed in terms of distance and time on a general level.

Adoption of a Modular Loop System for each individual city is going to generate what are considered to be intermediate trips for their particular situation.

The Modular Loop System is concerned with attracting those trips which are on a level, given its built-in restrictions and attractors, which will move people from their point of origin to their destination efficiently, safely and comfortably.

Major Generators

The purpose of the Modular Loop System is to move large amounts of people and goods to major interest points within the region. To do this one must know the origin and destination of most trips. For the purposes of this discussion the origin is where the trips are produced. The destination will be the "attractor" because people are being drawn to these points for certain reasons whether it be work, shopping, recreation or other. This thesis will look at only one

direction of the production and attraction; that of the home base to all other destinations. In this case it follows logically that the home base produces the trips and the destinations are the attractors. Because of the trend in this country toward low density, single family housing there is no large concentration of population in one area which will generate large volumes of trips.

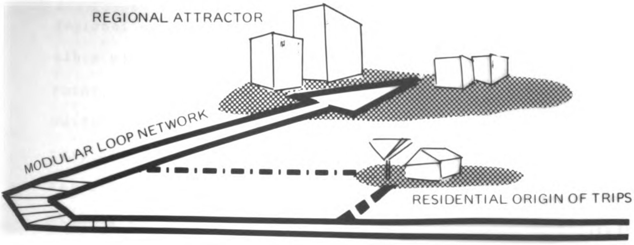
There are, however, areas which are more densely populated than others and the routes can be mapped out on existing street networks which will present the most logical route for the loop network to follow. These routes would conceivably follow major collectors and arteries running near residential areas. Keep in mind that the loop is circular in form and is designed to pass along boundaries of living areas without disturbing the environment, both natural and man made, within the loop. Movement, activity and the environment in the interior of the loop will be discussed later.

The major attractors for the region should also be carefully considered. We must determine the location of these attractors in the region and the type of attraction they provide, be it shopping, work, etc. For example, a major attractor which generates a large volume of trips might be a regional shopping center. Here, peak hours are not a factor because people shop at all hours of the day. Another example would be an industrial complex. By scheduling the change of shifts to coincide with off-peak hours the need for direct access to the loop system may not be necessary as long as the network is in close proximity to the industrial complex.

The major attractor for all types of trips is usually the central business district (CBD) of an urban area. This is an extremely unique case because of the volume and type of traffic and reasons for the trips and the environment which is created. A complete section of this paper has been devoted to this subject and will be discussed later on.

It has been shown that the function of the M.L.S. is to provide a route for intermediate trips, and trips being drawn to major regional attractors. For intermediate trips the M.L.S. sifts the trips by being in general proximity to the production areas but not in close proximity. The production area for most trips is the home, and as discussed before are in low density areas. The M.L.S. will run near these areas but most of the travelers will have to go some distance before having access to the M.L.S. As for the attractors, because these are more concentrated and the flow of traffic is higher at these focal points, swift moving corridors should be adjacent to or extremely near the attractors so that the traffic can enter the M.L.S. quickly and be dispersed quickly (Figure 10).

Consider the old adage "The shortest distance between two points is a straight line". In the literal sense this is not the case on the M.L.S., but the concept is similar. Given that there are regional attractors which draw trips from all over the area, it stands to reason that these attractors should have direct access to any regional network or



THE RESIDENTIAL PRODUCTION POINT OR THE ORIGIN OF THE TRIP IS NOT IN DIRECT CONTACT WITH THE NETWORK BUT RATHER IN GENERAL PROXIMITY THIS DO TO LOW DENSITIES AND DESIRE ENVIRONMENTAL REASONS.

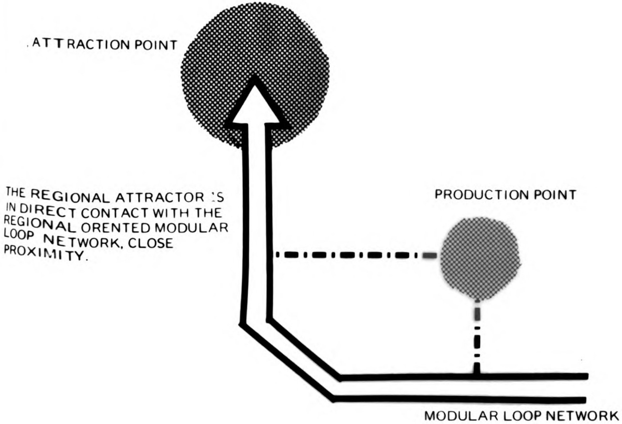
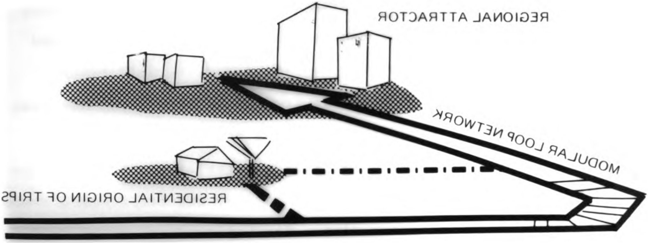


FIGURE 10
PROXIMITY



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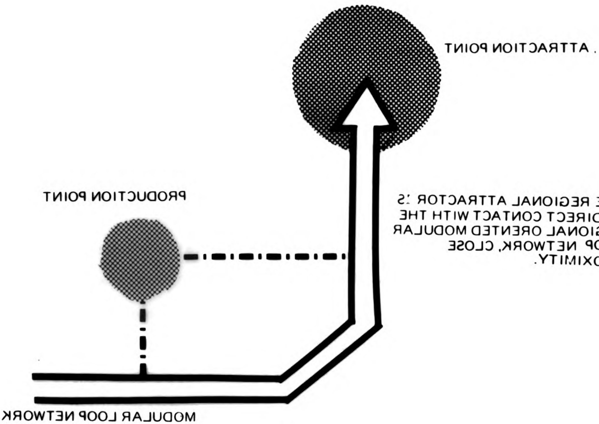


THE REGIONAL ATTRACTOR IS IN DIRECT CONTACT WITH THE REGIONAL ORENTED MODULAR LOOP NETWORK, CLOSE PROXIMITY.

FIGURE 10
PROXIMITY

level of corridors. The production end of the trip is only in general proximity to the regional network and therefore the adage breaks down. However, by making the links to the regional network from the production point as small as possible without destroying the movement around that production point, and making the movement along the regional network as swift as possible, the desired ease and shortness of the trip becomes a reality. A vehicle moving along the loop system has the capability of going to any part of the region by picking the loop on which the desired destination is located.

B. MOVEMENT ON THE LOOP SYSTEM

In most cases today there is no substitute for the individual automobile for traveling from place to place. That is not to say that this will always be the case. It is conceivable that some sort of private transportation vehicle will be coupled with a public form of movement system, i.e., a dual mode system. But as of now, accessibility and convenience are qualities that no other form of transportation has achieved on the overwhelming scale that the individual automobile has. Whether we will have to sacrifice this in the future is undetermined. However, the validity of any type of transportation which would digress from the levels of services existing through the use of the automobile is questionable. Practical and functional improvements are necessary in the design, use and patterns of movement for the automobile.

The Modular Loop System is committed to a constant flow of traffic, achieved through a directional flow, moving traffic in one direction through the urban area. This results in both an in-going movement toward the center of the urban area and an out-going movement away from the core of the urban area taking place. Links are in general proximity to the network either through direct relation to the Modular Loop or by means of a pathway to a major collector.

The Modular Loop has established standards of movement for the urban setting. These are to disperse traffic to the appropriate level of circulation, to alleviate congestion and promote rapid movement to desired destinations without detrimental effects to the environment of the region. While maintaining the standards the element of safety must be considered.

Safety

By developing the Modular Loop System as a network of one-way loops, safety is increased. If the system were two-way the efficiency in direct A to B access would increase because one would follow the same route to and from ones destination. However, at the speeds desired for the system, safety would surely decrease. As the system stands safety actually becomes a desirable by-product of the network. By designing the system to have one-way directional flow, head-on collisions are completely eliminated. Other types of accidents will also be reduced. Accident statistics prove that there are less accidents and fatal injuries on expressways than on non-expressway corridors and in fact the loop system has those qualities that are the assets of an expressway, namely, limited access, non-stop movement and one-way directional flow.

By establishing a rate of accidents for specific road types a general guide for judging the Modular Loop System in relation to the amount of safety can be formed. The State and local police tabulate reports on amounts of accidents which occur in a given year in a given area. This makes it possible to develop accident rates per miles traveled on expressways or non-expressways for urban and rural areas. The following statistics were obtained through the Michigan State Department of Highways and Transportation, Safety Division and pertain to the State of Michigan. The Loop System will enter into both urban and rural fringe areas.

TABLE 2

RATE OF ACCIDENTS
(Rate of Accidents per Million Miles Traveled)

ROAD TYPE	URBAN RATE	RURAL RATE
Limited Access	2.106	1.652
Arterial	9.212	4.987
Collector	6.894	2.843

The following example illustrates the effect on safety that the Modular Loop System could have in a given area. Consider an urban area which has an average daily traffic volume of 15,450,000. On the network the 15,450,000 can be broken down into the amount of traffic on each type of link in the network. This could be apportioned as shown in Table 3.

TABLE 3

VEHICLE MILES TRAVELED BY LINK TYPE

2,500,000 V.M.T.	Urban Limited Access Roads
4,000,000 V.M.T.	Rural Limited Access Roads
1,000,000 V.M.T.	Urban Arterial Roads
2,225,000 V.M.T.	Rural Arterial Roads
1,000,000 V.M.T.	Urban Collectors
2,225,000 V.M.T.	Rural Collectors
12,750,000	TOTAL VEHICLE MILES TRAVELED

The total distribution to all types of links in the network was developed purposely to have less vehicle miles traveled than originally stated; only 12,750,000 of 15,450,000. The remaining 2,700,000 vehicle miles traveled are those that would be affected by the Modular Loop System. The others can be multiplied by the accident rate and then multiplied by 340 to arrive at the number of accidents per year. (340 is generally used instead of 365 to compensate for the decrease in the amount of vehicle miles traveled during the weekends, holidays, etc.). The results of these tabulations are as follows.

TABLE 4

NUMBER OF ACCIDENTS BY LINK TYPE

Limited Access	# Of Accidents
Urban	1,790
Rural	2,246
Arterial	
Urban	3,132
Rural	3,772
Collector	
Urban	2,344
Rural	2,150
	15,634 Accidents per Year

The Modular Loop roads are more complicated. These roads are created primarily from existing arterials and from collectors. In urban areas approximately 75% of the roadways are derived from arterials and 25% from collectors. At the very worst, a major artery, the system will perform in such a fashion as to create a rate of accidents per millions of miles traveled of 8.633 in urban areas and 4.129 in rural areas.

$$\frac{(75 \times 9.212) + (25 \times 6.894)}{100} = 8.633$$ Accident Rate for M.L.S. Under Worst Conditions

75 = Arterial Roads %
9.212 = Accident Rate for Arterial Roads
25 = Collector Roads %
6.894 = Accident Rate for Collector Roads

The same holds true in the rural areas. However, 60% of the roadways are derived from arterials and 40% from collectors which produces a rate of 4.129.

$$\frac{(60 \times 4.987) + (40 \times 2.843)}{100} = 4.129$$

We then multiply the rate by 340 (days in the year) and the V.M.T.

$$\frac{8.633 \times 340 \times 1{,}500{,}000}{1{,}000{,}000} = 4{,}403 \text{ Accidents per Year on the Urban M.L.S.}$$

$$\frac{4.129 \times 340 \times 1{,}000{,}000}{1{,}000{,}000} = 1{,}403 \text{ Accidents per Year on the Rural M.L.S.}$$

The total accidents would then be 15,634, plus the urban (4,403) and the rural (1,403) Modular Loops or 21,440 accidents per year. This is the high figure for the development of the M.L.S. The low value would be found by implementing the expressway, or limited access, rates for the loop system. This would mean that the loop system with its limited access and constant slow one-way traffic is as safe as the expressway system. If this were the case, by following the same procedure as above, the amount of accidents would be:

$$\frac{2{,}106 \times 340 \times 1{,}500{,}000}{1{,}000{,}000} = 1{,}074 \text{ Accidents on Urban M.L.S.}$$

2.106 = Accident Rate for Limited Access Road (Urban)
340 = Days in the Year
1,500,000 = V.M.T.

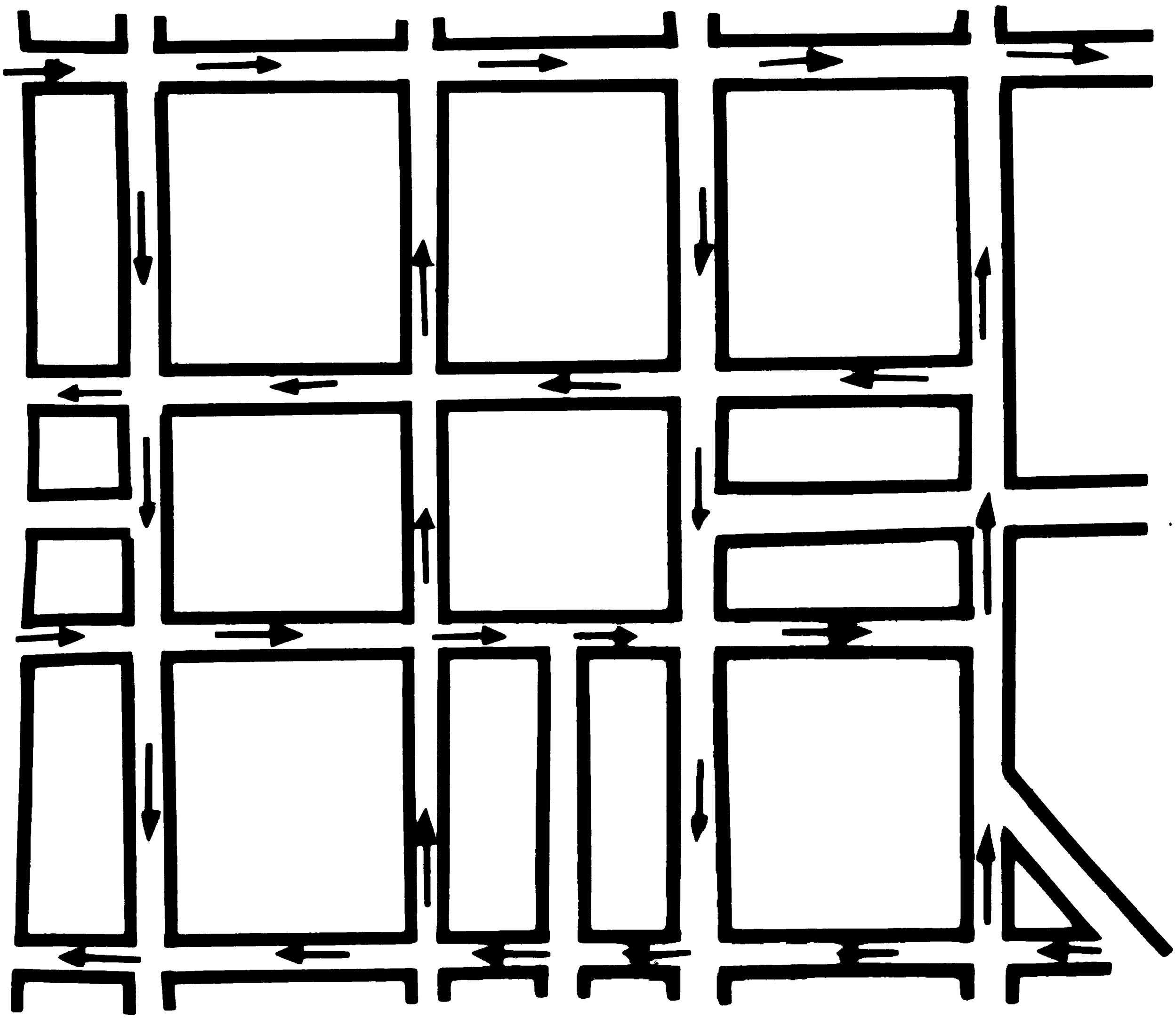
$$\frac{1{,}652 \times 340 \times 1{,}000{,}000}{1{,}000{,}000} = 562 \text{ Accidents on Rural M.L.S.}$$

In this case the area would have 17,270 accidents or a 20% reduction in the amount of accidents. Thus the safety factor has increased considerably. It is not possible to get a completely accurate picture of the safety effect that the M.L.S. has on an area. But because of the form of the system, and its clear resemblance to a parkway, the accident rate is going to be close to that of a limited access road.

One Way Pairs

The one-way pairs concept is a working instrument of traffic engineering. Its purpose is to move traffic swiftly from point to point and relieve congestion. The one-way pairs concept works on the principle of two streets running parallel to each other so that one street can be used to move traffic in one direction and the second street to move traffic in the opposite direction. This concept has been relatively successful in its implementation which is usually restricted to Central Business Districts. Its effectiveness is due to attempts to maintain constant flow by synchronizing traffic signals along the street at critical intersections. Networks of one-way pairs have been developed in attempts to create constant flow, and at the same time increase the amount of safety in navigating in heavy traffic, likely to be generated in Central Business Districts. A good example of the implementation of a one-way pairs network would be the Central Business District of Lansing, Michigan (Figure 11).

The system does pose an interesting concept, which has been transformed into the concept of the Modular Loop System.



THE ONE WAY PAIR SYSTEM CAN EASILY BE ESTABLISHED ON A GRID IRON PATTERN OF STREETS. PROBABLY WHY THE ONE PAIR CONCEPT HAS BEEN ADOPTED IN SO MANY CITIES. EVEN WITH TIMED SIGNALS FOR THROUGH MOVEMENTS BACK LOGGING CAN OCCUR CAUSING CONJESTION. DOES NOT ATTACK TURNING MOVEMENT OR THE CONFLICT OF THE PEDESTRIAN AND THE AUTOMOBILE.

FIGURE 11
ONE WAY PAIRS

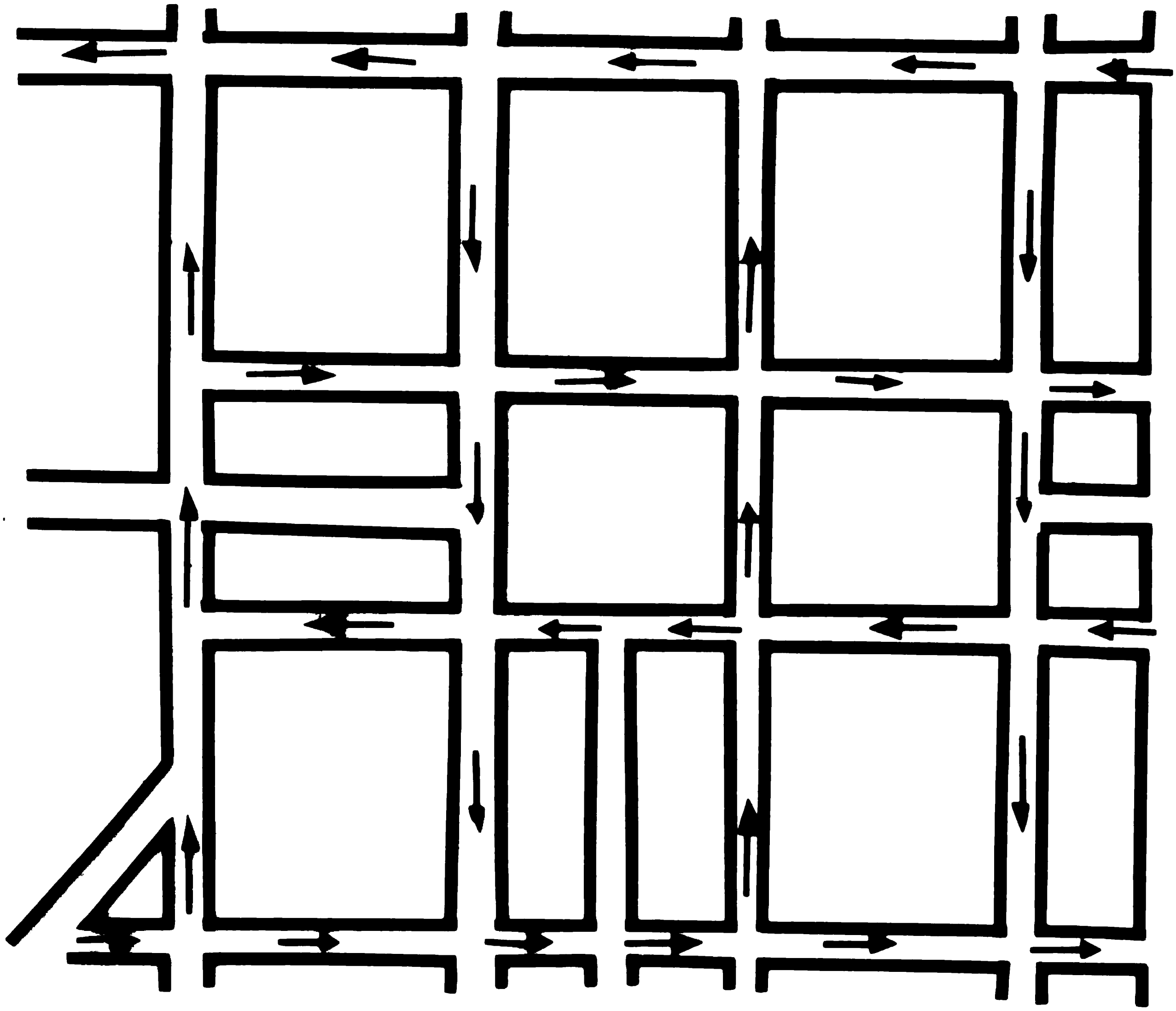


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FIGURE 11
ONE WAY PAIRS

However, two problems still plague the one-way pairs concept which do not appear in the Modular Loop System. While the pair network is more efficient than any two-way major artery it is still possible to create traffic congestion thus destroying the maximum efficiency of the automobile. Because the network runs on parallels, perpindicular streets have to be created. If the parallel streets run east and west, one-way pairs similar to those would have to be established in order to allow for north-south accessibility. When this is done traffic signals become necessary. Once traffic signals are implemented no matter how well synchronized, congestion is inevitable, especially at high use times such as peak hours in the morning and evening. The Loop System on the other hand, has no signals, thus traffic is allowed to flow freely at all times.

The one-way pairs network is equipped to bring people closer to their destination than the Loop System, because the Loop System is regionally oriented and the one-way pairs are locally oriented and enter directly into the downtown areas. They go from point a to point b while the Loop System goes around the area. However, built into the one-way pairs concept is a need for the streets to be in relatively close proximity. Because of this, the streets in the network become barriers and actually stifle interaction between the small islands of activity created by the network. The environmental areas denoted by the pairs network are limited in scope because of the barriers created by the corridors of

traffic. The function of the corridor is to bring goods and people to the activity centers. If the corridor becomes a deterent to the interaction of activities then it ceases to function as designed to. It is necessary to examine the interaction of activities occurring, then locate the arterial transportation in relation to those activities. The loop is designed to follow the path of least resistance. It goes around, rather than through congested areas like the Central Business District. By definition the function of the Loop System is to circle environmental areas and not to divide them. Thus, easy movement to the activity areas is achieved and at the same time the same time the desired activity is allowed to function in the proper fashion.

The Modular Loop System goes beyond the one-way pairs system by determining the proper sizes and shapes of the environmental areas and the relationship of the loops to the activities involved. It also brings forth a concept of one-way links on a regional level. That is to say not only densely populated or high traffic volume areas but rural fringe areas as well are involved in the network.

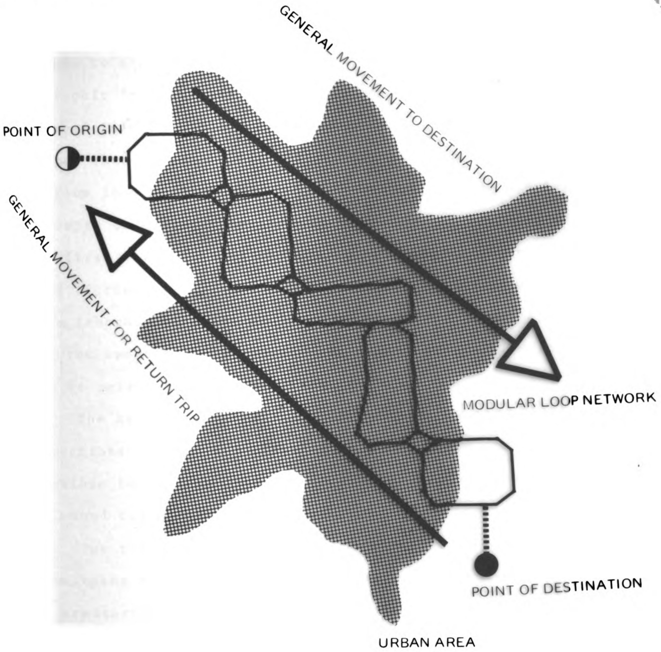
The reasons for developing the Loop System in these areas are simple. First, accident reports show that a large number of injuries and fatal accidents happen on rural, two-way corridors and trunklines. If the Modular Loop System is implemented in the rural fringe areas, it is conceivable that the number of accidents will decrease as shown previously.

The second reason involves one of the main objectives in developing the Modular Loop System and that is intermediate trips. The rural fringe areas would have to be included in any system that is concerned in upgrading and isolating intermediate trips. The movement from one section of a region passing through the urbanized area to a point on the other side is considered to be an intermediate trip (Figure 12).

The third reason is that by developing the system into the surrounding areas, access to any satellite community is increased. Because of the limited access of the Loop System, development along the Loop System can be checked, thus creating a network of movement throughout a region without encouraging commercial expansion, but increasing the opportunities of satellite communities to grow. At the same time this increases convenience of movement and accessibility to all parts of the region.

