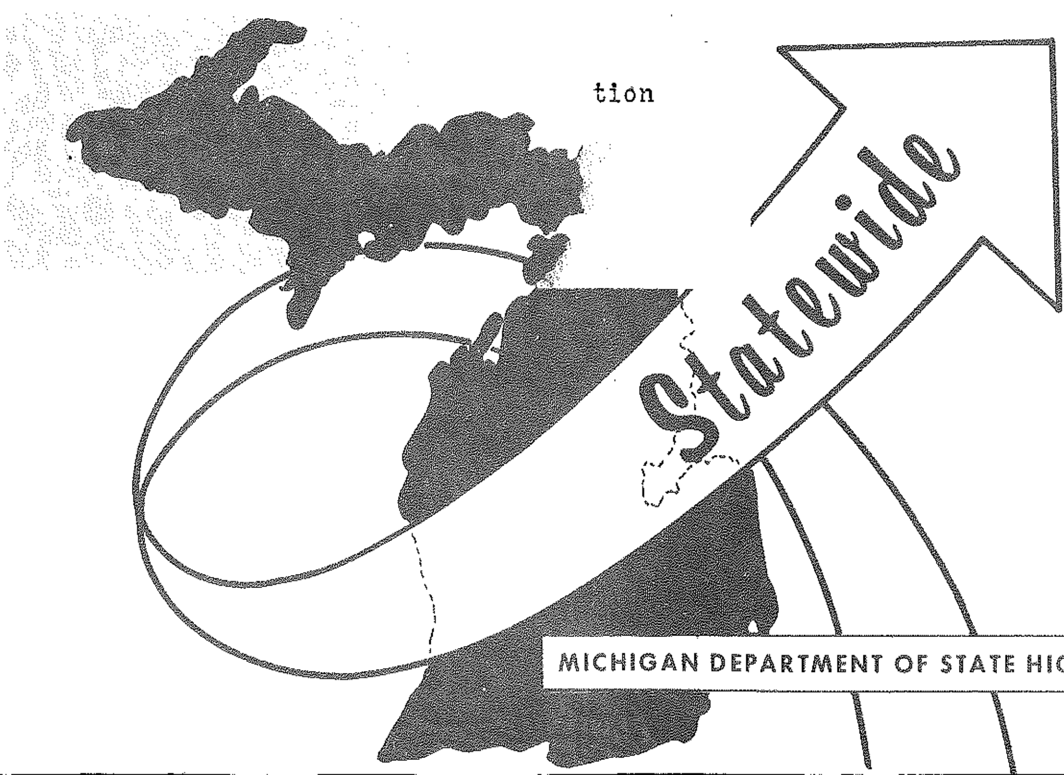
Statewide Transportation Analysis & Research

MICHIGAN'S
STATEWIDE TRAFFIC FORECASTING
MODEL

VOLUME II

DEVELOPMENT OF NETWORK MODELS

FEBRUARY, 1971
STATEWIDE STUDIES UNIT



MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

MICHIGAN DEPARTMENT

OF

STATE HIGHWAYS AND TRANSPORTATION

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ACKNOWLEDGMENTS

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Arthur Ashley: Graphics & Presentation

Dale Stanaway: Graphics & Presentation

Lucy D'Amelio: Editing & Form

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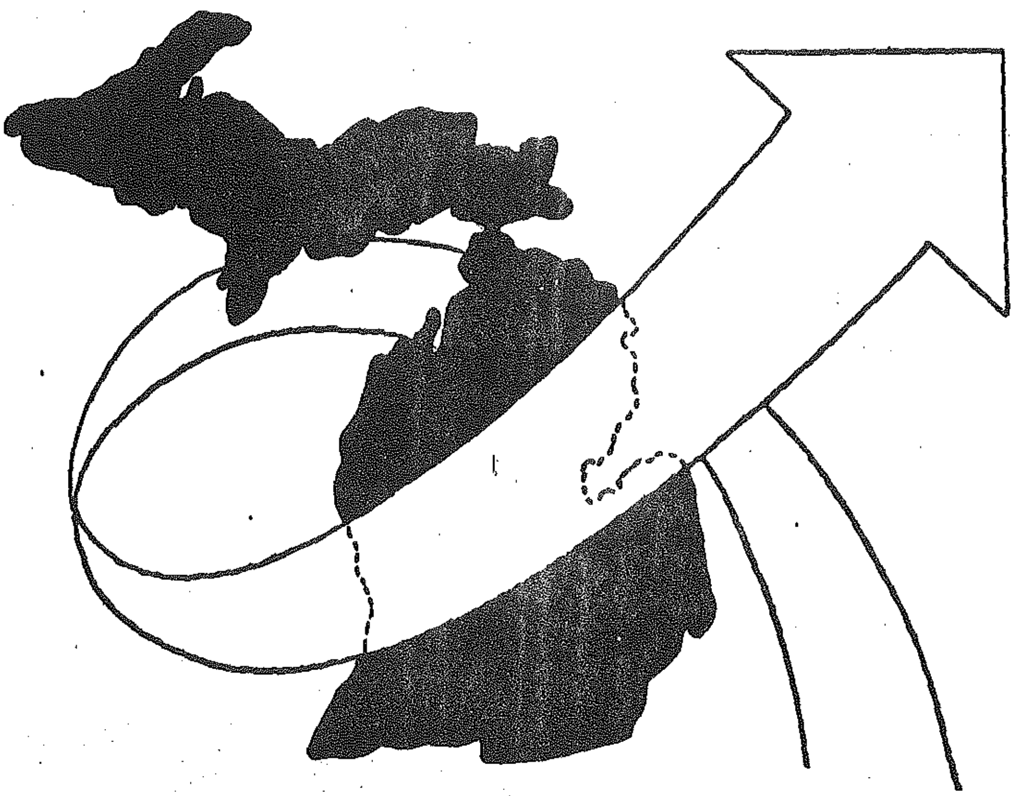


INTRODUCTION

This is Volume II in a series of reports dealing with the development and implementation of a computerized state-wide traffic forecasting model. As proposed in Volume I (Objectives and Work Program), Phase II of the development process would deal only with a 510 zone system. During Phases III and IV, however, a larger and more complex 2300 zone system was proposed.

The 510 zone system, as developed by Arthur D. Little Inc. Consultants, built on past efforts in the network model field and was kept as simple as possible to promote future usage and development. The first network model was simply a modification of an existing model developed by the Federal Highway Administration. At that time, the Administration's model appeared to be the most promising in terms of modification potential and practical application.