The direction of the one-way loops will generally be determined by desire lines. That is to say the directional flow along any link in the Loop System will be determined by the amount of traffic which is attracted in one particular direction. This can be done through the use of a computer which will plot the points to which people have a desire or reason for going. These points are invariably the major attractors such as shopping centers, employment centers, and the Central Business District, which have been discussed previously. Desire lines show where people want to go in an

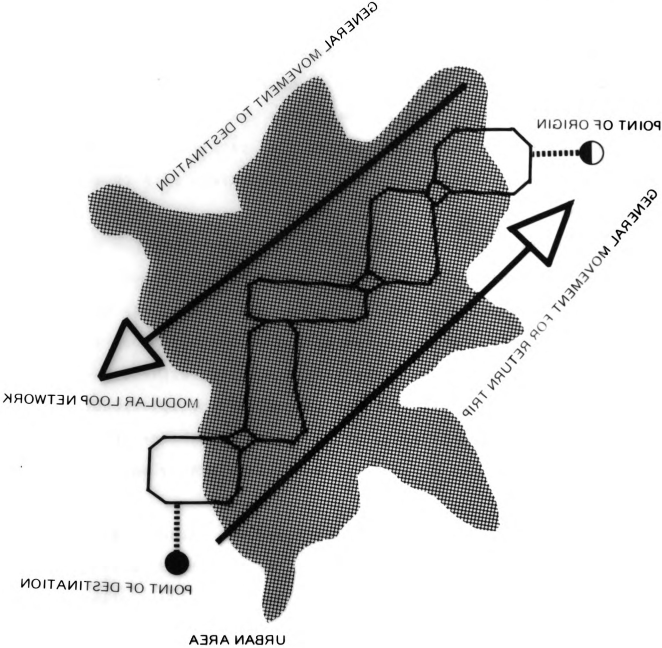
THOSE TRIPS OF A REGIONAL
NATURE ARE INTERMEDIATE
LENGTH TRIPS



THE LOOP SYSTEM ALLOWS TRIPS TO PASS THROUGH THE URBAN AREA
QUICKLY AND CONVENIENTLY

FIGURE 12
INTERMEDIATE TRIPS

THOSE TRIPS OF A REGIONAL
NATURE ARE INTERMEDIATE
LENGTH TRIPS



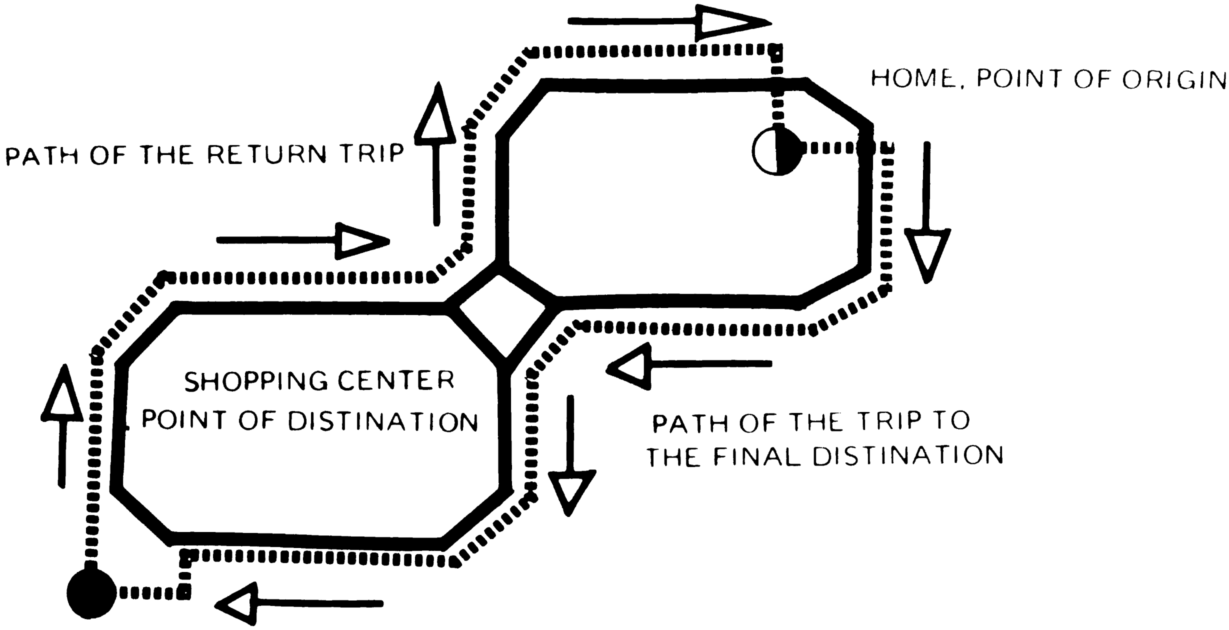
THE LOOP SYSTEM ALLOWS TRIPS TO PASS THROUGH THE URBAN AREA
QUICKLY AND CONVENIENTLY

FIGURE 12
INTERMEDIATE TRIPS

urban area. By the same token, people once achieving the desired point of interest, have an equally strong desire to return to their place of origin. Thus the desire line becomes difficult for they are established in two directions, A to B where A is origin and B is the attractor and then the return trip. This poses a difficult problem for a one-way directional flow loop system. However, the design of the Loop System attempts to combat this problem in one or all of three ways. The first way is that a given loop is designed so that the bulk of the living areas within the loop are equidistant from inbound and outbound links of the loop. Thus, by choosing the appropriate entrances and exits the travel distance can be relatively the same (Figure 13).

The second way is for the Loop System to run in opposite directions as they leave the urban area. Thus, it may be possible to use one loop for inbound travel and another for outbound travel (Figure 14).

The third way would be an increase on the speed. By developing the Loop System such that vehicles are able to go at greater speeds and able to maintain that speed for greater distances the actual time would remain the same or decrease, even if the travel distance may increase. In a general overview the desire to go to a major attractor is dominant, thus this movement is probably the most direct in the urban area and if there is any distortion in distance traveled it would most likely occur on the return trip home.



BECAUSE OF THE LOCATION OF POINT OR ORIGIN IT WAS POSSIBLE TO GO DIRECTLY TO THE DISTINATION POINT ON ONE LEG OF THE MODULAR LOOP SYSTEM

FIGURE 13
MODULAR LOOP MOVEMENT

BECAUSE OF THE LOCATION OF THE POINT OF ORIGIN TWO LEG OF THE LOOP NETWORK WERE NEEDED TO COMPLETE THE TRIP IN THE SHORTEST DISTANCE

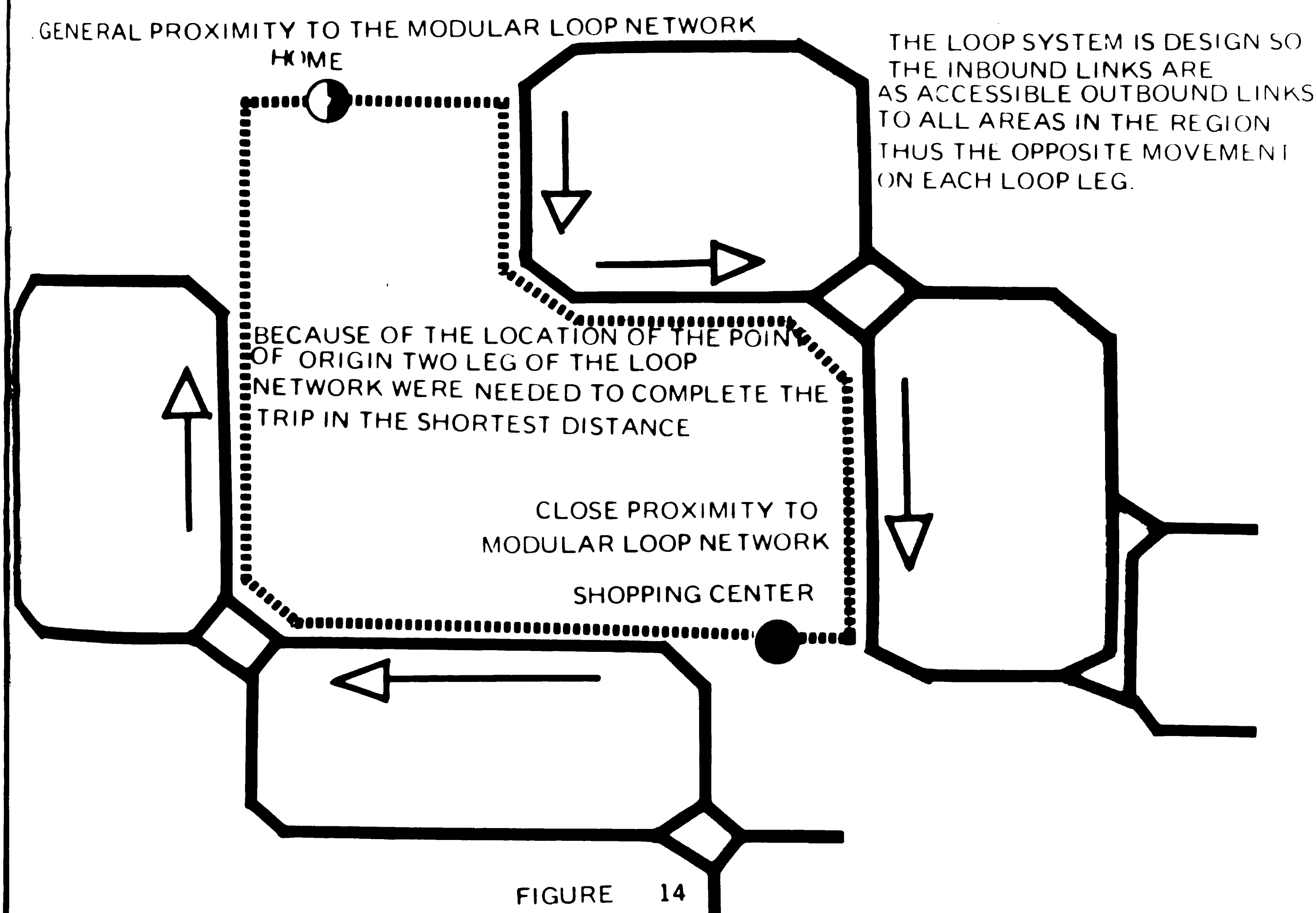
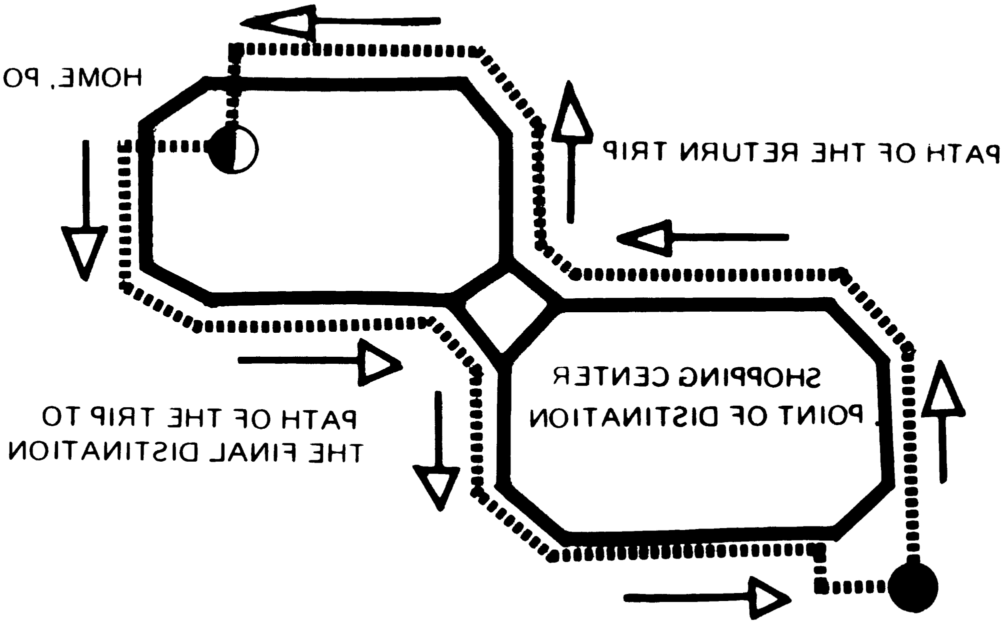


FIGURE 14
MODULAR LOOP MOVEMENT



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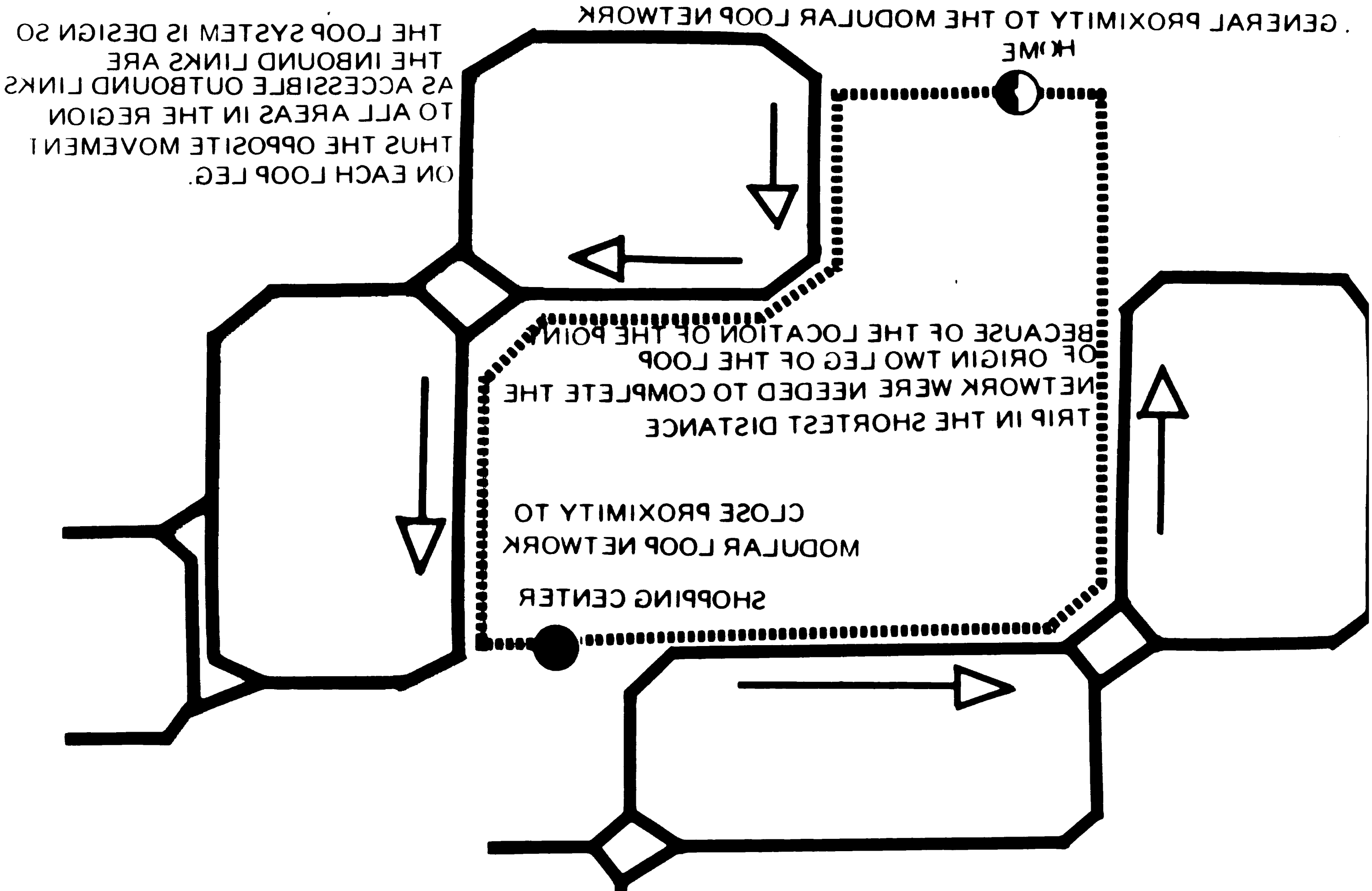


FIGURE 14
MODULAR LOOP MOVEMENT

Speed

The increase in speed on the Modular Loop System is not only an attempt to reduce the amount of time it takes for a vehicle to reach its destination. Also, the increase in speed is seen as an instrument for depressing the number of vehicles on the appropriate link types given the trip length and the desired destination. The faster one travels on the loop, the less time one must spend on the loop. The time saved becomes a by-product of the system and to some extent is seen as a benefit to some drivers.

The most important purpose of the increase in speed is tommove the appropriate length trips at a constant rate throughout the urban area. The speed on the Loop System is justifiable because of the way the Loop System is set up as sighted previously. However, in terms of convenience and accessibility, time saved does become a factor and as long as the conditions allow an increase in speed without jeopardizing safety, then time saved does in fact become a valid by-product of the Loop System. Consider a typical urban area that has an average speed of 40 miles per hour. (For an intense urban area this speed is quite high but for simplicity it will be used.) An average speed of 50 m.p.h. can be used on the Loop System. A table can be set up showing the direct relationship of the two speeds given the number of miles traveled, and produce the output of time saved.

TABLE 5

TIME SAVED
(Distance/Speed)

MILES TRAVELED	40 m.p.h.	50 m.p.h.	TIME SAVED
5	7 1/2 min.	6 min.	1 1/2 min.
10	15 min.	12 min.	3 min.
20	30 min.	24 min.	6 min.
30	45 min.	36 min.	9 min.
40	60 min.	48 min.	12 min.
50	75 min.	60 min.	15 min.

The table simply illustrates what was known all along and that is that there is a significant 20% decrease in the amount of time spent in transporting from place to place. But in fact the loop is not on all streets and the loop system does not take all the vehicle miles traveled in the network, only a portion. By putting this increase in speed into a theoretical network, the time saved becomes valid.

TABLE 6

AMOUNT OF TIME SPENT ON THE NETWORK
Network In (000)

10,000 Vehicle Miles Traveled

5,000 Expressway	55 m.p.h. due to over-capacity
5,000 non-Expressway	35 m.p.h.

TABLE 6 (Cont'd.)

AMOUNT OF TIME SPENT ON THE NETWORK
Input Loop System

10,000 Vehicle Miles Traveled

4,500	Expressway	55 m.p.h.
3,000	non-Expressway	35 m.p.h.
2,500	Loop System	50 m.p.h.

DISTANCE x SPEED = TIME

NETWORK					
Expressway	5,000	55	=	91.0	
non-Expressway	5,000	35	=	147.0	
LOOP SYSTEM				238.0	Hours
Expressway	4,500	55	=	80.0	
non-Expressway	3,000	35	=	86.0	
Loop System	2,500	50	-	50.0	
				216.0	Hours

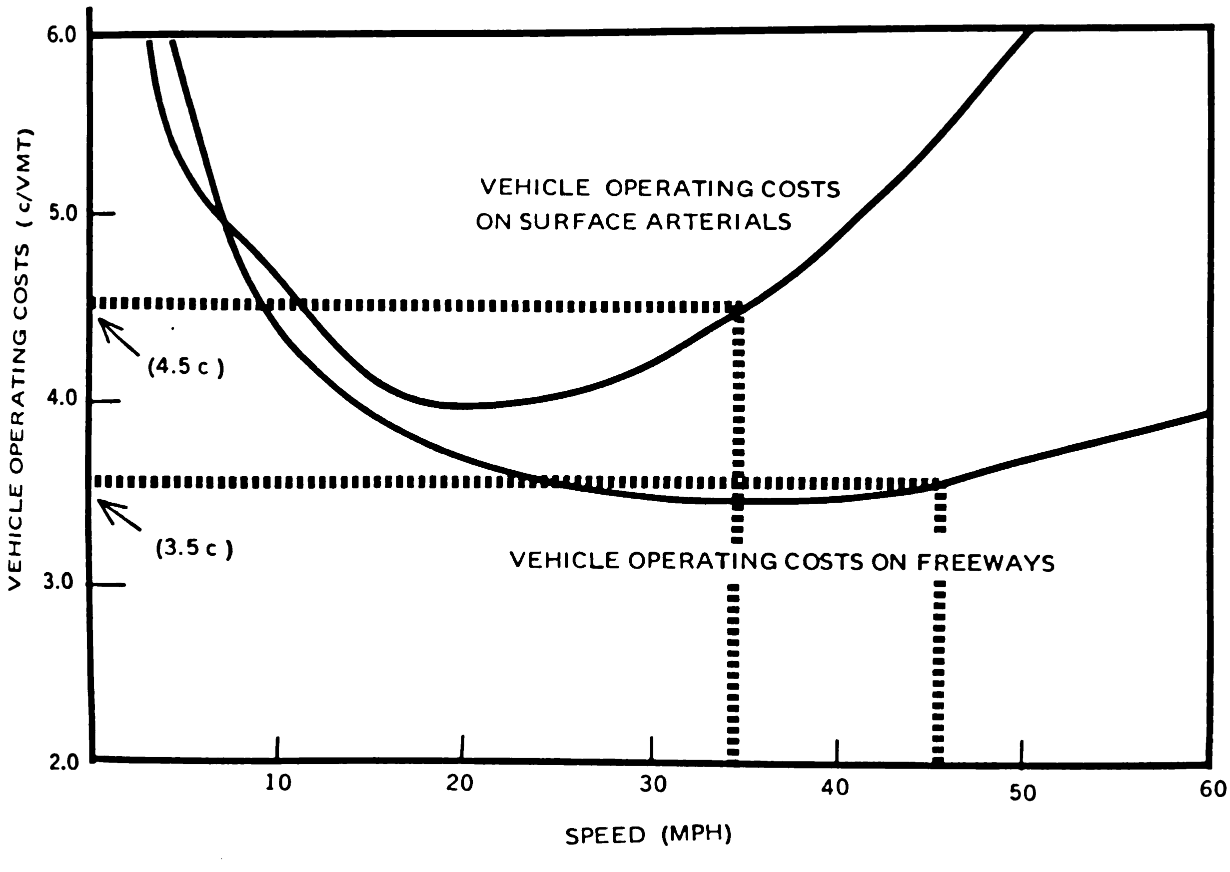
22 Hour Difference 9% Decrease in Time

This tabulation indicates a 9% overall savings in time by developing the Loop System. To carry this further, take x amount of vehicle miles traveled on the congested links of the network and put these on their proper link types throughout the network. Speed is therefore going to increase on all links and induce a percentage of decrease in time. Thus an overall decrease could possibly exceed 10%.

Not only is this beneficial in convenience and accessibility but operating costs are actually reduced because the automobile is running a shorter amount of time at more efficient speeds.

TABLE 7

OPERATING COSTS



Network Arterials	4.5¢ x 2,700,000 (V.M.T.) =	$121,500.00 Daily
Change to Modular Loop System		
	3.5¢ x 2,700,000 (V.M.T.) =	$ 94,500.00
		$ 27,000.00

$27,000.00 Reduction in Daily Operating Cost
2,700,000 = The V.M.T. Affected by the Modular Loop System.

It has been shown that the Modular Loop System is considerably safer than major arterials and collectors. However, increased speed has certain effects on the driver. These are:

1. Concentration increases
2. The point of concentration receded
3. Peripheral vision is diminished
4. Foreground detail fades increasingly
5. Space perception becomes impaired[1]

Most of these reactions can be combatted because the Loop System is of a limited access design. The reduction in the point of concentration could create a negative effect. The Loop System has all the attributes of a limited access link, or expressway, except one and that is the open, straight construction of the expressway. The expressway goes from point to point. The actual focal distance changes at different speeds of travel. For example, traveling at a speed of 20 m.p.h. the focal point is a little less than 500 feet while traveling at 50 m.p.h. the focal distance of the driver is about 1,500 feet.[2]

The size of the loops on the system varies according to the intensity of activity in the area. Loops in the CBD, for

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[1] Planning for Man and Motor, Paul Ritter, The Macmillan Company, New York, 1964, p. 58.
[2] Planning for Man and Motor, Paul Ritter, The Macmillan Company, New York, 1964, p. 14.

example, where there are many attractors and high density traffic are considerably smaller than those on the rural fringes. There will also be more lanes in the CBD loop to handle the entrances and exits of vehicles from the loop. Speeds should vary according to the size of the loop, the visual range of the driver, and the amount of volume on the loop. In the CBD the speed on the loops is 35 m.p.h. due to high volume on the link as well as activity occurring in close proximity to the driver, and the negotiation of smaller loops is required. Here the focal point of the driver will be about 700 feet and he is able to negotiate turning movements on the loops. As the loops become larger and traffic is dispersed and intense activity diminishes, the speed will increase to 45 m.p.h. with a focal distance of approximately 1,200 feet. Finally, speeds at the rural fringe will be 55 m.p.h. with a focal distance of 1,600 feet. This might vary according to amounts of volume and activity occurring in different sections of the urbanized area but this will remain the general speed hierarchy.

C. FORM OF THE MODULAR LOOP SYSTEM

Thus far we have discussed the goals of the Modular Loop System and the desired functioning on the links of the system. Now the superimposition of the system onto the physical network must be considered. In this section the pattern of the Modular Loop System will be mapped out and the reason for placement will be discussed.

A direct result of superimposing the concept of the Modular Loop System onto the physical network established by any existing urban region is the division of the area into very pronounced segments. Each of these segments should be considered in terms of its relation to the region and to the environment created within each of the segments.

This chapter is concerned with the physical development of the Loop System and the ramifications on the human and natural environment which may occur if the Modular Loop System is implemented.

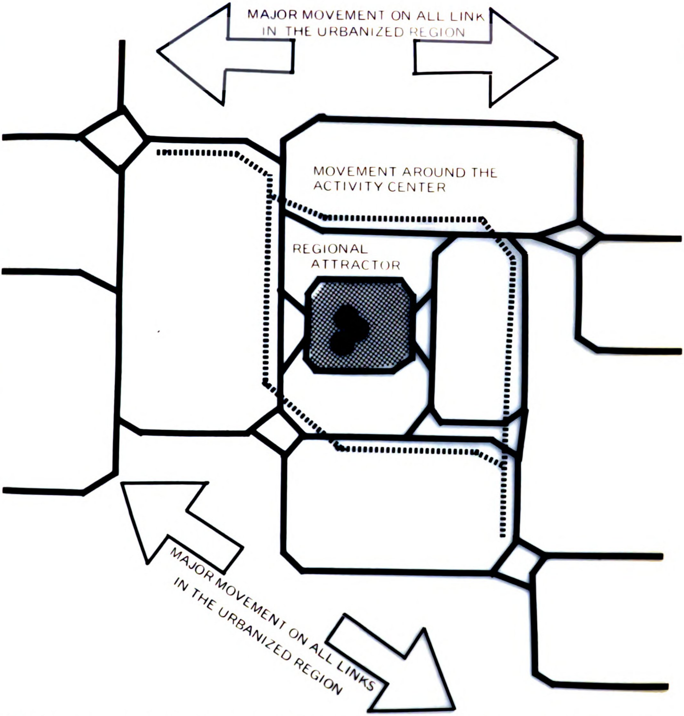
The physical placement of the Modular Loop System on any existing network is a product of the desired movement and goals of the system. Each network must be considered in terms of its major attractors. These attractors should be pinpointed and defined in terms of their contribution to traffic on the network. If it is a shopping center it will contribute shoppers and employees and an industrial complex will draw employees who will use the Loop System to go to and from work.

To be effective, the Modular Loop System must carry automobiles on the path they desire or as close to the desire lines as possible. These desire lines are derived from the origin and destination studies explained previously. They are plotted in a straight line in the basic direction desired. This can be a very helpful tool in determining the location of the loop in the system and the direction of the flow of traffic.

The existing roadways must also be examined, so a pattern of one-way loops can be established. No traffic lights will be used on the system. This eliminates any possibility of congestion at any point on the system. Traffic may be slowed down due to the volume of traffic using the system at any one point but stopping at an intersection will not occur, thus avoiding a back up of traffic.

Special design work becomes necessary at major attractor points on the network. At these focal points, separating "through traffic" from traffic headed for the focal points is necessary. This would be done by creating a secondary loop which would service this area having the number of access points necessary while maintaining a limited number of access points on the regional loop system. An area which would generate enough traffic to warrant this secondary loop would be a Central Business District, a satellite town, a major regional commercial complex that is not housed in one unit, or an employment center which has a large number of entrance points for the employees. This formulation of the pattern of the links involved in the Modular Loop System can most effectively be portrayed graphically (Figure 15).

For the most part, the M.L.S. was designed to use existing streets. For this reason a survey of the street network should be developed. Knowing the types of links on the network and approximate location a logical network of links can be established to function as the roadway for the M.L.S. The term link refers to a segment of roadway in a network. These



THE MODULAR LOOP SYSTEM IS DESIGN FOR CLOSE PROXIMITY TO REGIONAL ATTRACTION CENTERS, BUT AT THE SAME TIME TRAFFIC IS ABLE BY PASS ANY PARTICULAR REGIONAL ACTIVITY POINT TO AVOID CONJESTION.

FIGURE 15
REGIONAL ATTRACTORS

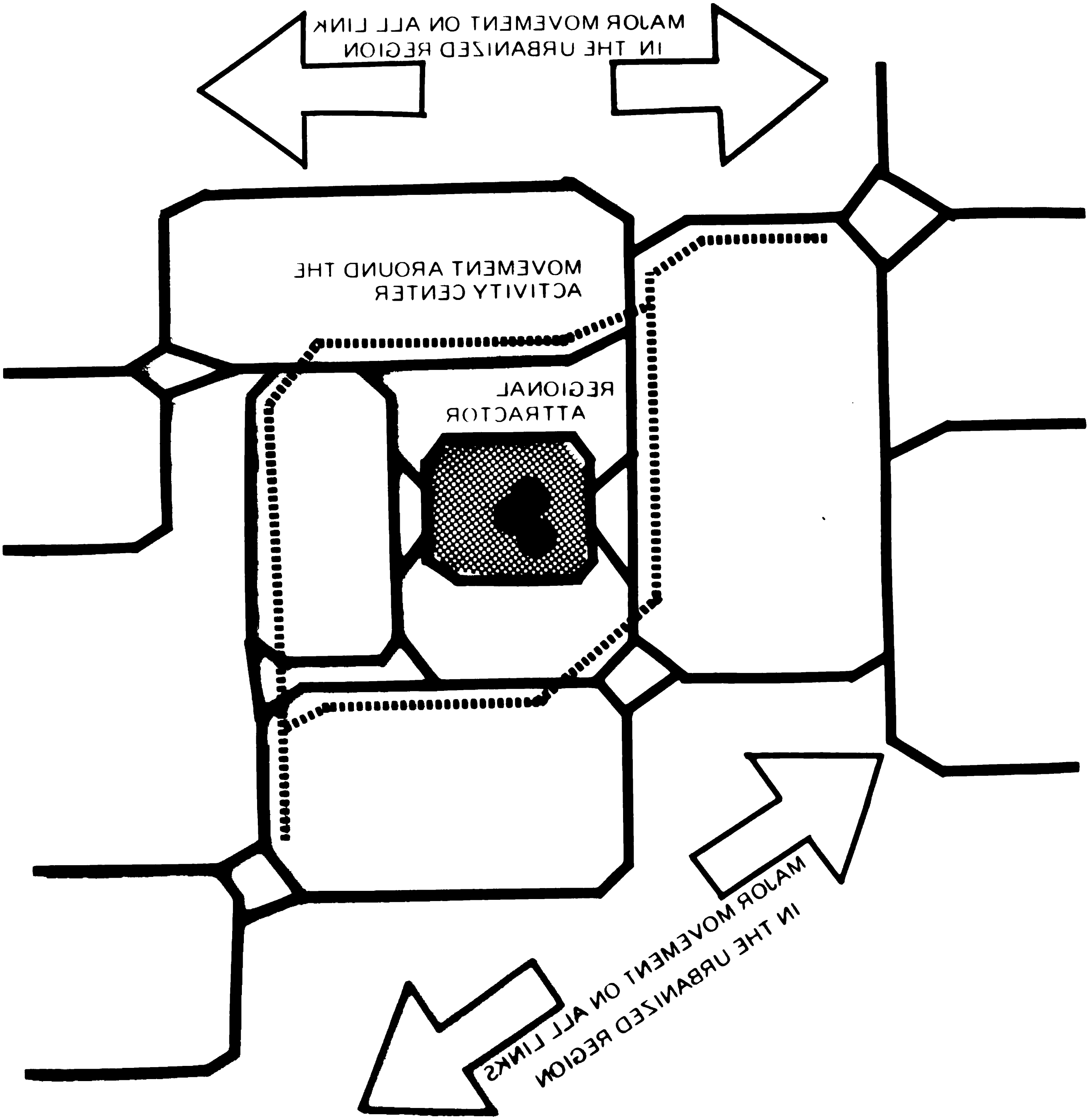


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FIGURE 15
REGIONAL ATTRACTORS

links can vary from being local streets 24 feet in width to streets 48 feet wide and wider such as major arterials.

Ideally, the M.L.S. would operate on higher type links, those links which are already four lanes (48 feet) wide. The major arterials are the main circulator roads for any region. Minor arterials are still regionally oriented roadways but with secondary status. The reason for using these arteries is simple. First, if an existing major artery is four lanes wide, that is the appropriate size of the link on the loop for the conceivable amount of traffic on the system. Second, because the four lane arteries are the appropriate size and in the proper location, construction costs would be greatly reduced. This need not be true. The width and the number of lanes on the links will vary as needed by the traffic. Generally, four lane arterials going one way at 50 m.p.h. have the capacity for 32,190 automobiles daily which is large enough for most links on any network.

Construction costs would quite conceivably be reduced to simply the cost of resurfacing and the cost of widening or right of way acquisition. The final reason for developing the Loop System on existing arteries is a lessening of the impact on the environment. Because of their nature, four lane arteries create very real boundaries for neighborhoods. If the Modular Loop System were superimposed on these corridors, the effect would be to make the boundary stronger but without destroying or chopping up existing neighborhoods. With the concept of limited access to the Modular Loop System, uses are going to have to be re-oriented or bought out. Either may require substantial capital. If there are no arteries available, that is to say there are no arteries in close proximity to the logical path for the loop to follow, then secondary roadways become necessary. These secondary roadways would be minor arteries or collectors. By developing the Modular Loop System on secondary roadways it becomes necessary to widen the corridor in order to reach a desirable capacity of the link for potential volume. This is obviously more expensive than merely resurfacing but still relatively inexpensive when compared to the cost of constructing new road links.

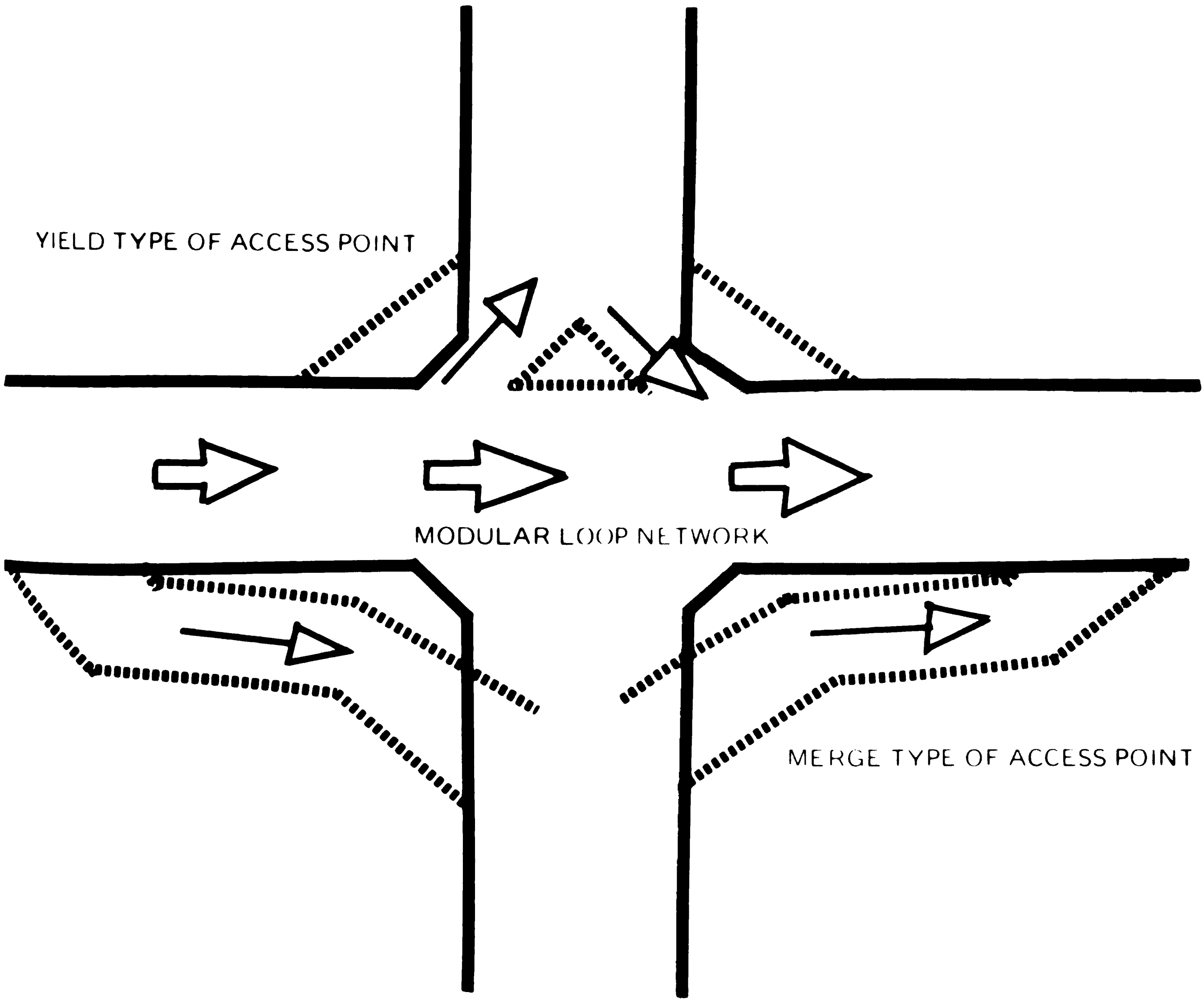
A possible additional cost might occur in acquiring additional rights of way in widening the road. This possibility is related directly to the urban area that the Modular Loop System is implemented in. For the right of way varies for each link in any network. Thus it is possible to encounter corridors of 50 feet, 60 feet, or 100 feet in width of right of way. Most likely the right of way will have to be acquired along commercial strip developments and at access points to the loop system. Along the commercial strip, service roads will most likely be needed to maintain the character and function of commercial enterprise in these areas. The second area in which right of way is important is at access points to the loop itself. Because of the nature of the Loop System and its goal of constant circulation, intersection of the perpindicular form are impossible; thus, as turning movement onto and off of, is necessary and at interchanges these movements must be accelerated. These entrances and exits need not be of the ramp type used for expressways but some gradual movement is needed in changing from one link type to another (Figure 16). Thus, acquisition of right of way becomes necessary for the interchange points of the Modular Loop System.

Access to the Modular Loop System should be limited. By limiting the number of access points, local trips or short trips are discouraged from using the system. By determining these short or local trips the Modular Loop System is able to function more efficiently with less chance of congestion. The access points will be determined in a regional perspective. The Modular Loop System was designed as a region-wide circulation system, thus access points should correspond to those points which are desirable on a regional basis. These access points would be in the CBD, major employment centers and major commercial centers. While it is not possible to completely eliminate the unwanted trips on the system, by the proper placement of the access points a large volume of traffic can be discouraged from using the Modular Loop System. While it is desirable to deter certain trips from the Modular Loop System, short trips must not be obstructed from their destinations. This is done by developing overpasses at critical points to allow short trips to pass through boundaries created by the Loop System.

By limiting the number of access points to the Loop System the system itself becomes safer, for the simple reason that there will be less merging points resulting in less obstacles for the driver on the system to contend with. This

IT IS POSSIBLE TO HAVE A YIELD EXIT AND ENTRANCE AT ONE POINT WHERE IT IS NOT AS LIKELY THAT MERGE EXIT AND ENTRANCE WILL OCCUR AT THE SAME ACCESS POINT

THE YIELD TYPE OF ACCESS POINT IS USE WERE CONJESTION IS LOW A DRIVING IS NOT AS CRITICAL



THE MERGE TYPE OF ACCESS POINT IS MOST COMMON IN CONJESTED AREA GIVE BOTH THE DRIVER ON THE NETWORK AND THE DRIVER ATTEMPING TO ENTER TIME TO REACT. THIS WOULD WORN IN REVERSE FOR A DRIVER EXITING ON A MERGE TYPE OF ACCESS POINT.

FIGURE 16

ACCESS POINTS TO THE MODULAR LOOP SYSTEM

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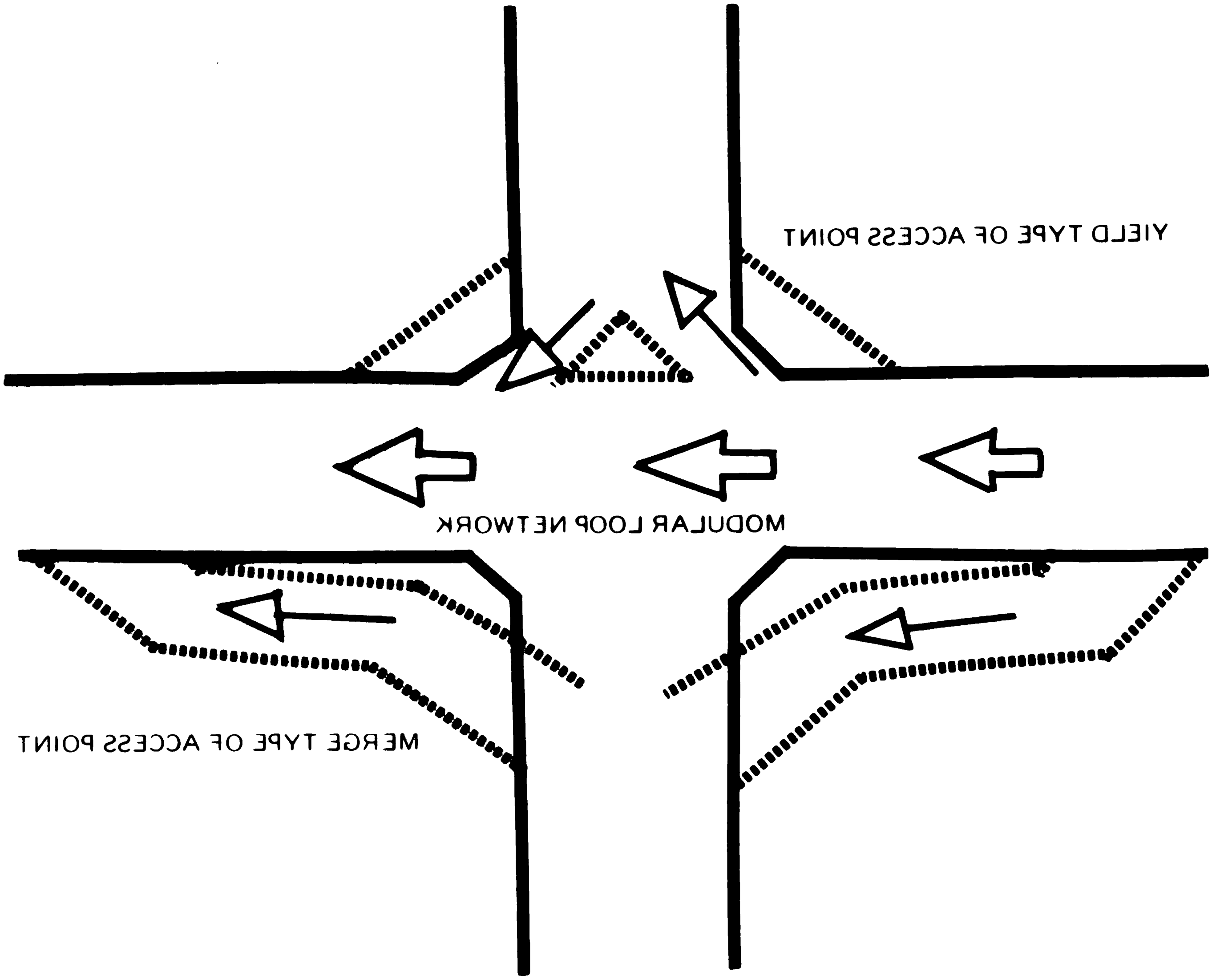

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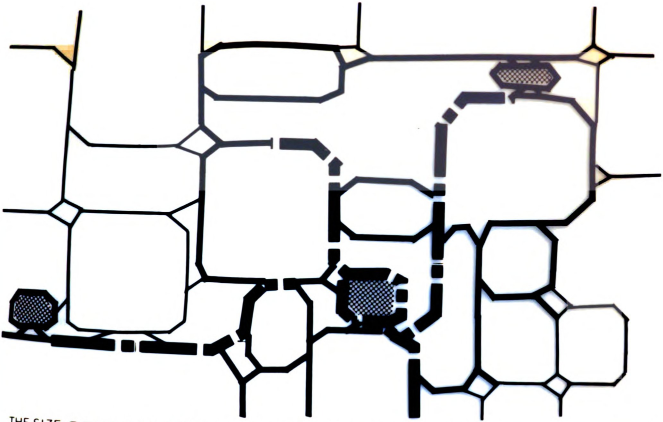
FIGURE 16
ACCESS POINTS TO THE MODULAR LOOP SYSTEM

will also result in some streets having to be closed from access to the Loop System. Because of the desired small number of access points and the small number of connector streets over the Modular Loop System, a great deal of the streets in the network will be closed to contact with the system. The blocking of the street will be determined by its value in the circulation pattern for the urban region. If the street is valuable in terms of the regional perspective then access from the loop system will be allowed, if not, access will be blocked. If the street is significant in local circulation it would probably expand the Modular Loop System. If neither of these is the case, then the street will probably be included in the circulation system as a neighborhood street. Traffic flows, O-D studies, desire lines and traffic assignments determine these.

The capacity of the Modular Loop System will obviously vary. The larger the congestion and volume of traffic the wider the link of the system (Figure 17). The capacity of the system will be considerably different on the urban fringe than in the CBD. However, for simplicity's sake a relatively conservative capacity was used so that when the theory was tested on the model of Genesee County the link type could be discerned from the rest of the network. At the same time, given a base capacity, a relationship evolves between the limits of the link in terms of physical restrictions, and actual volumes attracted to the loop. Base capacity was established by the number of lanes on the link. For the Loop



THE SIZE OF THE LINKS WILL VARY ACCORDING TO THOSE AREAS OF THE REGION WHICH HAVE HIGH TRAFFIC VOLUMES.

MAJOR LINKS IN THE NETWORK - THE NUMBER LANES USED WILL VARY WITH ACCORDING TO THE TRAFFIC ASSIGNMENT.

TYPICAL LINK - THE TYPICAL LINK FOR THE MODULAR LOOP NETWORK IS FOUR LANE (48' - 0'') IN WIDTH - WITH A CAPACITY OF 32,190 AUTOMOBILES DAILY.

MINOR LINK - THE SMALLEST LINK IN THE MODULAR LOOP SYSTEM WHICH WILL OCCUR IN LOW VOLUME, LOW DESIRE AREAS, THE WIDTH OF THE 30' - 0'' 2½ LANES

FIGURE 17
LINK TYPE

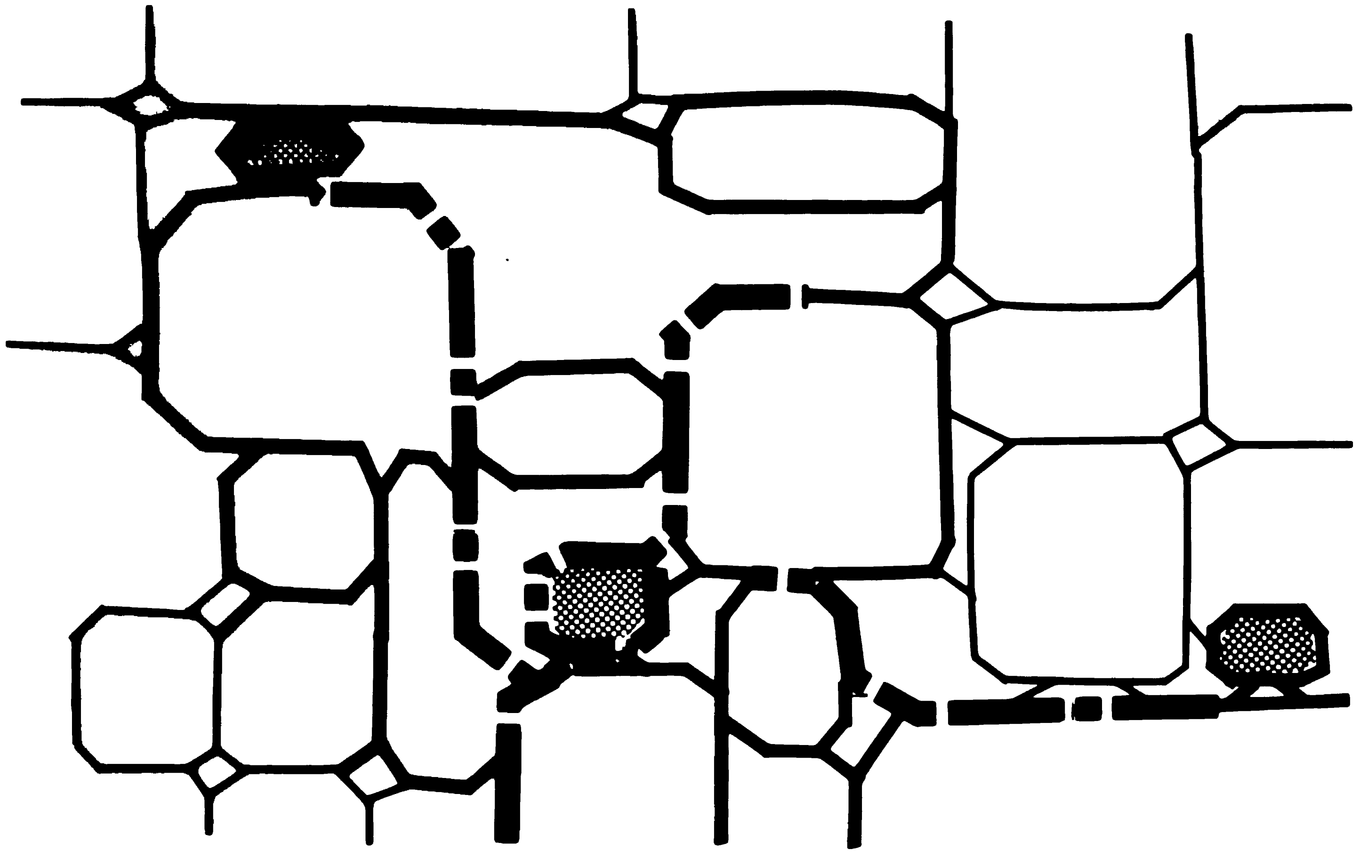


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FIGURE 17
LINK TYPE

System a base of four lanes was used, moving in one direction at a speed of 40.m.p.h. Each lane was figured as 12 feet wide. These base figures resulted in a conservative capacity of 32,900 vehicles per day. Obviously some major arteries have more than four lanes and the speeds are higher but this figure does serve as a basis for formulating the capacity of the Loop System in relation to the existing network.

Again, construction costs are going to vary given each project. But there are some figures that will aid in determining the cost of implementing the Modular Loop System (Table 8).

The effect of implementation of the Modular Loop System on the environment of the region must be considered. Given that the Loop System is a regional circulation network the problem arises of developing the system without having detrimental effects on the environment.

There are two good tests for these effects on the environment; these are noise and air pollution standards. Noise pollution is discussed in terms of decibles. The noise factor of an automobile going by is about 60 decibles. For the massive scale of traffic on any one link of the system, the noise would be considerable. However, by developing the Loop System along predominately commercial streets the effect on residential areas is restricted. By developing the Loop System, traffic is drawn away from local streets thus lessening the pollution effect on the majority of the environmental areas formed by the links of the Loop System.

TABLE 8

CONSTRUCTION COSTS PER MILE
(in $1,000's)

NOTE: These are average prices per mile. If unusual conditions exist, adjust accordingly.

TYPE OF CONSTRUCTION	AMOUNT	
Widen and Resurface to 24'	$ 130	
Widen to 5 lanes	500	
Widen to 6 lanes	600	
Widen to 6 lanes divided	650	
Reconstruct to 24'	290	
Reconstruct to 5 lanes	650	
8 lanes divided	1200	
Widen to 48', Resurface and C & G	400	
Widen to 5 lanes with C & G	650	
Widen to 7 lanes with C & G	900	
48' Pavement with C & G	600	
Reconstruct to 5 lanes with C & G	750	
Reconstruct to 7 lanes with C & G	1000	
2 Lanes @ 24' with C & G	775	
2 Lanes @ 36' with C & G	999	
2 Lanes @ 48' with C & G	1250	
Freeway 2 lanes @ 24' Rural with Struct.	1150	
Freeway 2 lanes @ 36' Rural with Struct.	1450	
Freeway 2 lanes @ 24' with Structures Urban	2000	not depressed
Freeway depressed 2 lanes @ 36'	4100	w/out Ser. Rds.
Freeway depressed 2 lanes @ 48'	4900	
Freeway depressed 2 lanes @ 60'	5700	
Rest Area	400	
Dual-Dual 4 lanes @ 36' depressed	13100	Inc. Sewer
Freeway interchange, Rural with Freeway	1900	
Freeway interchange, rural	1100	
Urban Interchange (2 depressed freeways)	25000	
66" Tunnel Sewer	628	
72" Tunnel Sewer	675	
90" Tunnel Sewer	1050	
96" Tunnel Sewer	1268	
102" Tunnel Sewer	1400	
Freeway lane widening with interchanges	950	
Freeway lane widening (no Int. imp.)	340	
Dual-Dual Surfacing	700	
5 lane depressed surfacing	625	
2 lane rural freeway surfacing	250	
Railroad Bridge	80 /sq. ft.	
River Bridge	40 /sq. ft.	
Under or Overpass (Urban)	35 /sq. ft.	
Under or Overpass (Rural)	25 /sq. ft.	
Urban Service Rds., Utilities and Struc.	5000	
Urban Service Rds., Utilities (No struc.)	2200-3000	
Urban Depr. R.O.W.	3500	Dual-Dual 6,000
Freeway Bit. Shoulders	32	

Air pollution is also reduced in the areas formed by the Modular Loop System as more traffic is concentrated at the periphery on the links of the system. Consider the three major emissions from the automobile; monoxide pollutants, nitro-carbon pollutants, and nitro-oxide pollutants. Of these monoxide and nitro-carbon have direct relationship to the efficient use of the automobile. Given a car running at an average speed of 25 m.p.h. the pollutant emissions from this car are considerably greater than those of a car running at a speed of 50 m.p.h. Thus what is taken into account is the acceleration and deceleration relating to a constant speed such as 25 m.p.h. For acceleration, idling and deceleration are where pollutants escape on a large scale. If it is possible to drive at a constant relatively efficient speed, pollution emissions of monoxide and hydro-carbon will be reduced. Nitrogen, on the other hand, is emitted in direct relation to the number of vehicle miles traveled on any network. Thus it seems logical to assume that nitrogen pollutants will increase given the nature of the Modular Loop System.

The Modular Loop System can function as a tool in establishing further land use that can reduce negative impact on the environment. Because of the nature of the system limited access is desirable. If appropriate use was made of pinpointing desirable land use for certain portions of the region by having a circulation system similar to the Modular Loop System, growth in these areas would be assured. By opening only those areas to access to the Modular Loop System, this can be achieved.

Here the system could be used as a tool for insuring desirable land use and if the appropriate government body uses this tool wisely a pattern of desirable land use with little impact on the environment could occur. Because of the limited access to the system cities can develop entrances where they see fit, because they construct the roads.

The areas bounded by the Modular Loop System will create types of environments for each area. The environment in each area will be determined by the land use functions in the area. The areas are "the rooms of the town; they are the areas or groups of buildings and other development in which daily life is carried on, and where, as a consequence, it is logical that a good environment is of great importance"[3]. The sizes of the areas will vary according to the function and the land use in the area and the placement of the logical routes for the Modular Loop System. The regional circulation pattern should be of prime importance but not at the cost of a viable functional environment.

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[3] Traffic in Towns, Her Majestys Stationary Office, London, 1963, p. 44.

CHAPTER III

SIMULATION

TESTING OF THE MODULAR LOOP SYSTEM

CHAPTER III

SIMULATION

TESTING OF THE MODULAR LOOP SYSTEM

To determine the validity of any proposed alternative network, that network must be tested. In urban transportation planning, simulation is the dominant procedure of testing and evaluating proposed alternatives. This simulation is produced through computer models which simulate situations in the future for any locale. This is done by inventorying the existing situation in the areas of land use, traffic movements, actual traffic counts, population, dwelling units and employment data. This is then forecast for some point in the future. To maintain their accuracy and efficiency these models are constantly updated.

The Michigan Department of State Highways provided the resources necessary for testing the Modular Loop System alternative network. The Modular Loop System was superimposed on the existing network and a committed network for the city of Flint, Michigan and Genesee County. An existing plus committed (E+C) network is what the street system looks like at the present time, and in addition any improvements to the street system which have been approved for future construction. An example of this would be the construction of I-475 in Flint. This construction has been approved and despite the fact that it has not yet been completed, it must appear in the model. Once the alternative has been imposed on the E+C network, projected traffic volumes are assigned to it. Once this has been accomplished a comparison can be established between the alternative and the E+C network, thus presenting how the alternative effects the future traffic patterns.

All of the figures used for the E+C network for Genesee County are computer printouts of data compiled through the simulation modeling process by the Michigan Department of State Highways and Transportation. This is true for the proposed alternative network, the Modular Loop System, as well. All of the comparisons and evaluations of the Modular Loop System network were formulated through procedures and tests by which the Michigan Department of State Highways and Transportation evaluates proposed network alternatives.

A. BACKGROUND

Genesee County is located in the mid-eastern portion of the State of Michigan. The population of Genesee County is primarily situated in the urban area surrounding the city of Flint. The projected land use configuration in the 1990 Land Use-Transportation Plan can be characterized as a controlled trend type of plan. At present industrial and other high density uses are located in close proximity to high level transportation facilities. "The high density policy is an extension of existing, market induced patterns of location in the area"[1]. The impact of this type of land use allocation on the freeway system and major arterials through traffic forecasts is represented by serious capacity deficiencies (see Figures 18 and 19). Any highway oriented solution to the projected demands would have to meet two criteria in order to provide the necessary relief.

1. New facilities must be of a functional class sufficient to provide a viable alternative to the congested freeways.

2. The new facility must be located in close proximity to the high intensity generators served by the congested facilities in order to relieve the congestion.[2]

From this, one must logically conclude that the optimum solution in terms of further highway construction would have to be adjacent to, above, or below the existing freeways. Locations even one or two miles away provide far less benefits for the costs incurred. Because of the restrictions regarding location for highway oriented relief, and the unrealistic costs that would be incurred in the acquisition of the land which is optimum, other solutions must be explored.

To date, two other alternative street networks have been tested. The first involved increased capacity of various major arterials by increasing the number of lanes available on that particular link in the network. By doing this no significant decrease in congestion was obtained. The expense was about $38,000,000.

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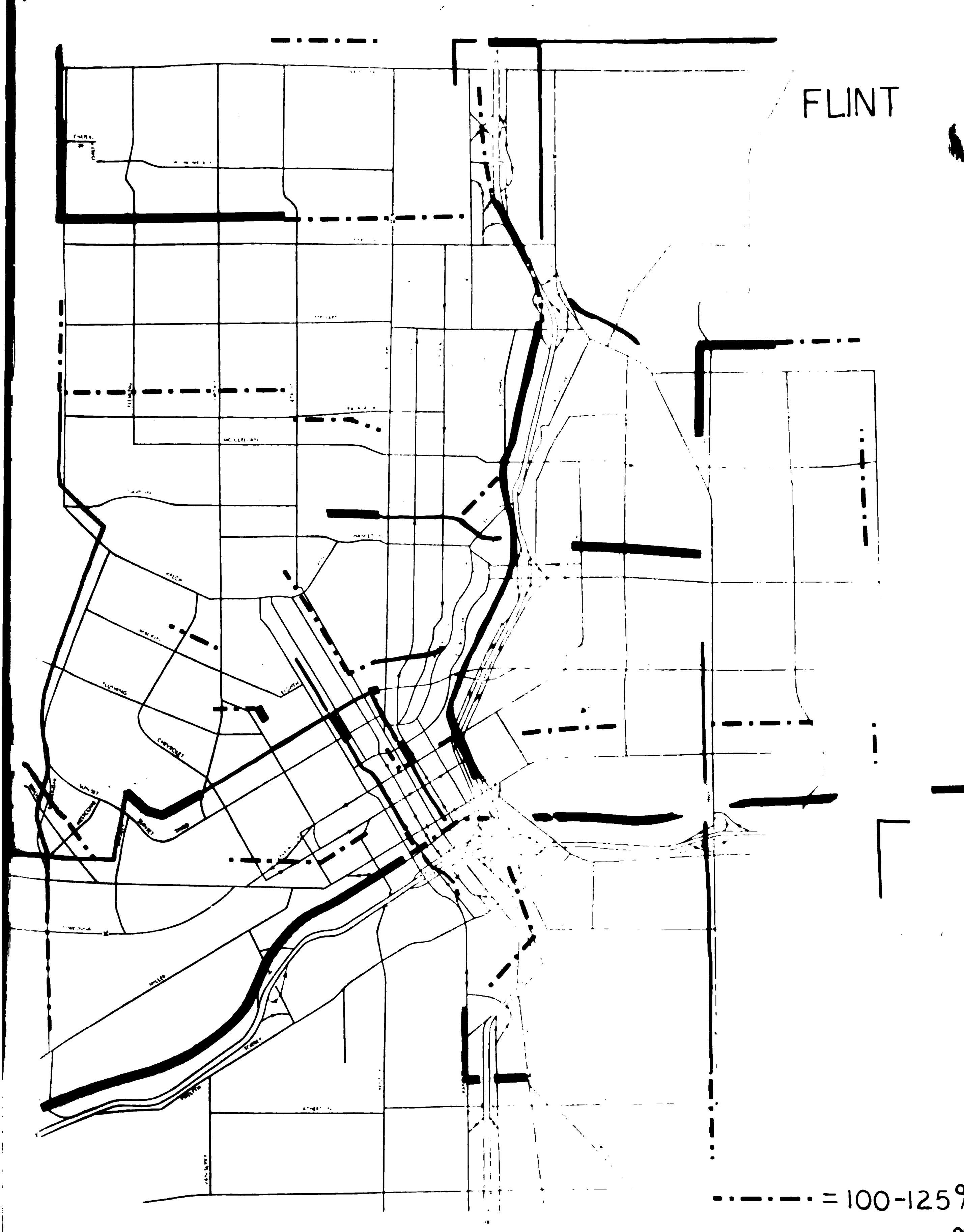
[1]"Position Paper: The Unified Work Program for Flint/Genesee County", Michael D. Eberlein, Michigan Department of State Highways and Transportation, Lansing, Michigan, August, 1973, p. 10.
[2]Ibid, p. 11.

CAPACITY DEFICIENCIES



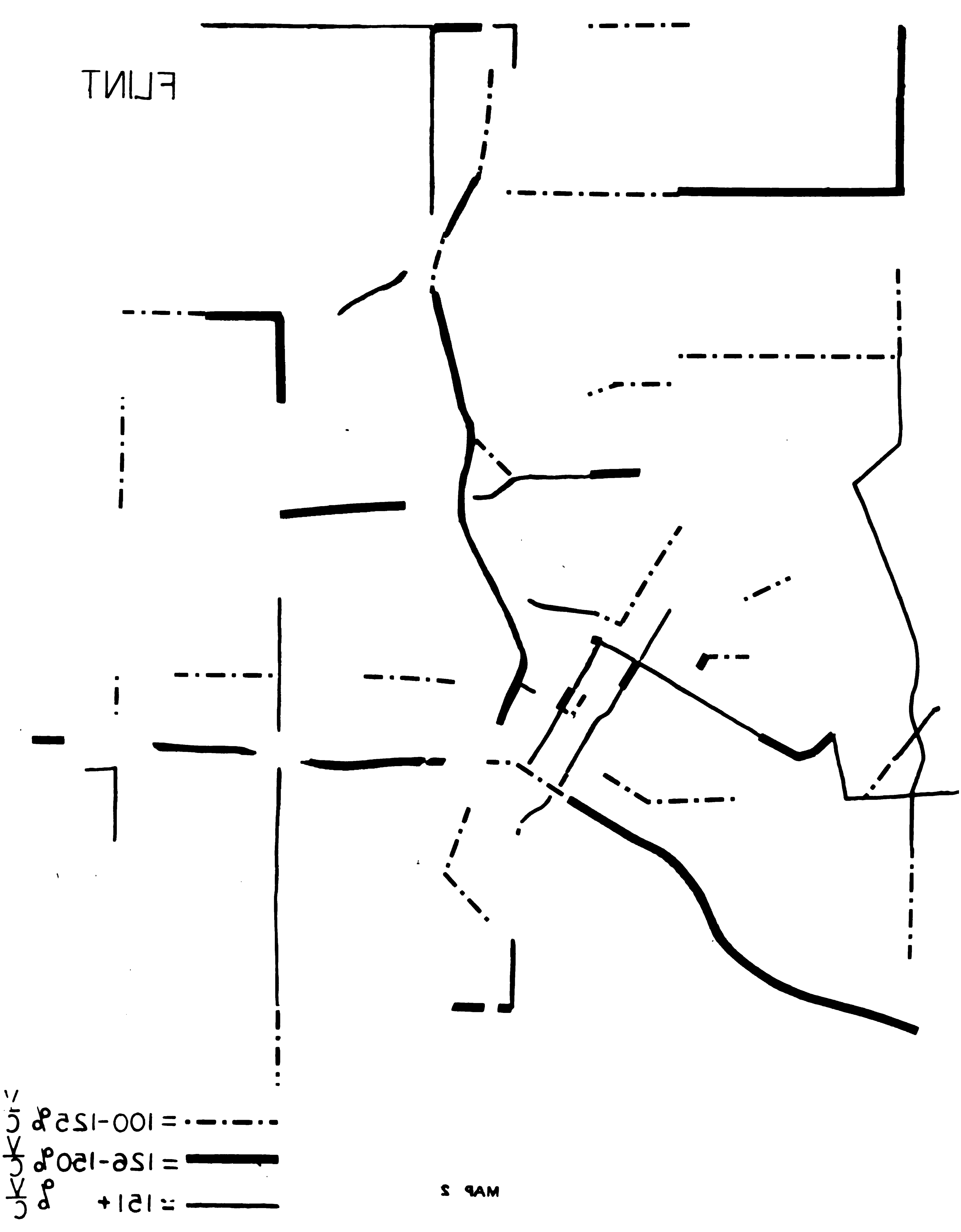
$-\cdot-\cdot-$ = 100-125 % $\frac{V}{C}$

━━━ = 126-150 % $\frac{V}{C}$

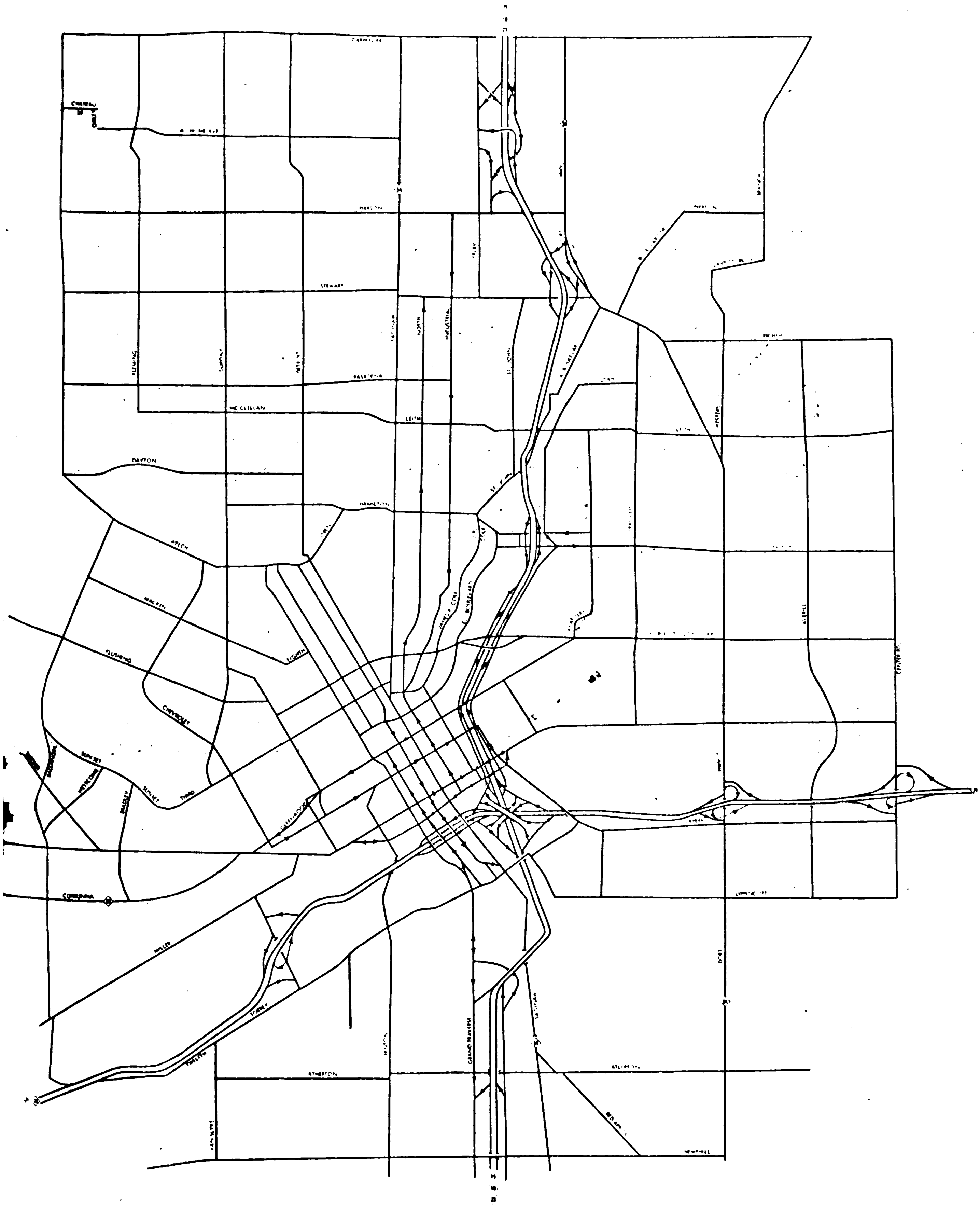
——— = 151+ % $\frac{V}{C}$

FIGURE 19

CAPACITY DEFICIENCIES



MAP 2


CHATEAU
STEWART
MC CLELLAN
LEITH
DAYTON
HAMILTON
FLUSHING
CHEVROLET
SUNSET
THIRD
CORUNNA
MILLER
ATHERTON
GRAND TRAVERSE

1995

CAPACITY DEFICIENCIES

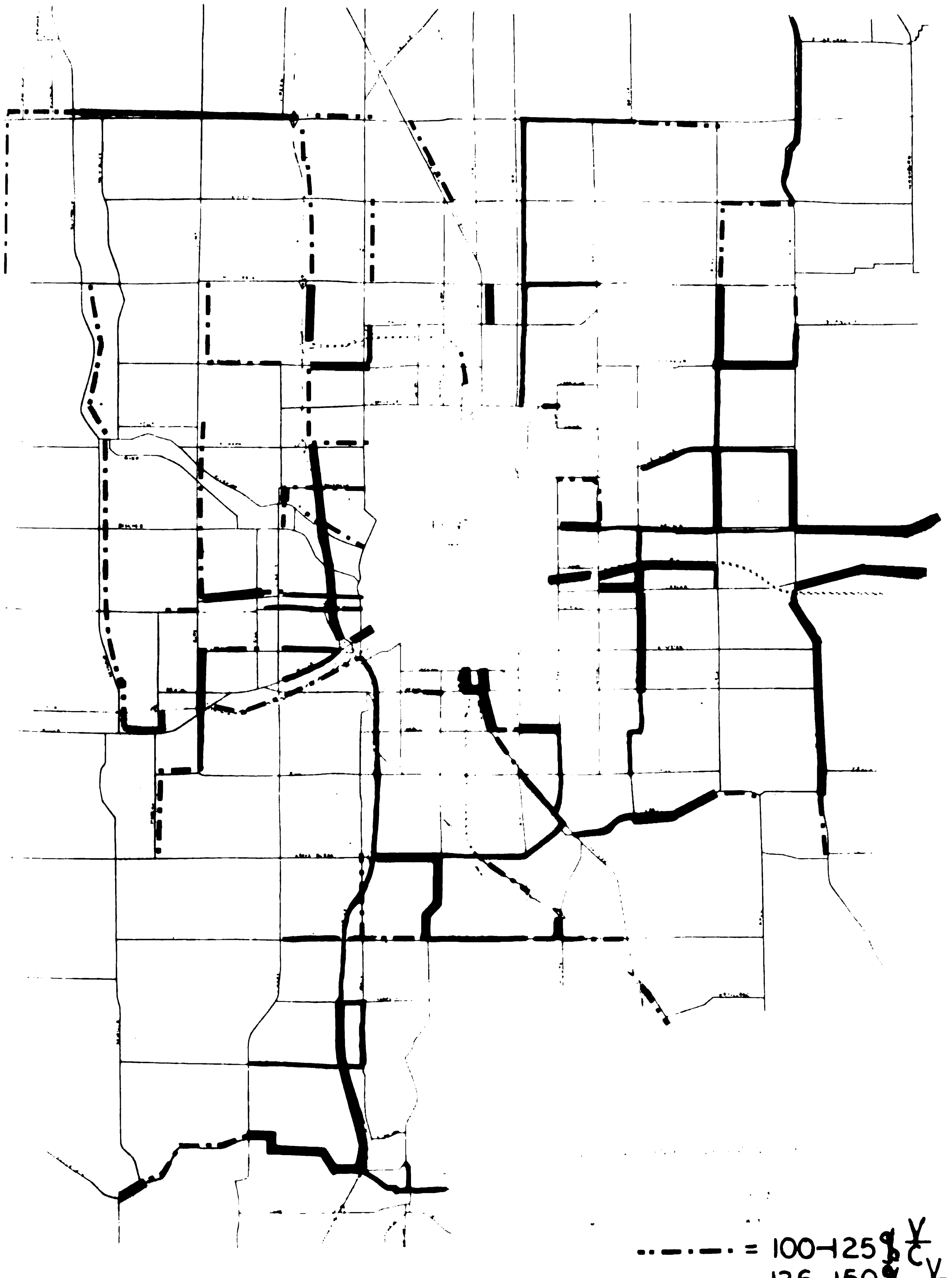
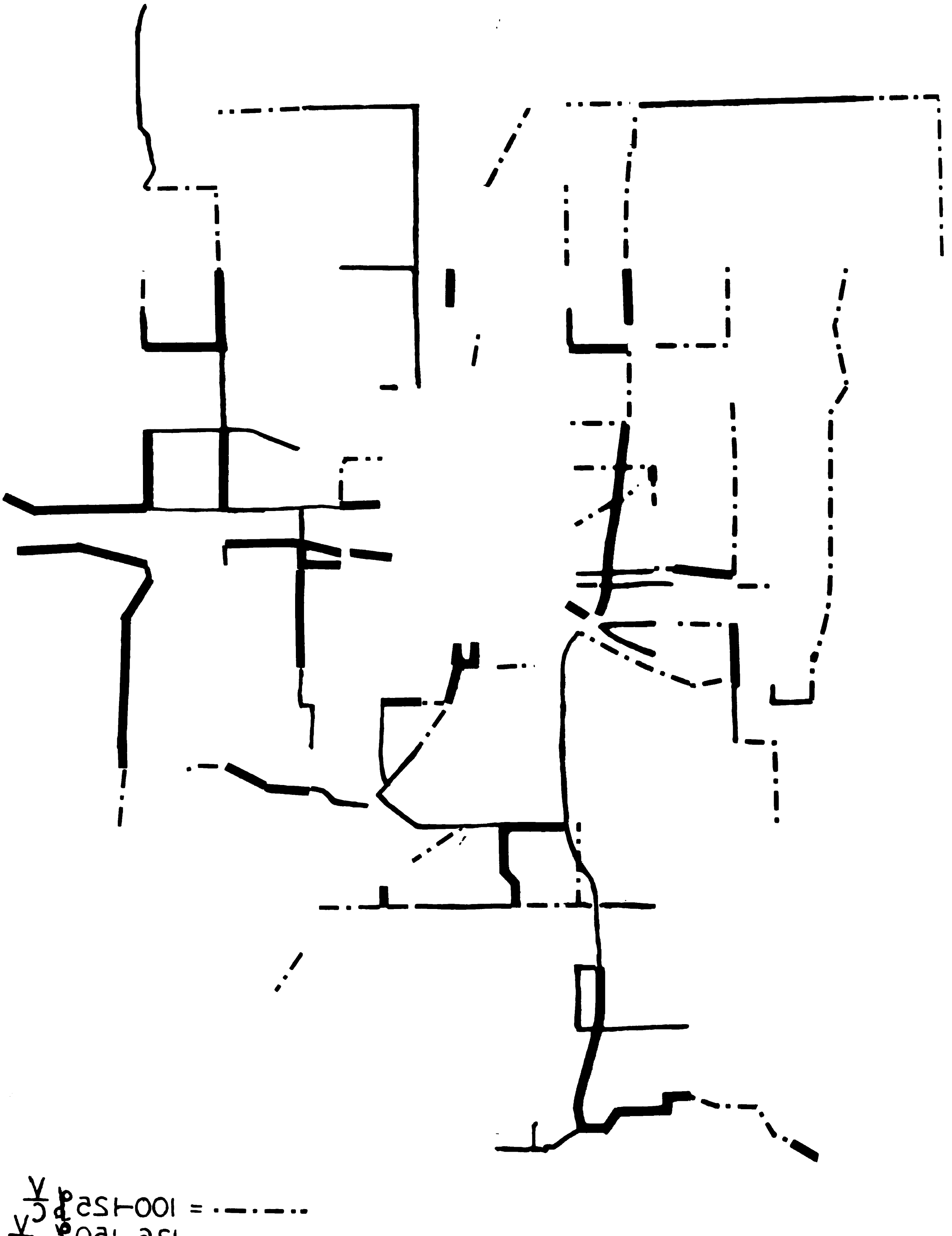


FIGURE 18

1995

CAPACITY DEFICIENCIES



MAP 1

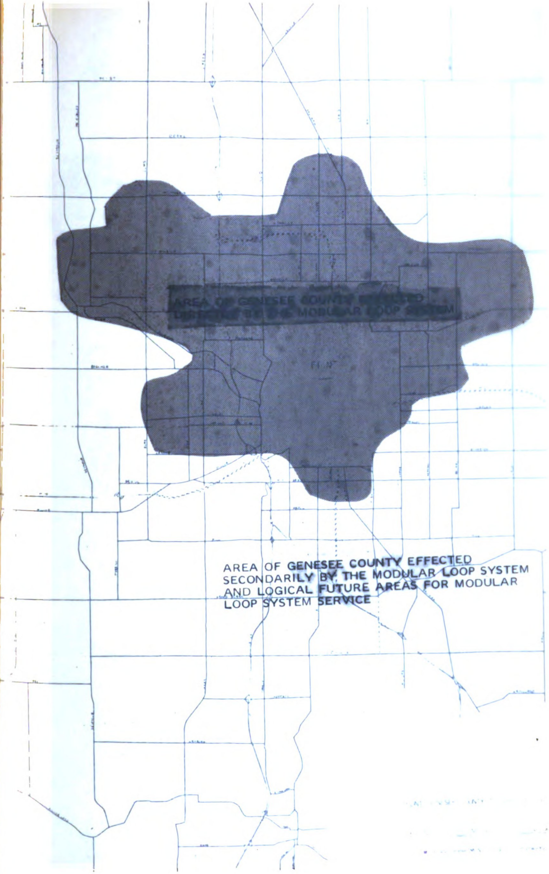
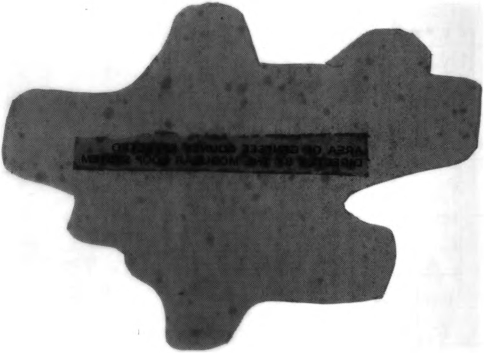
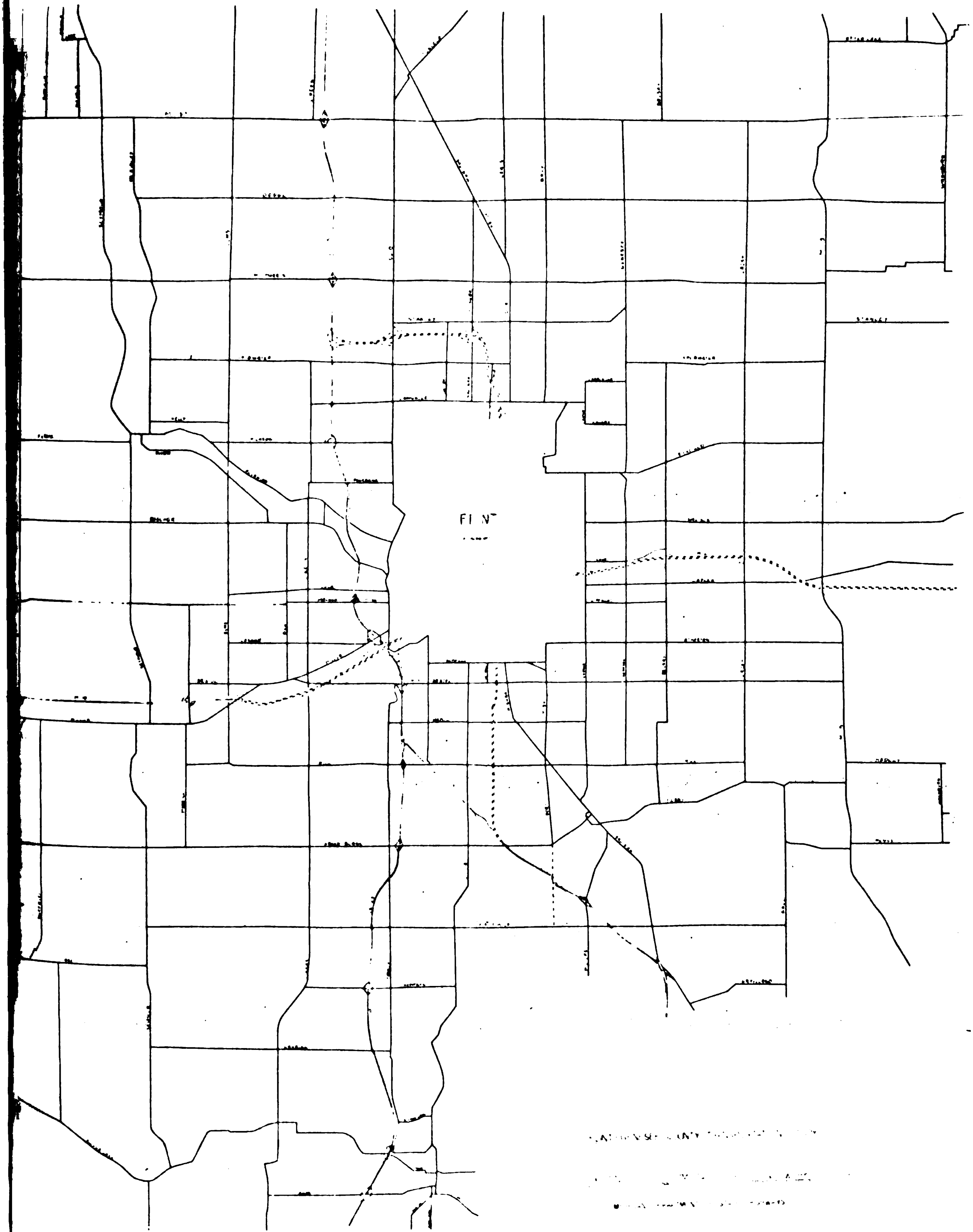

AREA OF GENESEE COUNTY EFFECTED
SECONDARILY BY THE MODULAR LOOP SYSTEM
AND LOGICAL FUTURE AREAS FOR MODULAR
LOOP SYSTEM SERVICE

FIGURE 20



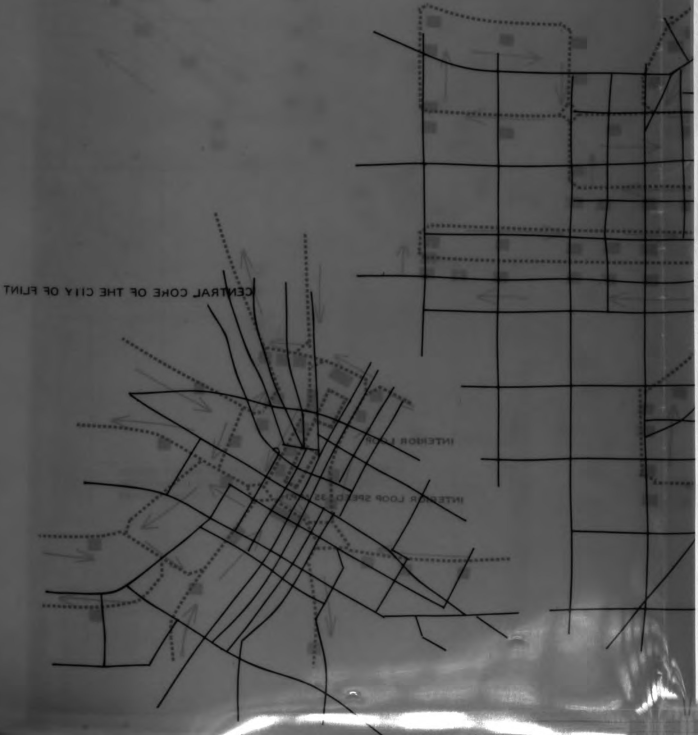
AREA OF GENESEE COUNTY EFFECTED
SECONDARILY BY THE MODULAR LOOP SYSTEM
AND LOGICAL FUTURE AREAS FOR MODULAR
LOOP SYSTEM SERVICE

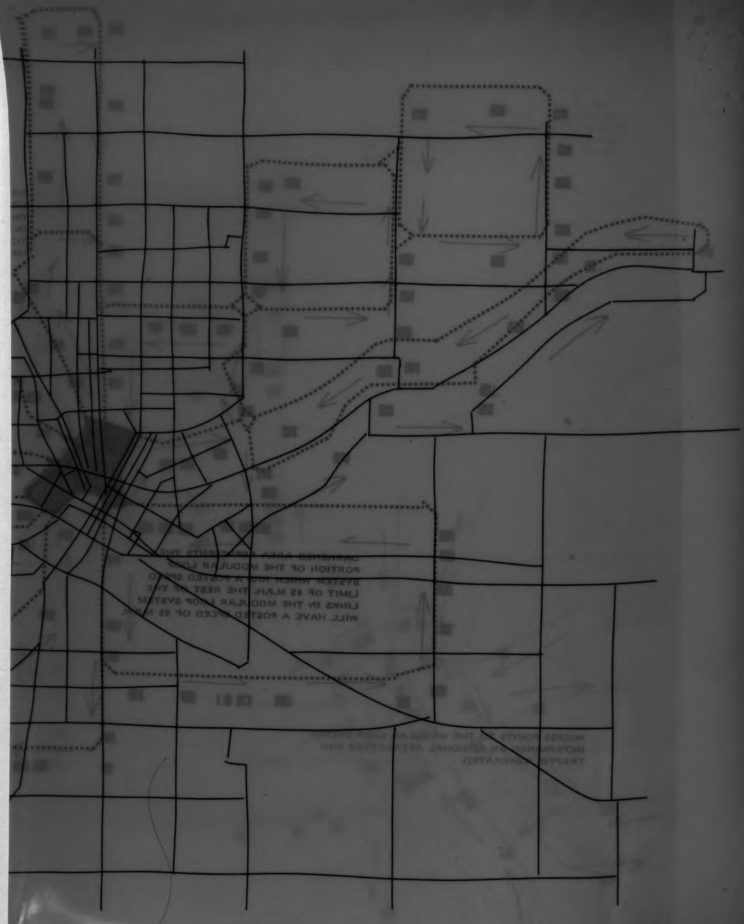
MAP 3



1995 NETWORK FOR URBAN AREA OF GENESSE CO.

THE FOCAL POINT OF THE URBAN AREA OF GENESSE COUNTY WAS ASSUMED TO BE THE CENTRAL CORE OF FLINT. THE MODULAR LOOP SYSTEM FOR THIS AREA WAS DEVELOPED IN THE FASHION PRESENTED HERE IN DIRECT RELATION TO THE CENTRAL CORE OF FLINT BEING THE FOCAL POINT





MAP 4

URBAN AND URBANIZING AREAS OF GENESEE COUNTY

The second alternative, ultimate system tested, if implemented, would cost $600,000,000 and showed less impact on the congestion problem than the Modular Loop System. The ultimate alternative is a highway system which is in direct relationship to the existing plus proposed highway network. Both of these alternatives failed to relieve the deficiencies to a substantial extent. The Modular Loop System was then tested. The results are as follows.

B. PHYSICAL FORM

Figure 21 portrays the physical adaptation of the Modular Loop System onto the urban region of Genesee County. In determining the pattern of links in the Modular Loop System it is necessary to consider the physical location of desired destinations for shopping, employment, etc. in the region. Figure 22 and Figure 23 present the location of major attractors. The Modular Loop System was designed as a service network connecting these regional and community facilities to all parts of the urban area. It is assumed that the central core of the city of Flint is the hub of the urban region for Genesee County, thus the Modular Loop System emanates from that point.

If the Modular Loop System was to be implemented on the 1995 committed and existing network for Genesee County there would be tremendous changes made. The benefits and drawbacks of the MLS alternative solutions to the problem become clear in such a way as to judge the merit of the MLS as a viable alternative.

ODULAR LOOP NETWORK FOR THE URBANIZING REGION OF GENESEE COUNTY, MICHIGAN

MAJOR COMMERCIAL CENTERS FOR URBANIZING REGION OF GENESEE COUNTY

MAJOR EMPLOYMENT CENTERS FOR URBANIZING REGION OF GENESEE COUNTY

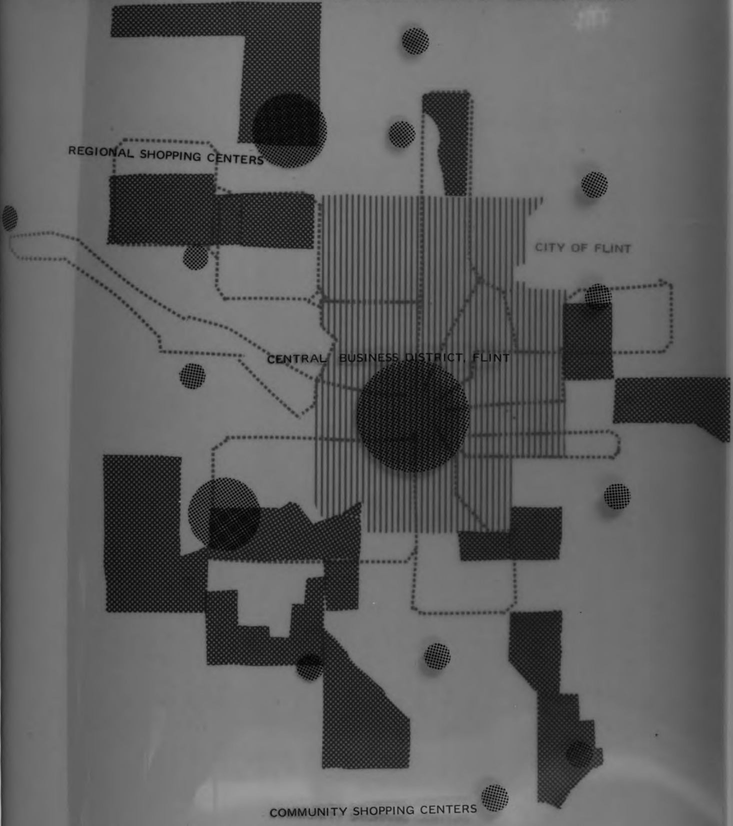
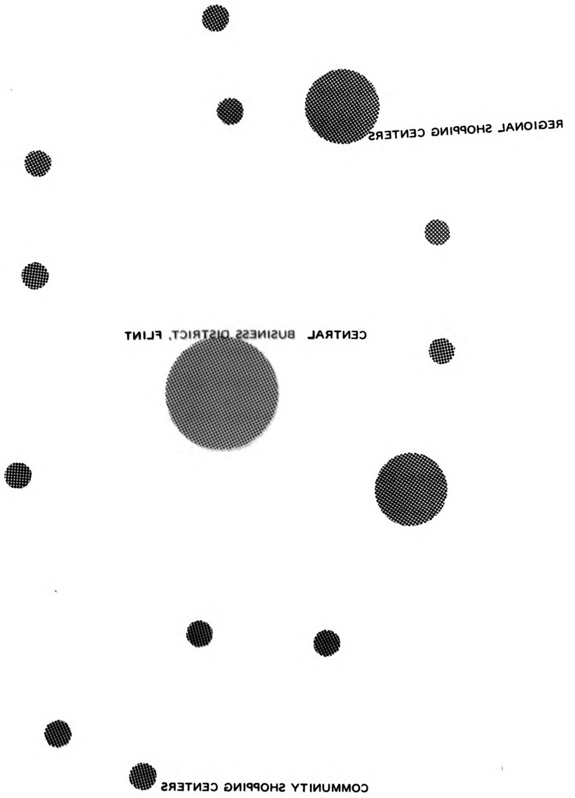


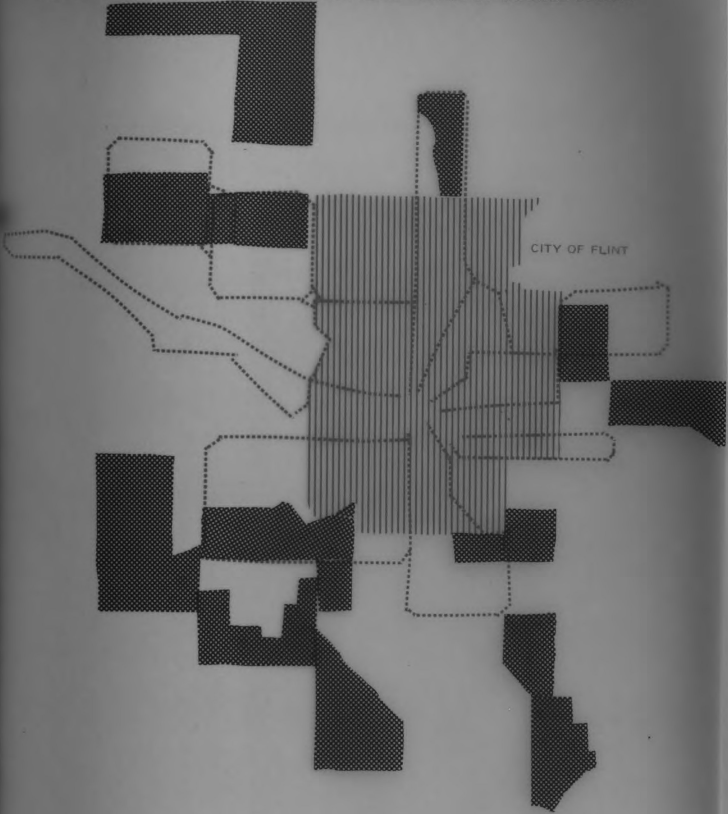
FIGURE 22

MAJOR COMMERCIAL CENTERS FOR URBANIZING REGION OF GENESEE COUNTY

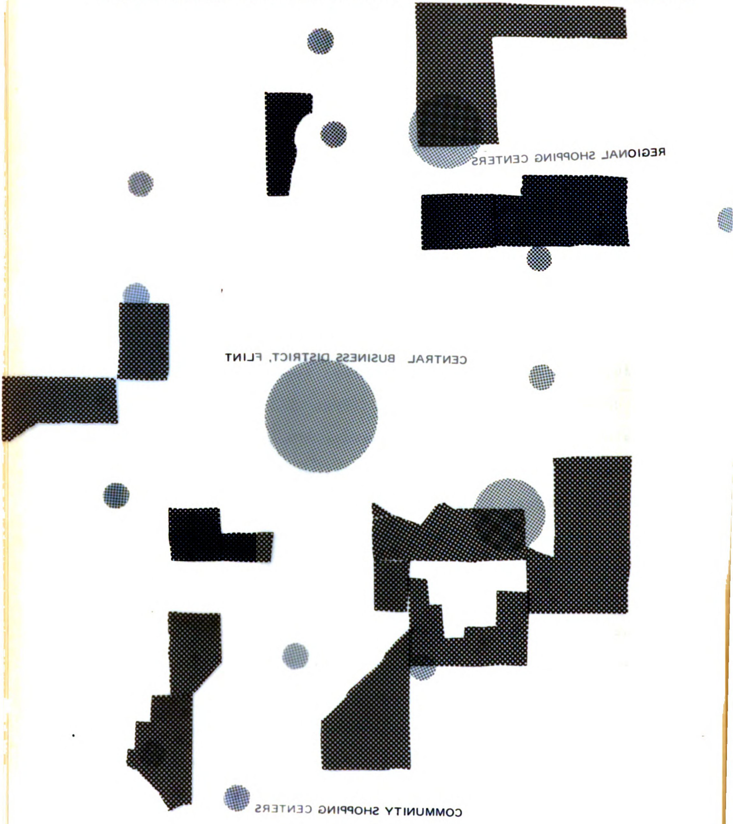


MAP 5

MAJOR EMPLOYMENT CENTERS FOR URBANIZING REGION OF GENESEE COUNTY

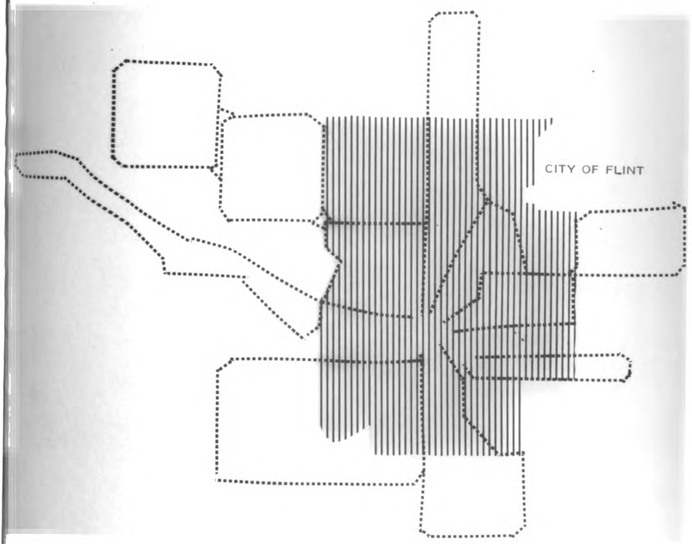


MAJOR COMMERCIAL CENTERS FOR URBANIZING REGION OF GENESEE COUNTY
MAJOR EMPLOYMENT CENTERS FOR URBANIZING REGION OF GENESEE COUNTY



MAP 5

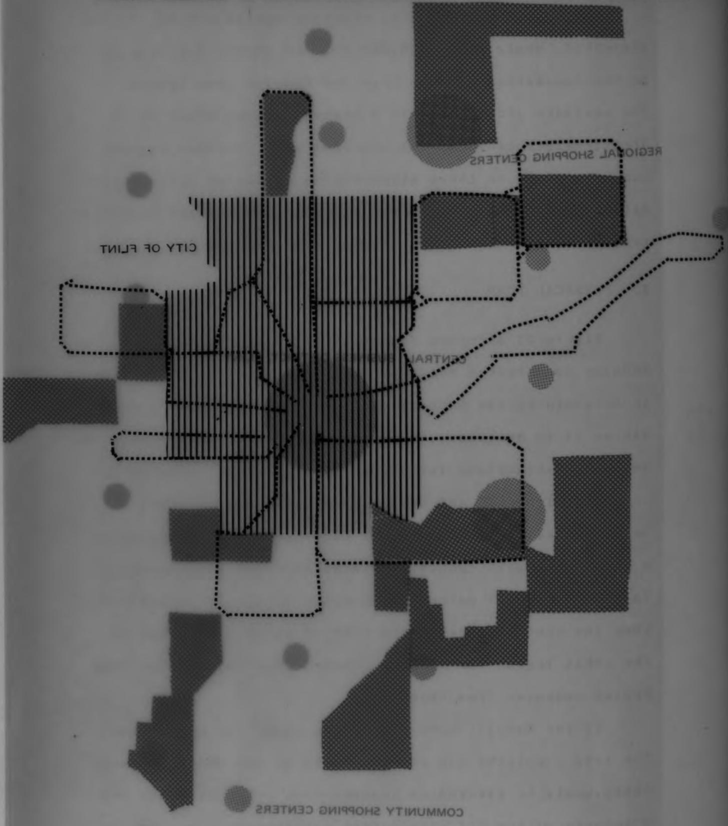
MODULAR LOOP NETWORK FOR THE URBANIZING REGION OF GENESEE COUNTY, MICHIGAN



MODULAR LOOP NETWORK FOR THE URBANIZING REGION OF GENESEE COUNTY, MICHIGAN

MAJOR COMMERCIAL CENTERS FOR URBANIZING REGION OF GENESEE COUNTY

MAJOR EMPLOYMENT CENTERS FOR URBANIZING REGION OF GENESEE COUNTY



MAP 5

MODULAR LOOP NETWORK FOR THE CITY OF FLINT, MICHIGAN

MAJOR COMMERCIAL CENTERS, FLINT MICHIGAN

MAJOR EMPLOYMENT CENTERS, FLINT MICHIGAN

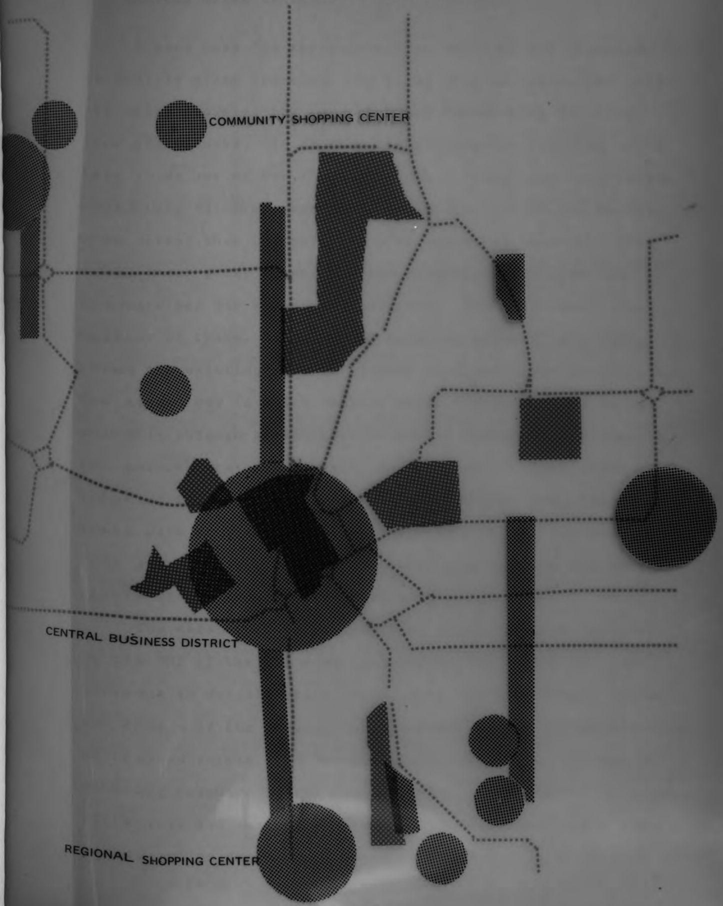
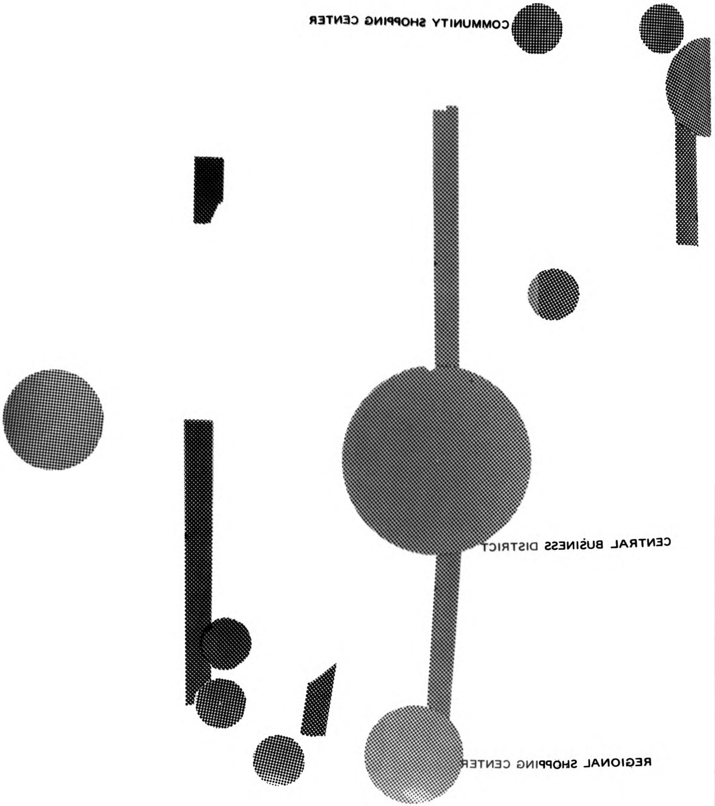


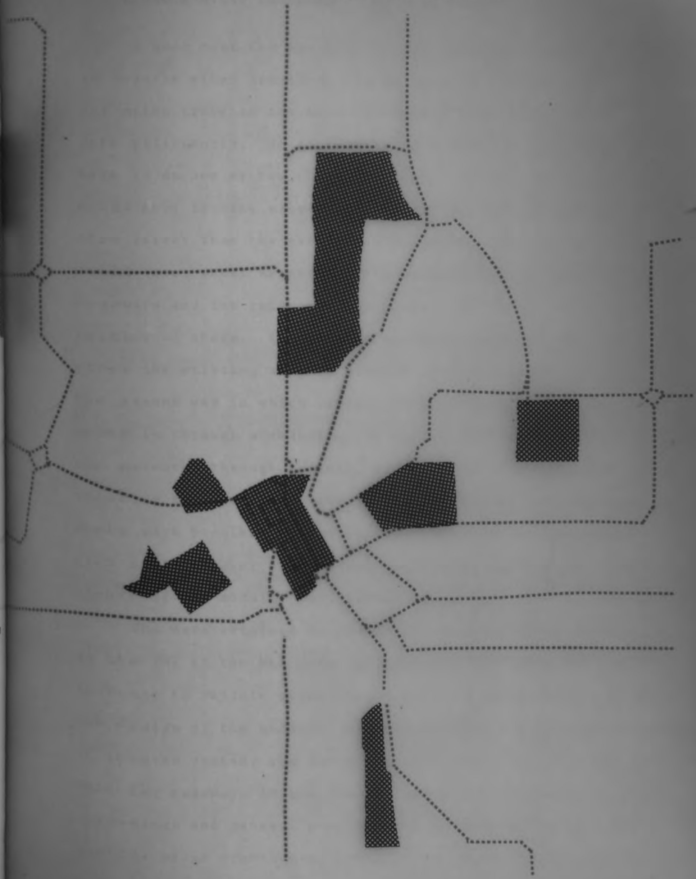
FIGURE 23

MAJOR COMMERCIAL CENTERS, FLINT MICHIGAN



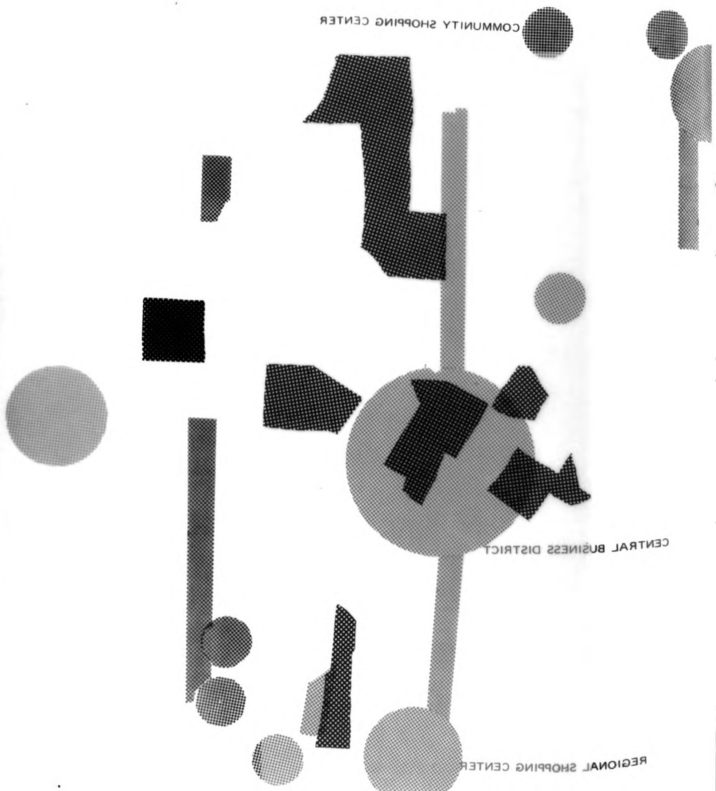
MAP 6

MAJOR EMPLOYMENT CENTERS, FLINT MICHIGAN



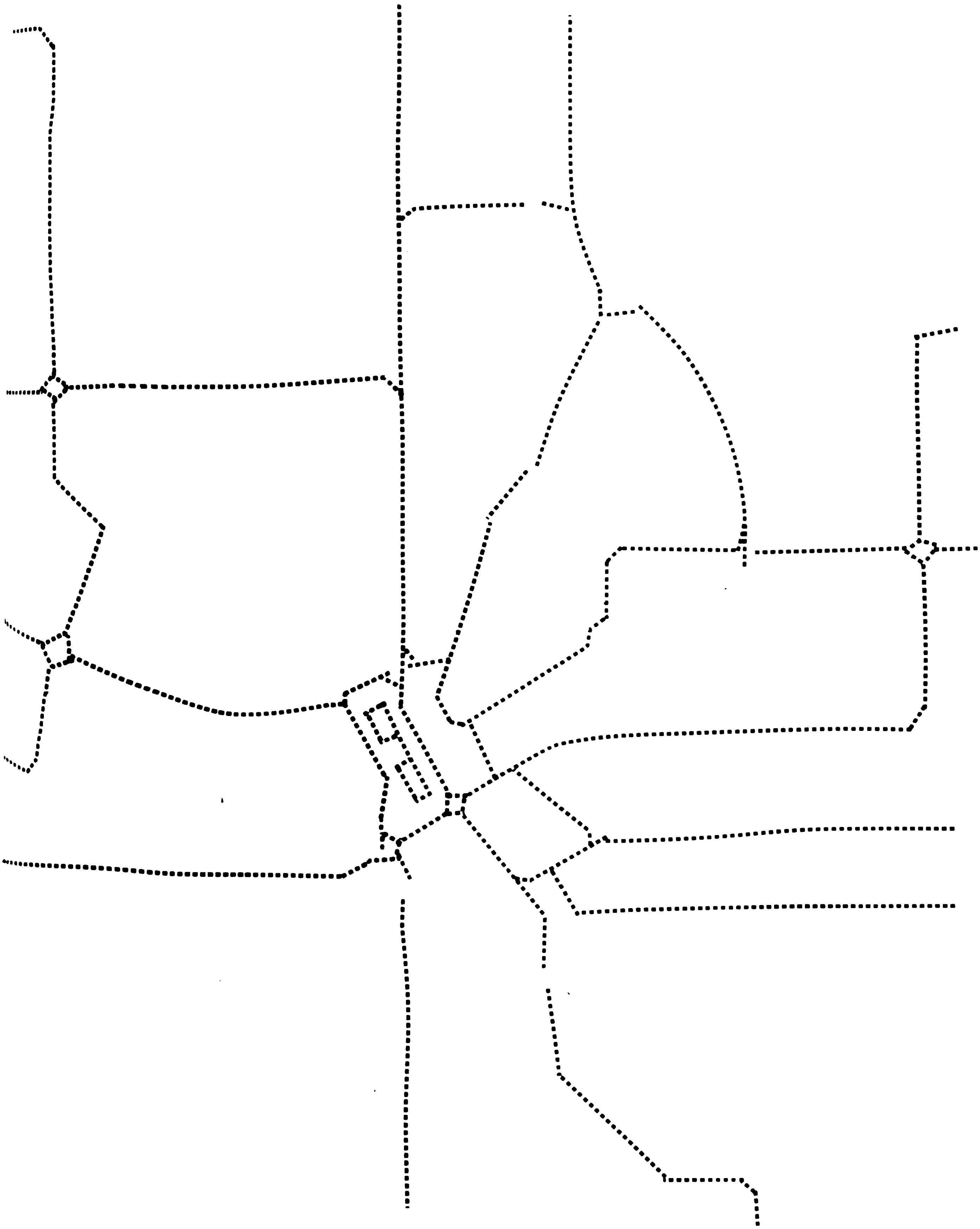
MAJOR COMMERCIAL CENTERS, FLINT MICHIGAN

MAJOR EMPLOYMENT CENTERS, FLINT MICHIGAN



MAP

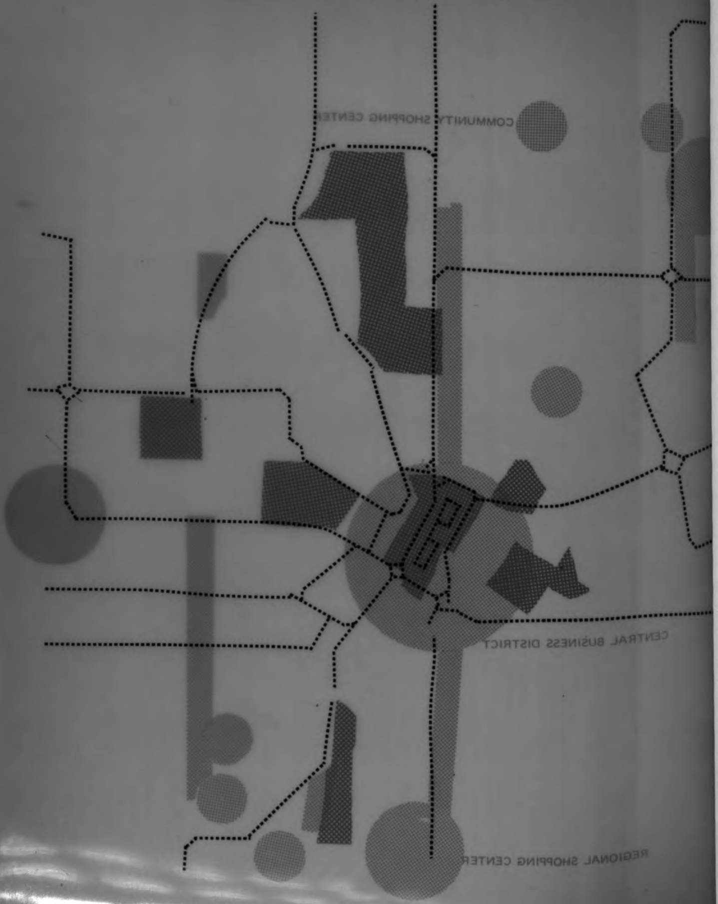
MODULAR LOOP NETWORK FOR THE CITY OF FLINT, MICHIGAN



MODULAR LOOP NETWORK FOR THE CITY OF FLINT, MICHIGAN

MAJOR COMMERCIAL CENTERS, FLINT MICHIGAN

MAJOR EMPLOYMENT CENTERS, FLINT MICHIGAN



MAP 6

C. VEHICLE MILES TRAVELED

A good test for any alternative would be the reduction in vehicle miles traveled. By being able to reduce the vehicle miles traveled the network could conceivably function more efficiently. To do this the alternative solution would have to do one of two things or both. First, the alternative would have to make access to major attractors in the region more direct than the existing plus committed network. This would incur great expense in the acquisition of land for roadways and for relocation purposes. The loop system does neither of these. It uses the existing network as a base, since the existing network already services major attractors. The second way in which vehicle miles traveled could be reduced is through a reduction in actual number of vehicles on the network, through transit, car pooling or other means of reducing the number of vehicles. The Modular Loop System deals with problems on the physical network and any reduction in the number of vehicles would also enhance the efficiency of the modular loop system as well.

The data obtained by the model illustrates an increase in the VMT if the MLS were implemented (see Table 9). An increase in vehicle miles traveled is not surprising. Given the design of the modular loop system with its characteristics of limited access, its one-way directional flow, the use of existing roadways in the network for close proximity to major attractors and general proximity to residential areas, the vehicle miles traveled is bound to increase. It should be noted that the increase in VMT on the Modular Loop System could be conceivably reduced by looking into alternative road paths for the system to follow. While the total VMT did, in fact, increase, it is more important to analyze the component parts of the MLS. Because of its characteristics it has become desirable enough to attract VMT from congested expressway systems (see Table 10). Approximately 571,000 vehicle miles traveled were diverted from the extremely congested expressway to the Modular Loop System. What is even more impressive is the knowledge that the existing expressway is over capacity in sections but is not in the severe problem stage that the committed expressway network is, and it is from here that the Modular Loop System diverts most of the VMT. In fact, 15% of the VMT are diverted from the over capacity committed expressways to the Modular Loop System.

The impact on the rest of the network is not as clear in terms of diverting VMT from minor and major arteries. This is because the Modular Loop System is superimposed for 92 miles of the links in these particular link classes. However, by knowing the VMT for the existing and committed 1995 networks and the VMT for the MLS alternative in each of these link classes, and the actual miles in each class, and how many actual miles were not used in the MLS, a relationship can be established. This would be done by finding the relationship of the old VMT to the old actual miles, and the new VMT to the new actual miles. The difference of the results would

TABLE 9

VMT EFFECTED BY THE MODULAR LOOP SYSTEM

FOR THE CITY OF FLINT, GENESEE COUNTY

	Modular Loop	Expressway	Non Expressway	Total
Existing + Committed Network	0	3,957,000	4,629,000	8,586,000
Modular Loop System	2,106,000	3,486,000	3,302,000	8,894,000

Difference of 308,000 VMT

Increase of 3.5% (VMT)

TABLE 10

EXISTING + COMMITTED EXPRESSWAYS

FOR THE URBAN AREA OF FLINT

	Expressways	Committed Expressways Ramp	I-475	M-78	Total
1995 Network	1,227,000	440,000	1,066,000	1,224,000	3,957,000
Modular Loop System	1,146,000	401,000	866,000	1,073,000	3,486,000
Differences	81,000	39,000	200,000	151,000	571,000
% Decrease	7%	9%	19%	12%	12%

be the percentage increase or decrease the Modular Loop System would have on each link class (see Table 11).

TABLE 11

EFFECT OF MLS ON MAJOR & MINOR ARTERIALS

1995 E+C NETWORK	MAJOR ARTERIAL	MINOR ARTERIAL
VMT (000)	2131	2408
Actual Miles	275	320
Result VMT/Mile	7.8	7.5
MODULAR LOOP		
VMT (000)	1819	1654
Actual Miles	251	274
Result VMT/Mile	7.2	6.0
Difference in % Decrease	8%	20%

The Modular Loop System has effected the minor and major arteries positively, as well as the expressway by diverting VMT on to the loop system thus reducing congestion for these links of the network.

D. TRAFFIC VOLUME

The Modular Loop System alternative was an attempt to reduce congestion on heavily traveled links in the network. On Maps 7 and 8 the increases in volume on links of the MLS can be seen. These increased volumes on the links range from a decrease of 8,000 vehicles daily to an increase of 81,000 vehicles daily. The three places that incurred decreases in volume of traffic are on the northwest loops on the Linden Road, on Beach Street in the CBD of Flint and on the Dort Highway by Boulevard Drive. Two of the decreases, on Linden Road and Beech Street, occur on the only two links of the system that are two-way. It is understandable that these two links might incur decreases given the change in link type, etc. The decrease in traffic volume which occurs on the Dort Highway is somewhat of a mystery. The decrease occurs at an important intersection of two of the loops in the system. This particular link in the system decreased from a volume of 13,500 to a volume of 5,505. Given the location and the large decrease which occurred on the system, further analysis should be made. A few characteristics of the location might shed light on this occurrence. North of the link of the MLS in question on the Dort Highway is an interchange with I-475. This could possibly account for the large increase in traffic volume at this point. South of this link on the Dort Highway is another large increase which is due to the Industrial Complex on Dort Highway. The direction of that particular link on the MLS may be wrong but, whatever the reason, this particular occurrence on the MLS should be analyzed further.

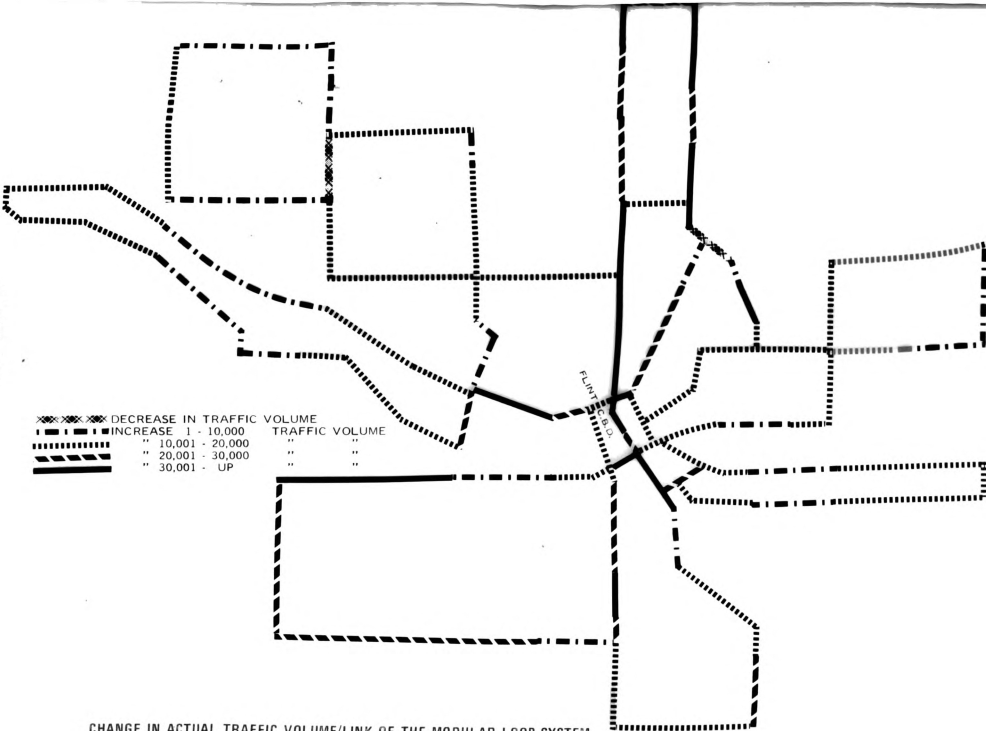
At the other end of the spectrum, the MLS was so desirable as to draw an additional 81,000 vehicles daily on Saginaw Road north of the CBD. It becomes obvious that improvement to North Saginaw Road on a large scale is needed, possibly the MLS.

The rest of the links fall between the perameters set forth by these changes in volume of traffic. For the most part, the MLS has attracted large quantities of traffic from other link types in the network. This relieves the congestion on the other links in the network (see Figures 24 and 25).

E. TRIP LENGTH

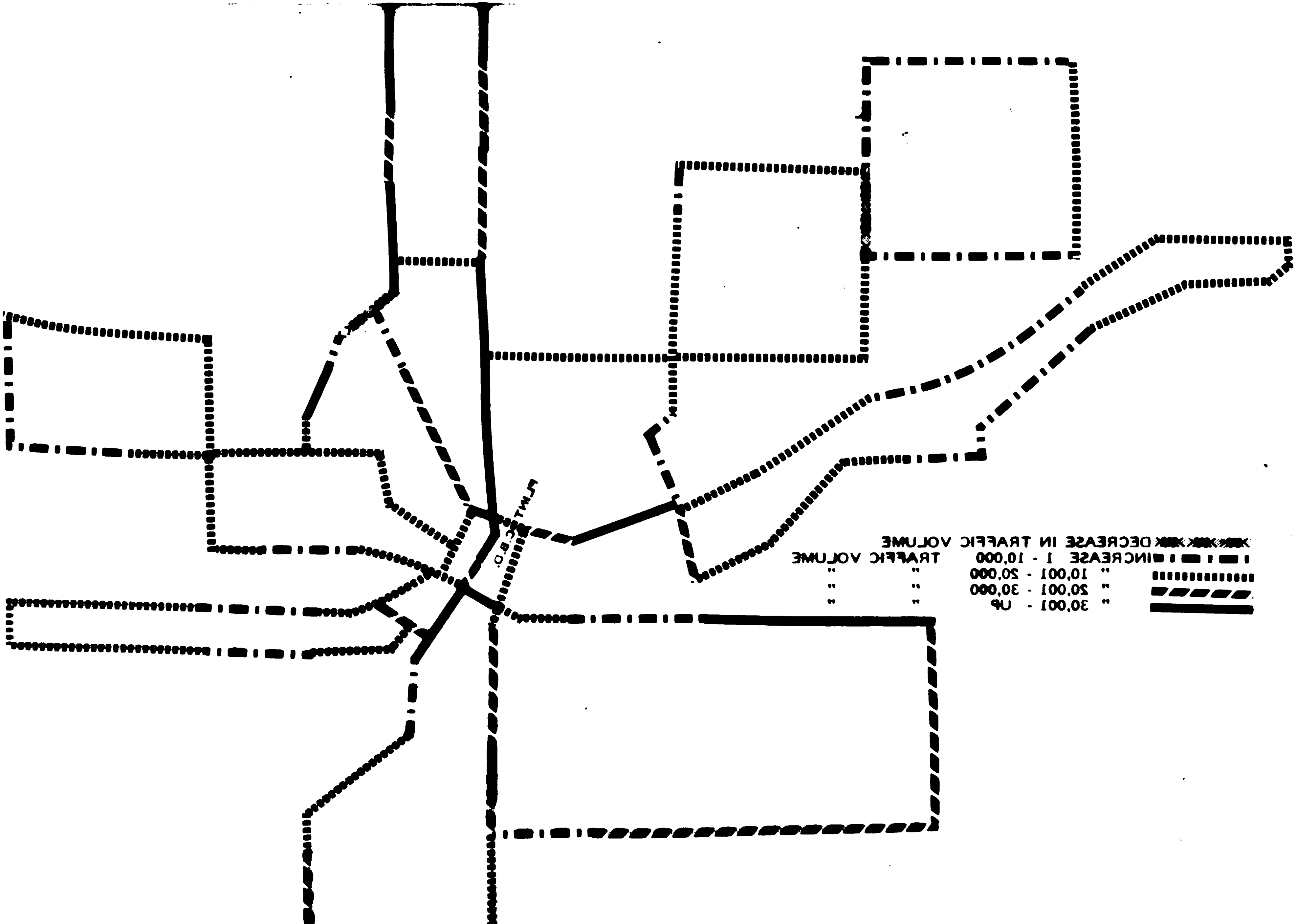
For the Modular Loop System to function effectively it must divert not simply trips but intermediate trips from the expressways and the major arteries thus setting up a regional network of facilities to function in a heirarchy for specific length and purpose. Figure 26 illustrates the change in the average trip length per link on the expressway system in the urban area of Genesee County. The changes are seen by comparing the 1995 network average trip length to the resultant average trip length of the MLS. The change occurs as an increase, a decrease, or no change in the trip length. For the expressway system to function properly it is assumed that the average length of any trip on the system should be longer than on the 1995 E+C Network. The expressway system was designed for through traffic and not to be congested with regional or local traffic. The MLS does in fact increase the length of the trips on specific links of the expressway system, particularly for I-475 where each link has increased substantially in average trip length.

Figure 27 presents the average trip length on the links of the Modular Loop System. For the most part the lengths



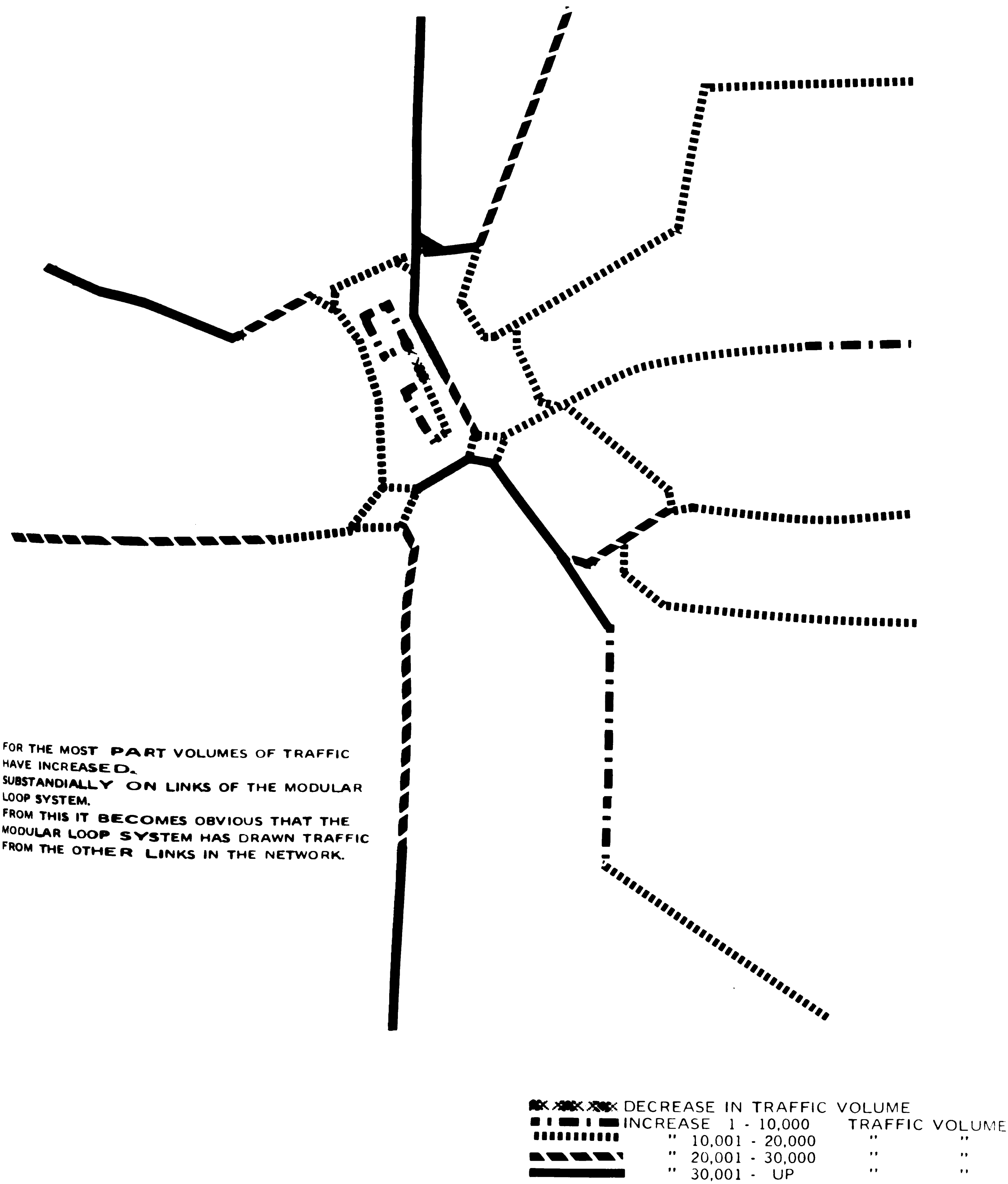
CHANGE IN ACTUAL TRAFFIC VOLUME/LINK OF THE MODULAR LOOP SYSTEM

FIGURE 24



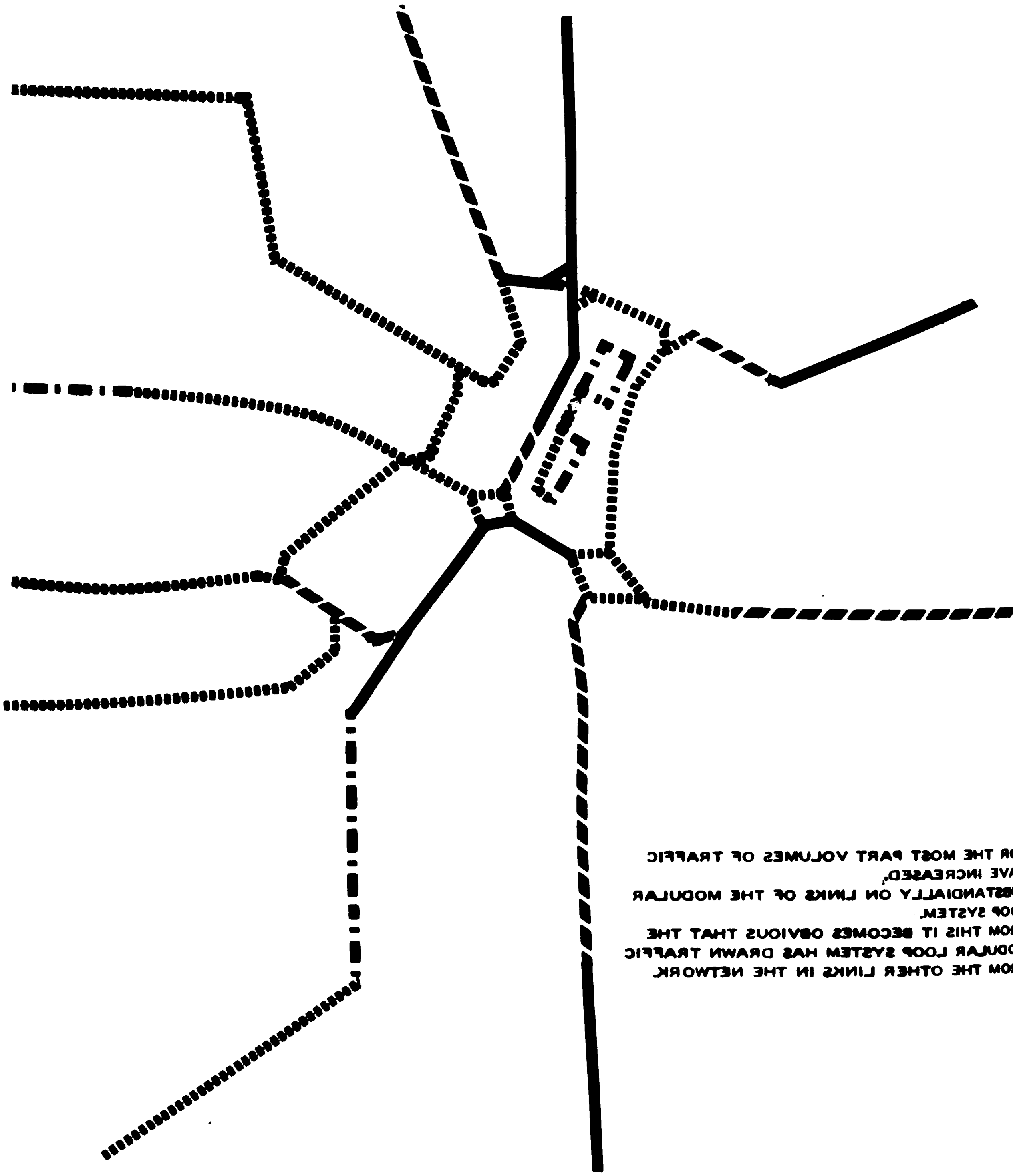
MAP 7

CHANGE IN ACTUAL TRAFFIC VOLUME/LINK OF THE MODULAR LOOP SYSTEM



CHANGE IN ACTUAL TRAFFIC VOLUME/LINK OF THE MODULAR LOOP SYSTEM IN THE CENTRAL CORE OF FLINT

FIGURE 25



FOR THE MOST PART VOLUMES OF TRAFFIC HAVE INCREASED, SUBSTANDIALLY ON LINKS OF THE MODULAR LOOP SYSTEM.
FROM THIS IT BECOMES OBVIOUS THAT THE MODULAR LOOP SYSTEM HAS DRAWN TRAFFIC FROM THE OTHER LINKS IN THE NETWORK.

DECREASE IN TRAFFIC VOLUME
INCREASE 1 - 10,000 TRAFFIC VOLUME
" 10,001 - 20,000 " "
" 20,001 - 30,000 " "
" 30,001 - UP " "

CHANGE IN ACTUAL TRAFFIC VOLUME/LINK OF THE MODULAR LOOP SYSTEM IN THE CENTRAL CORE OF FLINT

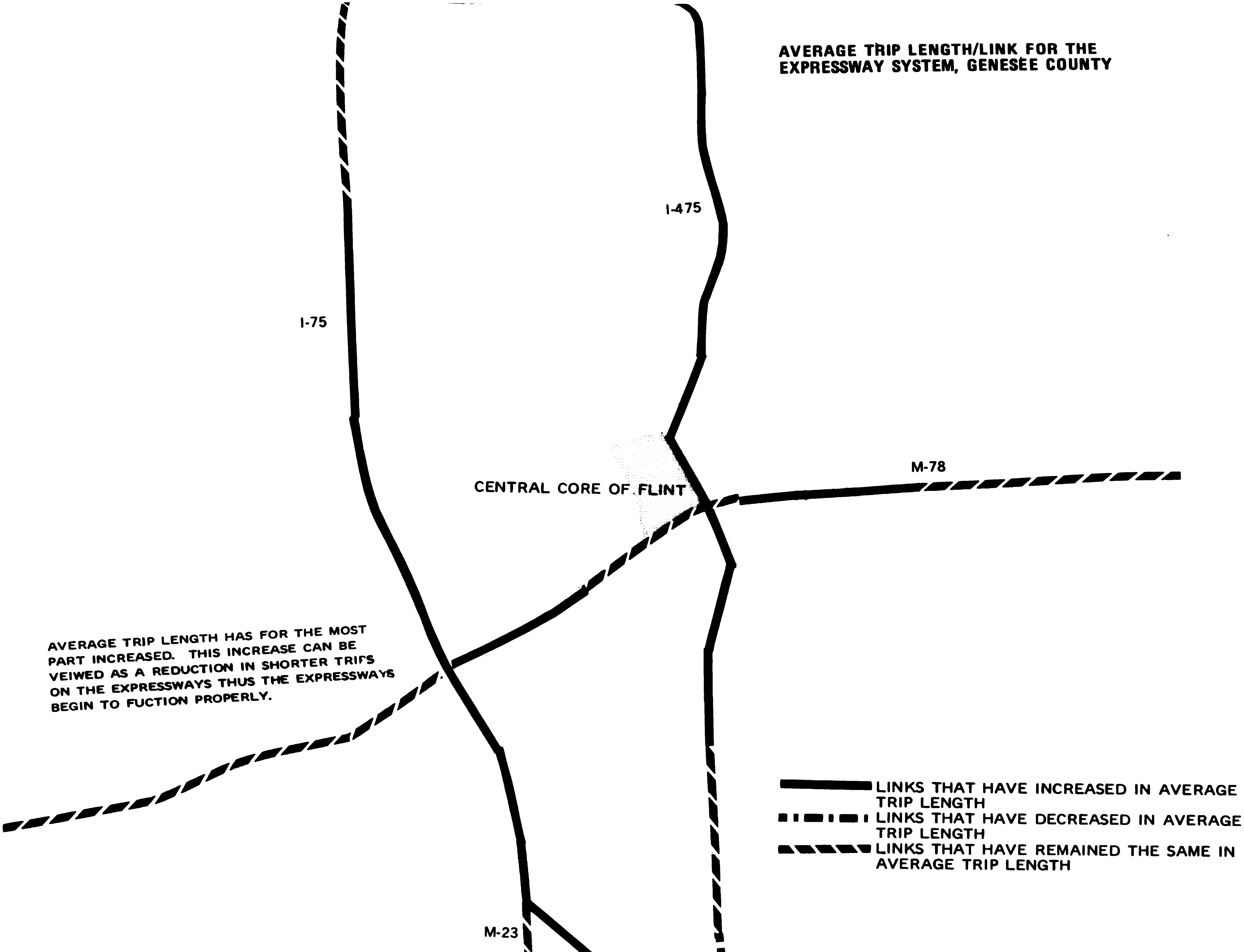
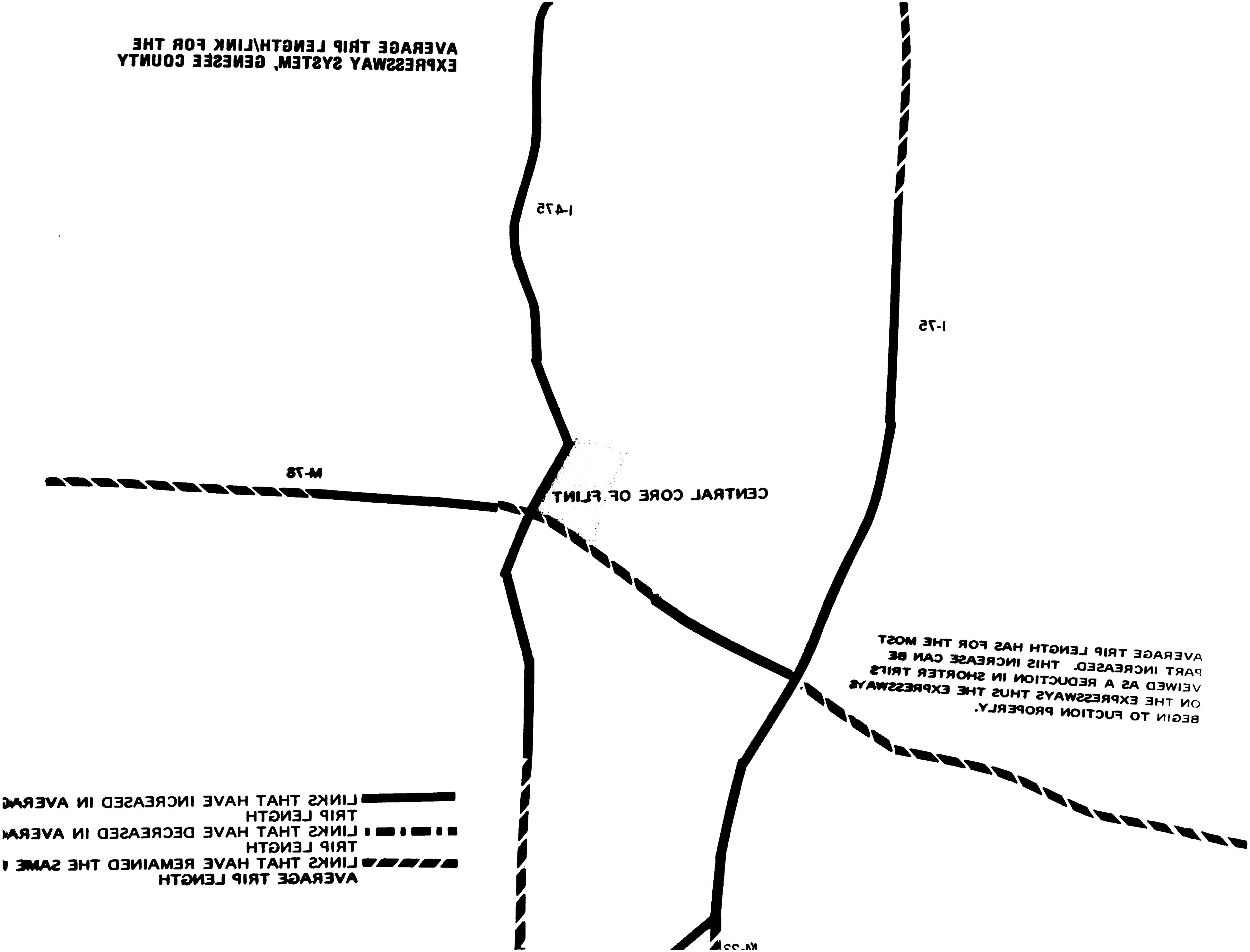

AVERAGE TRIP LENGTH/LINK FOR THE
EXPRESSWAY SYSTEM, GENESEE COUNTY
I-75
I-475
M-78
M-23
CENTRAL CORE OF FLINT
AVERAGE TRIP LENGTH HAS FOR THE MOST PART INCREASED. THIS INCREASE CAN BE VEIWED AS A REDUCTION IN SHORTER TRIPS ON THE EXPRESSWAYS THUS THE EXPRESSWAYS BEGIN TO FUCTION PROPERLY.
LINKS THAT HAVE INCREASED IN AVERAGE TRIP LENGTH
LINKS THAT HAVE DECREASED IN AVERAGE TRIP LENGTH
LINKS THAT HAVE REMAINED THE SAME IN AVERAGE TRIP LENGTH

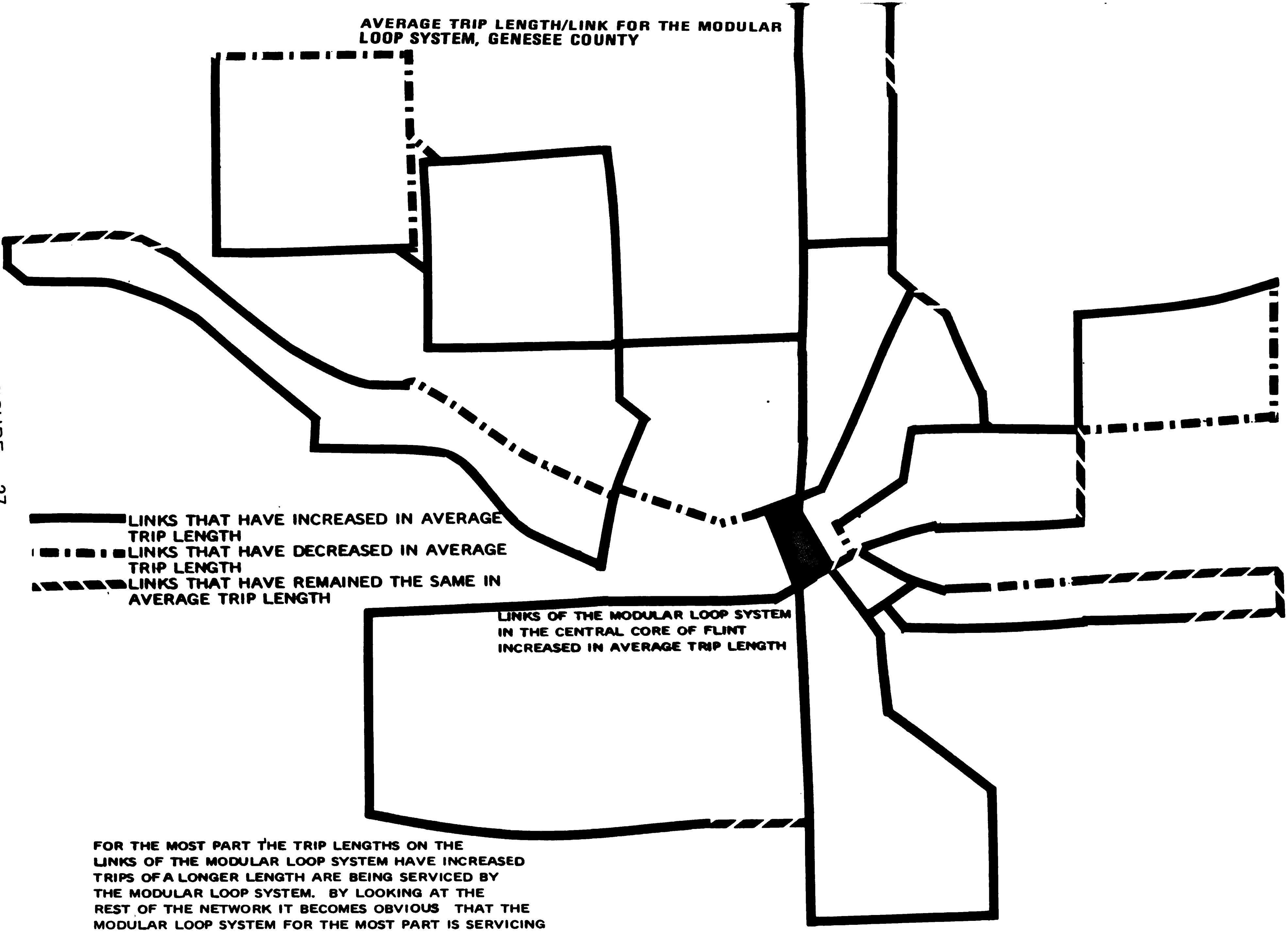
FIGURE 26

AVERAGE TRIP LENGTH/LINK FOR THE
EXPRESSWAY SYSTEM, GENESEE COUNTY



MAP 9

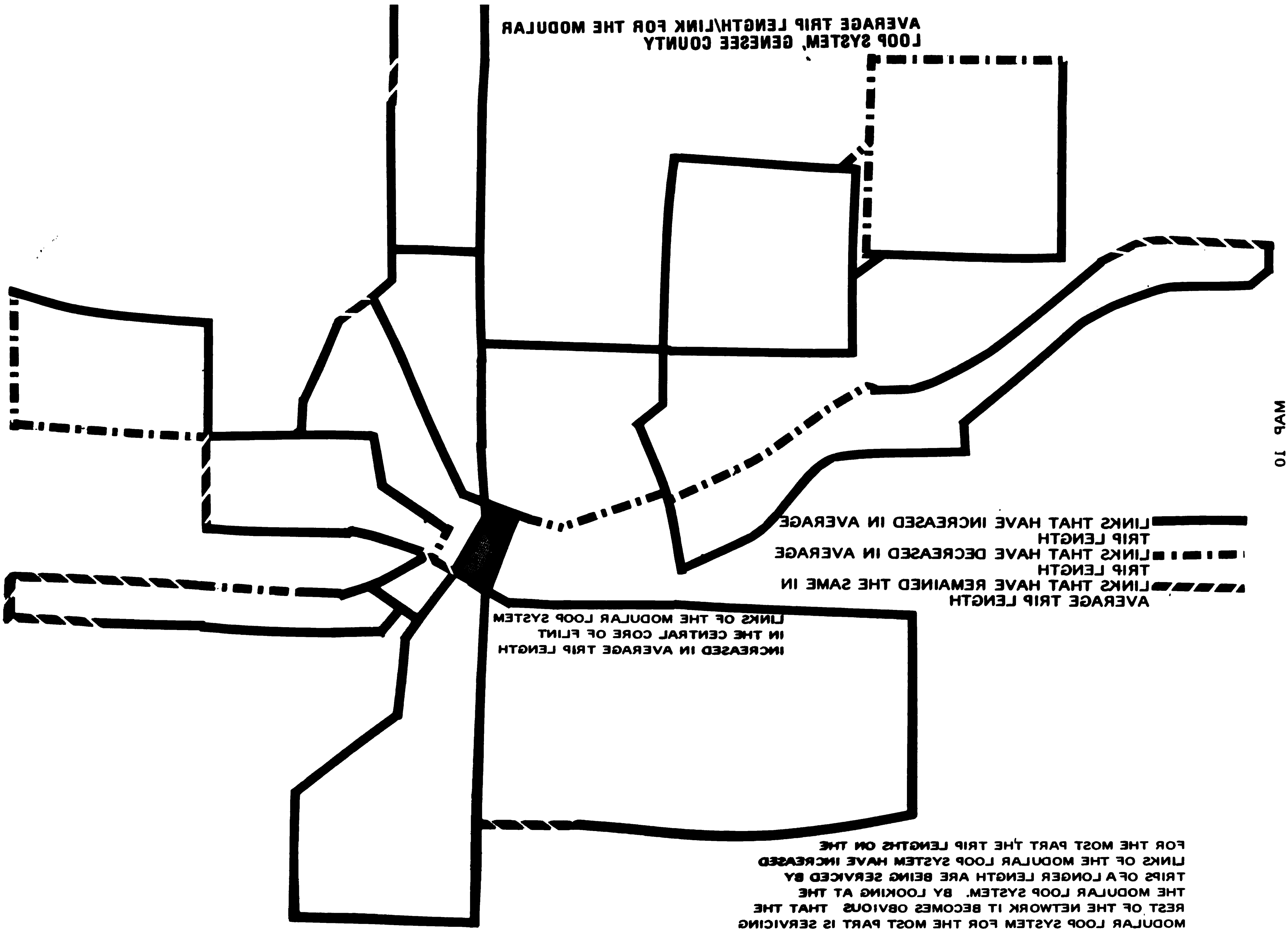
AVERAGE TRIP LENGTH/LINK FOR THE MODULAR LOOP SYSTEM, GENESEE COUNTY



FOR THE MOST PART THE TRIP LENGTHS ON THE LINKS OF THE MODULAR LOOP SYSTEM HAVE INCREASED TRIPS OF A LONGER LENGTH ARE BEING SERVICED BY THE MODULAR LOOP SYSTEM. BY LOOKING AT THE REST OF THE NETWORK IT BECOMES OBVIOUS THAT THE MODULAR LOOP SYSTEM FOR THE MOST PART IS SERVICING THE REGIONALLY ORIENTED TRIPS FOR GENESEE COUNTY

FIGURE 27

AVERAGE TRIP LENGTH/LINK FOR THE MODULAR LOOP SYSTEM, GENESEE COUNTY



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MAP 10

of the trips on the links of the MLS have increased over being major arterials on the 1995 E+C Network. The assumption is that the traffic on these particular links are regional in scope for the lengths are between the traffic using the expressways and that traffic on local streets.

Figure 28 presents the rest of the urban network in terms of change in average trip length per link. Many remaining links have decreased in average trip length representing a local orientation forming these particular links. Those links which have increased in length on the network for the most part have relationships to the Modular Loop System and the expressway system.

F. TIME

Although the vehicle miles traveled on the network have increased, the resulting volumes have been dispersed more desirably throughout the network. The time involved in making trips on the network has decreased substantially (see Table 12).

The time saved by implementing the Modular Loop System is very significant. Theoretically, the VMT can be reduced, thus the time involved in the network could be further decreased. As the system now appears there is an 8% decrease in the amount of time spent in transportation. The Modular Loop System, by reducing travel time, has made accessibility to all parts of the urban area of Flint greater (see Figure 29).

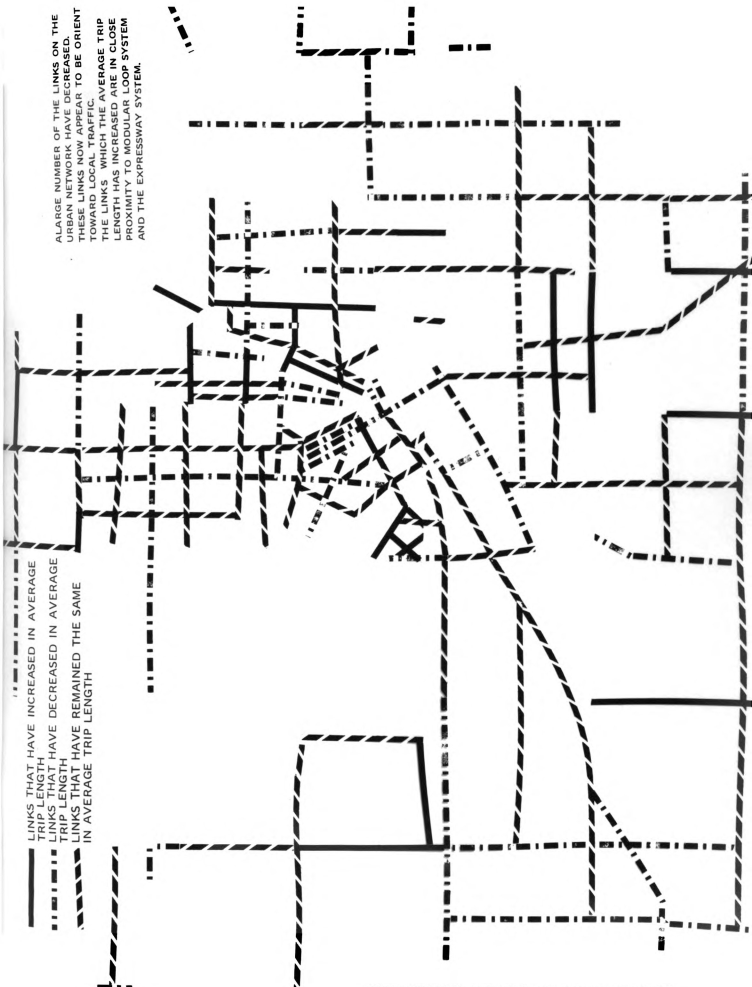
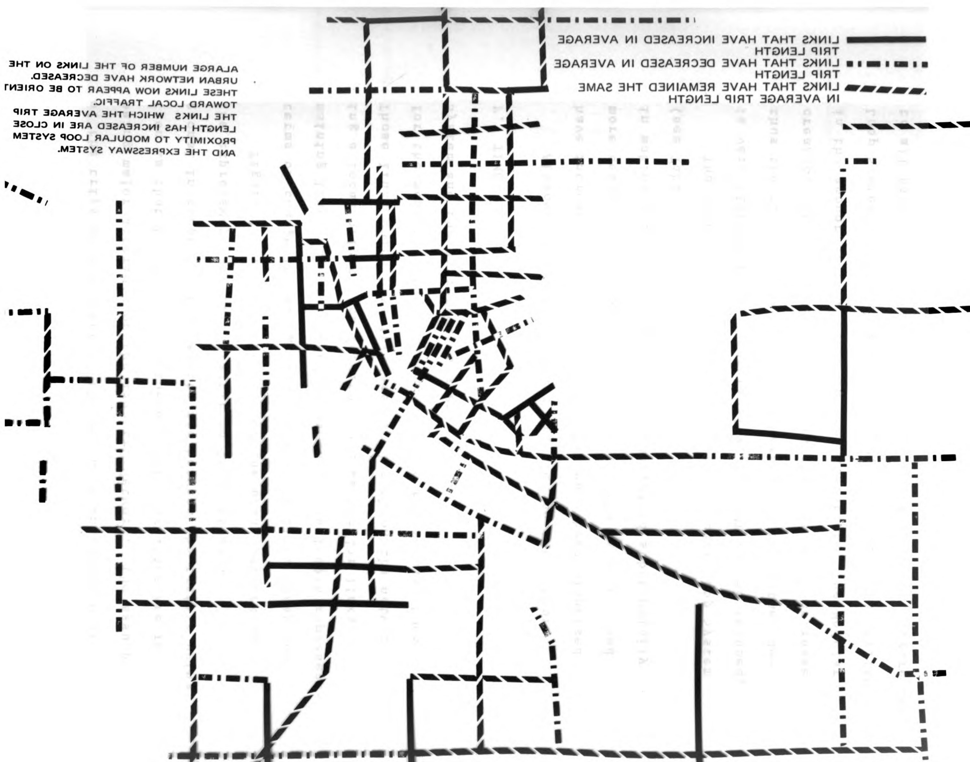


FIGURE 28 **AVERAGE TRIP LENGTH/LINK URBAN NETWORK GENESEE COUNTY**



AVERAGE TRIP LENGTH/LINK URBAN NETWORK
GENESEE COUNTY
MAP 11

TABLE 12

VEHICLE HOURS

	Old Highways	Major Arterial		Minor Arterial		Collectors		Centroid Links	Expressway			Modular Loop System	Total
In (000) Hrs.	0	1	2	3	4	5	6	7	8	9	10	15	
Existing + Committed													
1995	25	9	26	9	57	33	16	0	10	19	22	0	206
Modular Loop System	22	4	21	3	22	23	13	0	8	15	18	41	190
Difference	16,000 Hours Per Day												
% Decrease	8%												

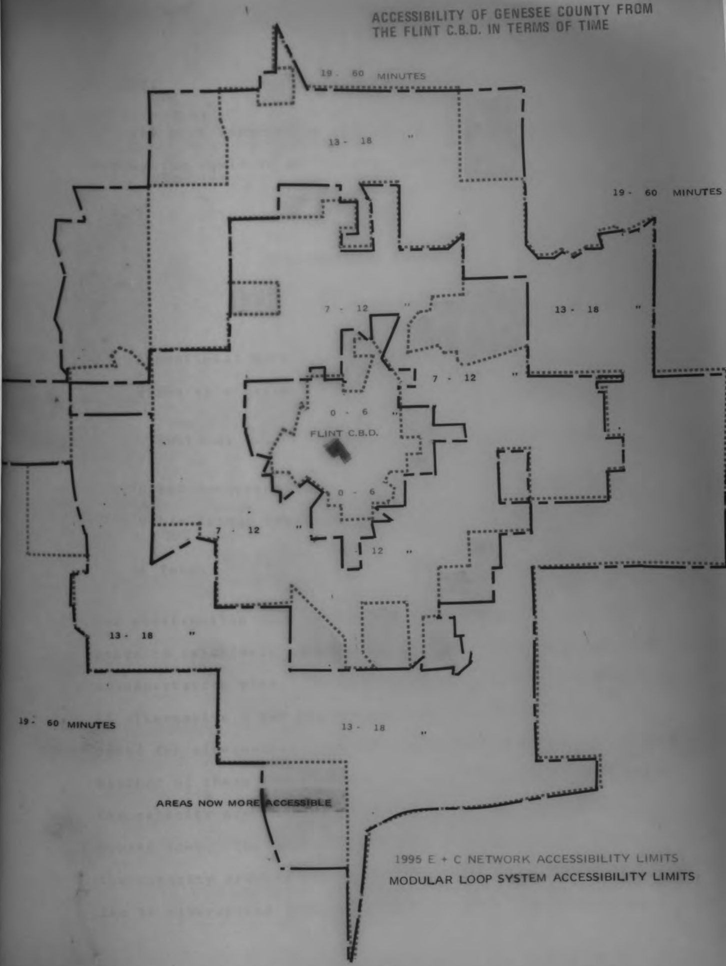
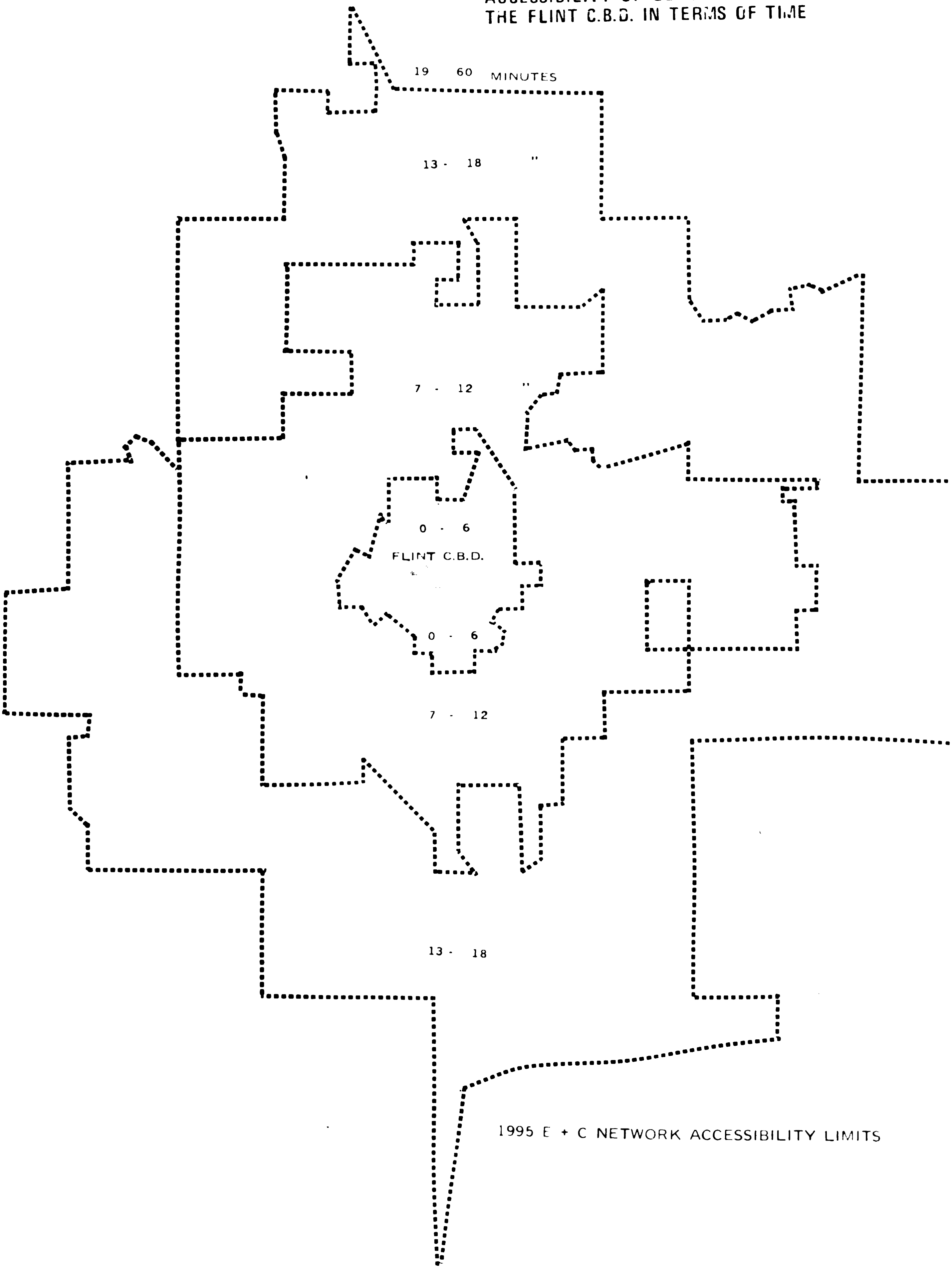
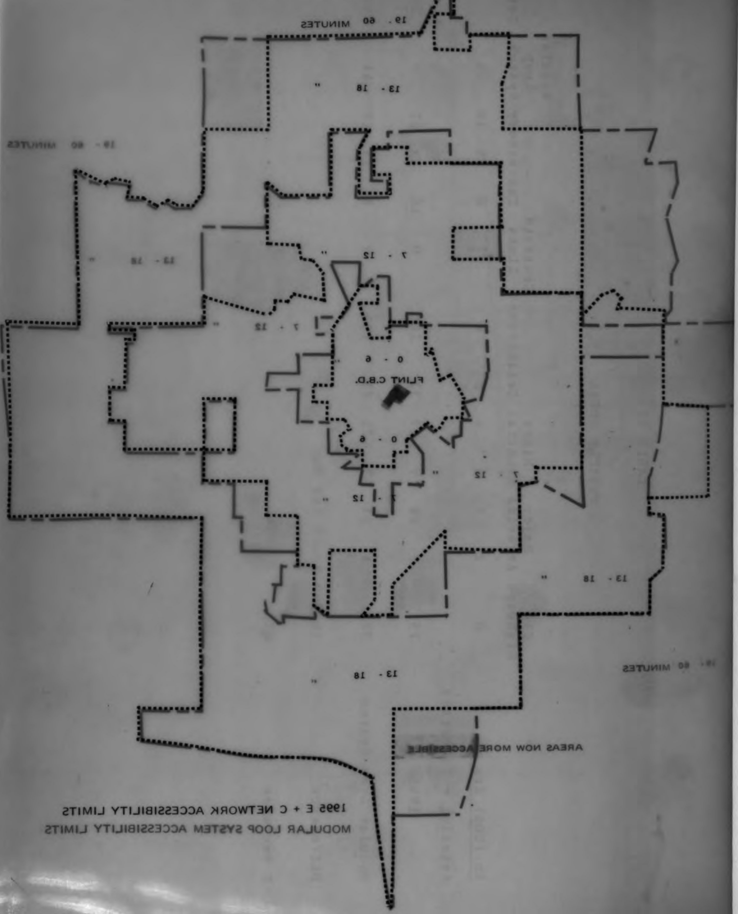

ACCESSIBILITY OF GENESEE COUNTY FROM
THE FLINT C.B.D. IN TERMS OF TIME
19 - 60 MINUTES
13 - 18 "
19 - 60 MINUTES
7 - 12 "
13 - 18 "
7 - 12 "
0 - 6 "
FLINT C.B.D.
0 - 6
7 - 12 "
12 "
13 - 18 "
19 - 60 MINUTES
13 - 18 "
AREAS NOW MORE ACCESSIBLE
1995 E + C NETWORK ACCESSIBILITY LIMITS
MODULAR LOOP SYSTEM ACCESSIBILITY LIMITS

FIGURE 29

ACCESSIBILITY OF GENESEE COUNTY FROM THE FLINT C.B.D. IN TERMS OF TIME



ACCESSIBILITY OF GENESEE COUNTY FROM THE FLINT C.B.D. IN TERMS OF TIME



MAP 12

G. COST

The cost incurred in the construction of the Modular Loop System would be as follows (Table 13).

TABLE 13

CONSTRUCTION COSTS

	Miles of MLS	Construction Cost
Superficial Work	26	$ 2,600,000
Widen to 4 Lanes	66	26,400,000
SubTotal	92	28,000,000
Urban Overpasses	6	6,000,000
Urban Fringe Overpasses	10	6,000,000
Total	200	$40,000,000

The construction cost of the MLS spread over the next twenty years is relatively inexpensive if instituted into the 1995 transportation plan. This compares to the cost of $39 million if alternative 1 was implemented and the $600 million proposed for alternative 2 or the "ultimate" freeway alternative. Neither of these two alternatives, if implemented will solve the capacity problems as effectively as the Modular Loop System does. The Modular Loop does not completely solve the capacity problem but by apportioning the volumes of traffic to diversified link types and to establish a regional system, the Modular Loop becomes a most viable alternative in formulating á transportation plan for Genesee County.

As well as being relatively inexpensive, the Modular Loop System shows a marked savings in operating cost (Table 14).

TABLE 14

OPERATING COST

Old Highways	44,800	40,800
Major Arterials	59,200	42,800
Minor Arterials	75,900	43,500
Collectors	80,000	59,900
New Highways	103,200	84,100
Modular Loop	0	74,700
	363,100 Daily	339,800 Daily

$6,400,000/yr. Savings

5.3% Decrease

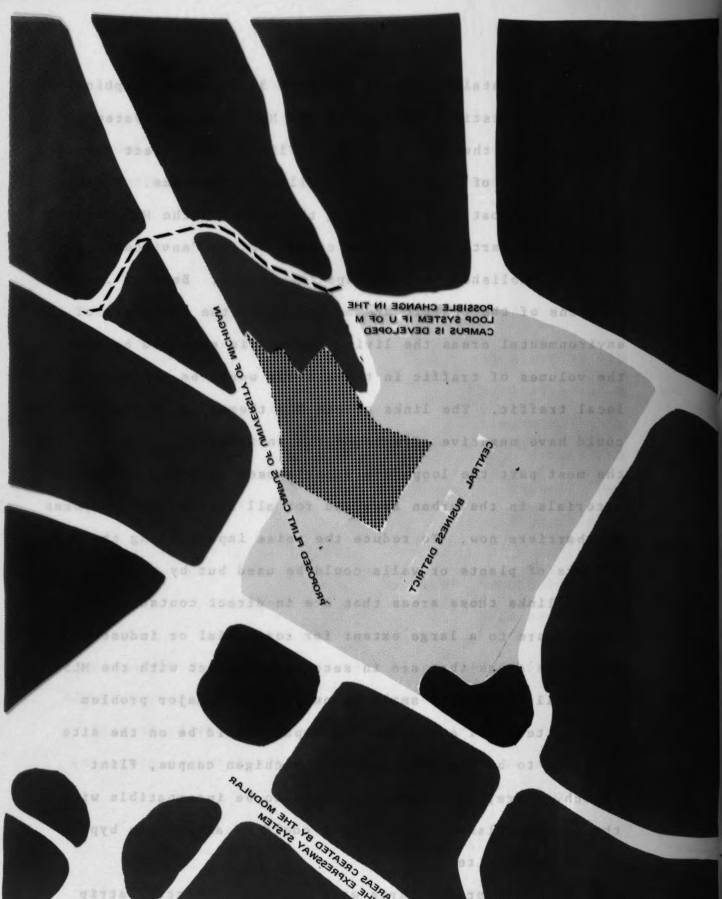
These figures were based upon speed/link type tables, taking into consideration stop and go movements. Because the MLS maintains constant traffic flow, the automobile is able to operate at a more efficient level thus reducing operating cost for the driver.

H. ENVIRONMENTAL IMPACT

The environmental impact if the Modular Loop System were to be implemented is a nebulous realm of public safety and environmental pollution. Figure 30 presents graphically the characteristic effects that the Modular Loop System would have on the central core of Flint. The effect involved would be that of noise and air pollution problems. These effects are most dominant along the links of the MLS dispersing the farthest into the center of the "environmental areas" established by the loops themselves. Because large portions of the traffic are moving along the periphery of the environmental areas the living quality is enhanced because the volumes of traffic in these areas would be restricted to local traffic. The links of the MLS themselves being barriers could have negative effects on the environment. However, for the most part the loops are superimposed on major and minor arterials in the urban area and for all intents and purposes are barriers now. To reduce the noise impact along the MLS buffers of plants or walls could be used but by the nature of the links those areas that are in direct contact with the MLS are to a large extent for commercial or industrial use. The areas that are in secondary contact with the MLS are still relatively small in number. One major problem area in terms of environmental impact would be on the site proposed to be the University of Michigan campus, Flint branch. Here, if the MLS is found to be incompatible with the proposed land use, the loop could be altered to bypass the proposed site.

A second problem area would be the commercial strip along Saginaw Road north of Flint. Here the structures are

FIGURE 30 | FLINT | ENVIRONMENTAL IMPACT | CENTRAL CORE

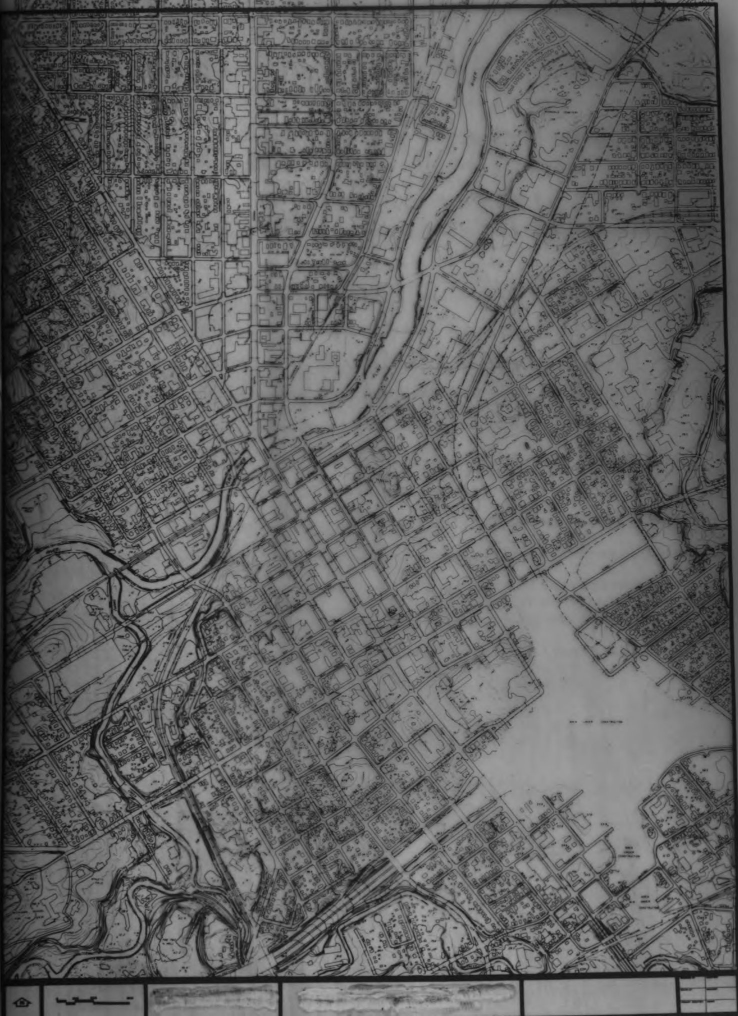


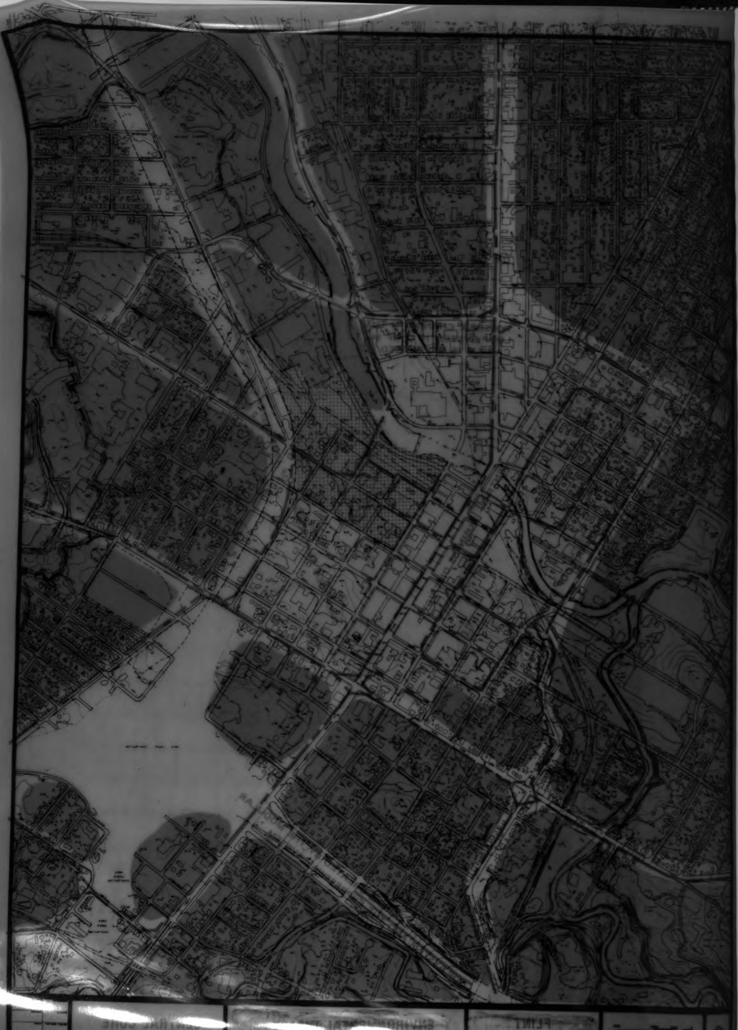
FLINT CENTRAL CORE ENVIRONMENTAL IMPACT MAP 13


LINKS OF THE MODULAR LOOP SYSTEM FOR CENTRAL CORE

CENTRAL CORE ENVIRONMENTAL IMPACT FLINT

MAP 13





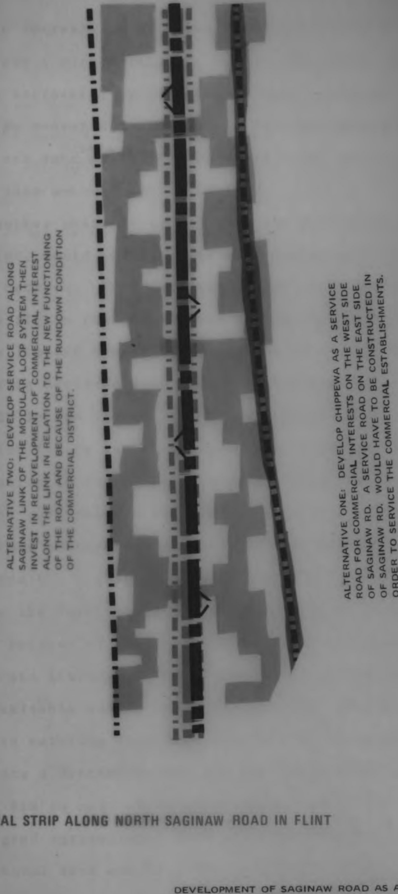
situated in such a way as not to allow right of way for a service road, which would be the logical concept to establish for all commercial strip developed, given the limited access is the desired results of the MLS (see Figure 31). A solution to the problem could be developed in either of two alternatives. First, because there is not enough space along Saginaw Road to develop service roads, side streets along the back of the commercial areas could be used. On the west side of Saginaw this poses no problem for Chippewa Street could be used. On the east side however, there is no clear cut side street, thus in order to service the commercial areas properly a service road would have to be constructed. The second alternative is far more costly, but, considering the area, probably more desirable. Given the deteriorating condition of the commercial strip in the next twenty year revitalization is necessary for this area. This revitalization could take the form of extensive redevelopment and allowing enough area for the MLS to function properly.

Further analysis of the MLS presented evidence that air pollution would actually be reduced (see Table 15).

TABLE 15

24 HOUR 1995 VEHICLE POLLUTANTS

Pollutant	1995 E+C	Modular Loop System	% Decrease
Carbon Monoxide	105,050 Lbs.	101,520 Lbs.	4.3%
Hydro-Carbon	5,489 Lbs.	5,212 Lbs.	5.3%
Nitrogen Oxides	9,444 Lbs.	9,783 Lbs.	+3.5%

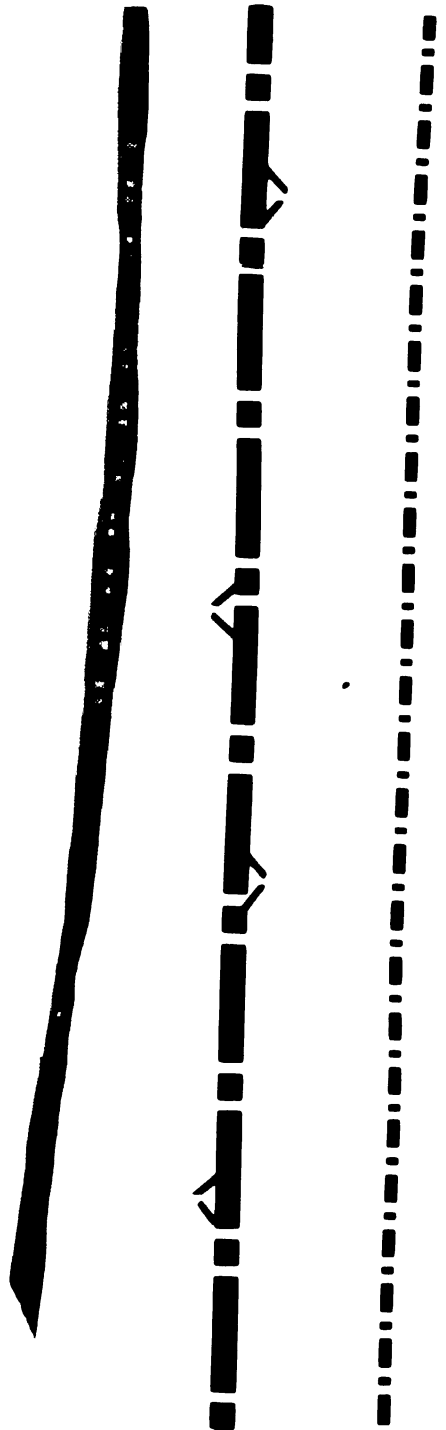


COMMERCIAL STRIP ALONG NORTH SAGINAW ROAD IN FLINT

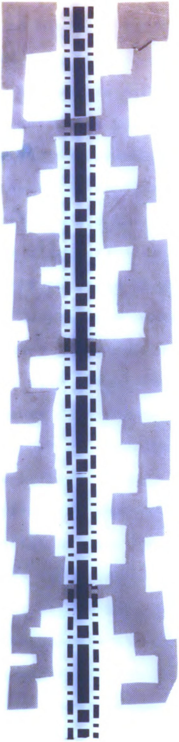
DEVELOPMENT OF SAGINAW ROAD AS A LINK IN THE MODULAR LOOP SYSTEM COULD HAVE DAMAGING EFFECT ON THE COMMERCIAL INTERESTS IN THE AREA.

FIGURE 31

ALTERNATIVE ONE: DEVELOP CHIPPEWA AS A SERVICE ROAD FOR COMMERCIAL INTERESTS ON THE WEST SIDE OF SAGINAW RD. A SERVICE ROAD ON THE EAST SIDE OF SAGINAW RD. WOULD HAVE TO BE CONSTRUCTED IN ORDER TO SERVICE THE COMMERCIAL ESTABLISHMENTS.



DEVELOPMENT OF SAGINAW ROAD AS A LINK IN THE MODULAR LOOP SYSTEM COULD HAVE DAMAGING EFFECT ON THE COMMERCIAL INTERESTS IN THE AREA.



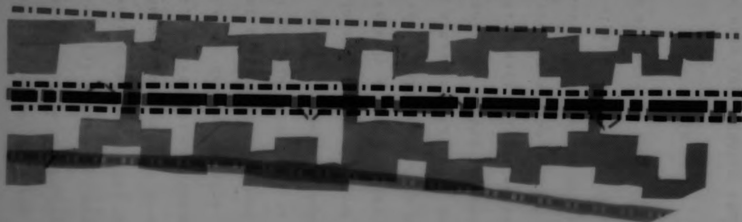
ALTERNATIVE TWO: DEVELOP SERVICE ROAD ALONG SAGINAW LINK OF THE MODULAR LOOP SYSTEM THEN INVEST IN REDEVELOPMENT OF COMMERCIAL INTEREST ALONG THE LINK IN RELATION TO THE NEW FUNCTIONING OF THE ROAD AND BECAUSE OF THE RUNDOWN CONDITION OF THE COMMERCIAL DISTRICT.

COMMERCIAL STRIP ALONG NORTH SAGINAW ROAD IN FLINT

FIGURE 31

COMMERCIAL STRIP ALONG NORTH SAGINAW ROAD IN FLINT

ALTERNATIVE TWO: DEVELOP SERVICE ROAD ALONG SAGINAW LINK OF THE MODULAR LOOP SYSTEM THEN INVEST IN REDEVELOPMENT OF COMMERCIAL INTEREST ALONG THE LINK IN RELATION TO THE NEW FUNCTIONING OF THE ROAD AND BECAUSE OF THE RUNDOWN CONDITION OF THE COMMERCIAL DISTRICT.



ALTERNATIVE ONE: DEVELOP CHIPPEWA AS A SERVICE ROAD FOR COMMERCIAL INTERESTS ON THE WEST SIDE OF SAGINAW RD. A SERVICE ROAD ON THE EAST SIDE OF SAGINAW RD. WOULD HAVE TO BE CONSTRUCTED IN ORDER TO SERVICE THE COMMERCIAL ESTABLISHMENTS.

DEVELOPMENT OF SAGINAW ROAD AS A LINK IN THE MODULAR LOOP SYSTEM COULD HAVE DAMAGING EFFECT ON THE COMMERCIAL INTERESTS IN THE AREA.

MAP 14

The increase in Nitrogen Oxide pollution is unavoidable for it has a direct relation to the VMT, thus, because the VMT was increased, so was the nitrogen oxide pollution. However, the monoxide pollution did decrease substantially and over a one year period the decrease would result in 1,400,000 pounds less monoxide being emitted.

Another positive impact that the MLS would have if implemented, would be a reduction in the numbers of accidents on the network. This increase in public safety is due to the traffic on the loop system moving in the same direction and the limited number of access points to the MLS. Because the MLS is designed with these characteristics, a reduction of 16.3% in the number of accidents is possible. With a reduction in the number of accidents likewise there will be a reduction in the accident costs. These decreases in accident cost coupled with the reduction in operating costs represents substantial savings for the automobile user.

Finally, a long range positive impact of the MLS would concern the physical environment and future land use preparation. Because of the nature of the MLS with constant desirable speeds and limited access points to the system future land use of a desirable nature could be obtained. While the MLS conforms to existing land use, it could be of great benefit in promoting a desirable land use pattern. By limiting access to the MLS to only those areas deemed desirable for development, good agricultural land and land chosen to be left in its natural form can be saved from development.

I. SUMMARY

The Modular Loop System is a network of one-way, limited access roadways which are superimposed on existing streets in the urban area of Genesee County. It's function is to attract intermediate length trips from over capacity links in the network and to bring the trips at desirable speeds into close proximity of major commercial, employment centers, etc. Table 16 illustrates, in summary, the results of model testing of the Modular Loop System.

TABLE 16

COST & BENEFITS

OF MODULAR LOOP SYSTEM

1. Increased vehicle miles traveled by 3.5%.	1. Dispersed trip more proportionately through the system.
2. Construction cost, $40,000,000.	2. Reduced over capacity on congested links.
3. Increased nitrogen pollution by 3.5%, 115,054 LBS/yr. due to higher VMT.	3. Decreased travel time by 8% savings, 5,400,000 Hr./Yr.
4. Possible redevelopment of commercial strip along North Saginaw.	4. Increased accessibility in Genesee County.
	5. Decreased operating cost by 5.3%, $6,390,000/Yr.
	6. Construction cost in terms of other alternatives.
	7. Decreased number of accidents by 16.3%
	8. Decreased accident cost.
	9. Decreased monoxide pollution by 4.3%, 1,400,000 LBS/Yr.
	10. Decreased hydro-carbon pollution by 5.3%, 94,860 LBS/Yr.
	11. Promotes peripheral circulation less damaging to the environment.
	12. A tool for insuring desirable future land use.

CHAPTER IV

CONCLUSION

CHAPTER IV

CONCLUSION

To be effective as a viable alternative transportation network, the Modular Loop System must have a positive impact on the problems associated with the motor vehicle mode of transportation. The problems are congestion, efficient land use, pollution, and lack of both change and the capacity to change. Through the simulation modeling process it was possible to see the effects which the Modular Loop System has on these problems.

Congestion

When implemented onto the Flint-Genesee County network, the Modular Loop attracted large volumes of traffic, 2,106,000 vehicle miles traveled. Of these, 571,000 were attracted from the over capacity links of the highway system, relieving, to some extent, the congestion on those particular links. This was accomplished also to a lesser extent on the major arterials in the region, thus reducing the traffic on those corridors. Because the Modular Loop System was attractive to drivers as a regional roadway, some over capacity on the Modular Loop was inevitable. North Saginaw Road in Flint is an example of this.

If the city of Flint becomes committed to some form of regionally oriented network of corridors, such as the Modular

Loop System, traffic can be diverted and congestion can be reduced on other links in the network. Traffic congestion can be avoided on the Modular Loop System itself if the proper accommodations are made for the number of vehicles expected to travel on the loop.

Efficient Land Use

This is emphasized in several characteristics of the Modular Loop System. The first is the re-use of existing roadways. This is done by upgrading and in some cases widening existing corridors to serve as links on the Modular Loop System. In the test case concerning the city of Flint, 93 miles of existing major and minor arterials were used as the links of the network. By using existing roadways, allocation of funds for transportation purposes was kept at a minimum.

The second characteristic of the Modular Loop System which could foster more efficient land use in the future is the concept of limited access. By limiting access to the transportation corridors it is possible to arrange for those areas considered to be the most desirable for development to have the most direct access, while those areas considered to be most desirable in the natural state would have very limited, secondary access.

Air Pollution

For the most part air pollutants have been reduced due to the Modular Loop System. In the simulation model testing the monoxide pollution was decreased by 4.3%, a reduction of 1,400,000 pounds of monoxide per year. Hydro-carbon pollution was reduced 5.3% or 94,860 pounds per year. Only nitrogen emissions were increased. This is due to the fact that nitrogen pollution varies directly with the vehicle miles traveled. Because of the increase in vehicle miles traveled the increase in nitrogen pollutants was 3.5% or 115,000 pounds per year.

Lack of Change

Capacity for Change

This deals with the physical properties of any mode of transportation. It is the ability of any mode of transportation to change as the needs of the system change. The automobile has been able to make the changes necessary; however, the roadways and corridors have not. Given the fact that the roadways involved in the Modular Loop system are existing streets it is possible that they can revert to their original form if they are no longer needed as a link in the network.

While these were the basic problems that the Modular Loop System was attempting to ameliorate, there are other, equally important, positive aspects. Briefly these are: (1) A reduction in operating costs. An individual will experience a reduction of 5.3% in operating costs for his automobile per year. For the entire network this is a savings of $6.4 million. (2) A decrease in the number of accidents. Because of the limited access, one-way movement aspects of the system, accidents could decrease 16.3%. That is almost one out of five accidents that could be prevented. (3) A decrease in accident costs. (4) A decrease in travel time. This has been decreased 8%, thus making specific locations in the region more accessible.

While there were many positive effects caused by the implementation of the Modular Loop System, there were also several negative effects. Because of the circumfrential movement of the system, distance traveled did in fact increase. Barriers were created and islands were established by the pattern of roadways in the network, because of the high capacity use, with relatively high speeds and wide links. The most damaging negative effect is the reorientation of lands adjacent to the Modular Loop System. By using existing streets for links of the Modular Loop System existing land uses can be hindered, given the limited access concept of the Modular Loop System. Special consideration is needed in these areas to determine the proper procedure.

The Modular Loop System could definitely be improved in the implementation stage. Although the pattern of links in the MLS was developed according to urban regional traffic flow, and the situation of the regional attractors, several alternative pattern placements should be attempted. If time and access to the Genesee County model were available, several alternative patterns could be made. Because of the traffic volumes involved; traffic flows, etc., it was assumed that the city of Flint was a strong central core and thus all the component legs of the Modular Loop System. Though the theory provides for bypasses to regional attractors, as does the simulated network, the city of Flint and particularly the Central Business District, play a very important role.

If another pattern were to be tested, one with dominant bypass links to the CBD would be beneficial to contrast with the MLS. As it stands, the Modular Loop System patterns of links was an attempt to create a network given the concepts involved and the limited computer modeling time. If there were more resources available it would be interesting to see what effects would be created if the bypasses between environmental areas were eliminated, what would happen if access was restricted even more, and to test locations for access points. Essentially, if at all possible, the regional circulation system proposed in the Modular Loop System network can be improved upon.

The Modular Loop System is an effective and beneficial form of street networks for a motor vehicle based transportation system. The MLS is not a complete solution but possibly an integral part of an urban transportation plan which attempts to insure efficient and convenient use of the automobile, transit, and all forms of transportation. Figure 32 presents the interrelations between the various components of a comprehensive urban transportation both private and public should be considered. Further study is feasible to uncover the possibility of some form of public transportation being adapted to the Modular Loop System.

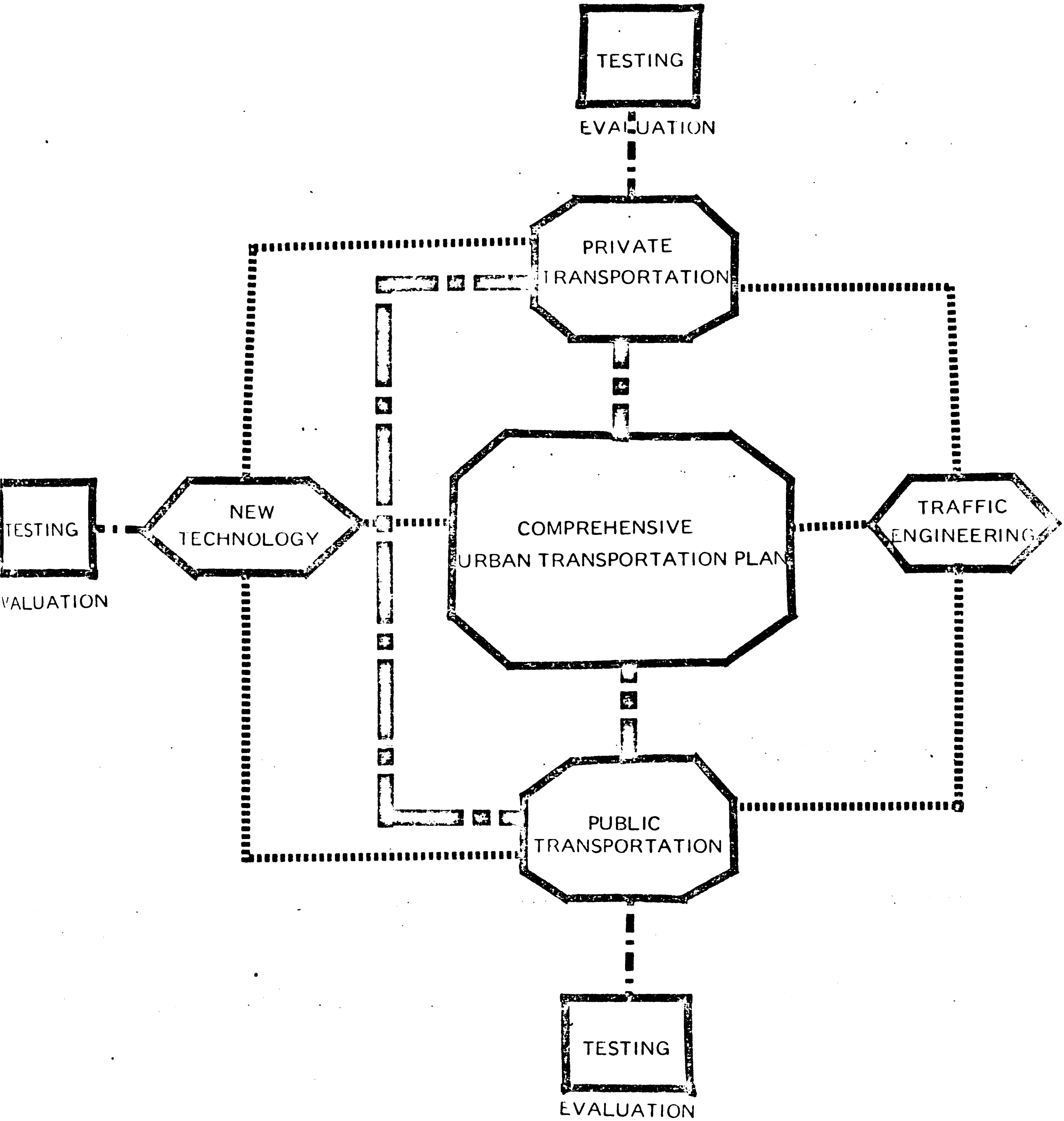


FIGURE 32

URBAN TRANSPORTATION PLAN

This possibility is very real for the pattern of roadways involved in the Modular Loop, to effectively cover the urbanized area of Genesee County and with the interconnecting character of all the major attractors the concept has appeal. Bus lines, bus stops, etc., could be easily injected to the network. Today the trend is toward private transportation and motor vehicle public transportation. The Modular Loop System is an effective base for the formation of any urban transportation plan, as long as all forms of transportation are sufficiently examined and either disregarded or implemented into the transportation plan.

If, in fact, the automobile is to remain the dominant form of transportation, and all indications are that it will be, then transportation planning must focus on goals, procedures and policies which will dictate a more efficient use of the automobile while maintaining or surpassing the conveniences which the automobile provides. The Modular Loop System was designed to create a regionally oriented road network and to relieve congestion. If this is achieved, the efficiency of the automobile would be greatly increased. This was, in fact, achieved. In terms of cost, the operating cost to the individual driver decreased due to operating the automobile at constant speeds. Time efficiency was greatly increased as well. Greater distances can be traveled in less time in the urban area. This time saving is a great convenience. The Modular Loop System and its simulated implementation are by no means a solution in themselves but do present an alternative that efficiently increases the usefulness and convenience of the automobile and in view of these results should be considered, for these are the basic goals of urban transportation planning.

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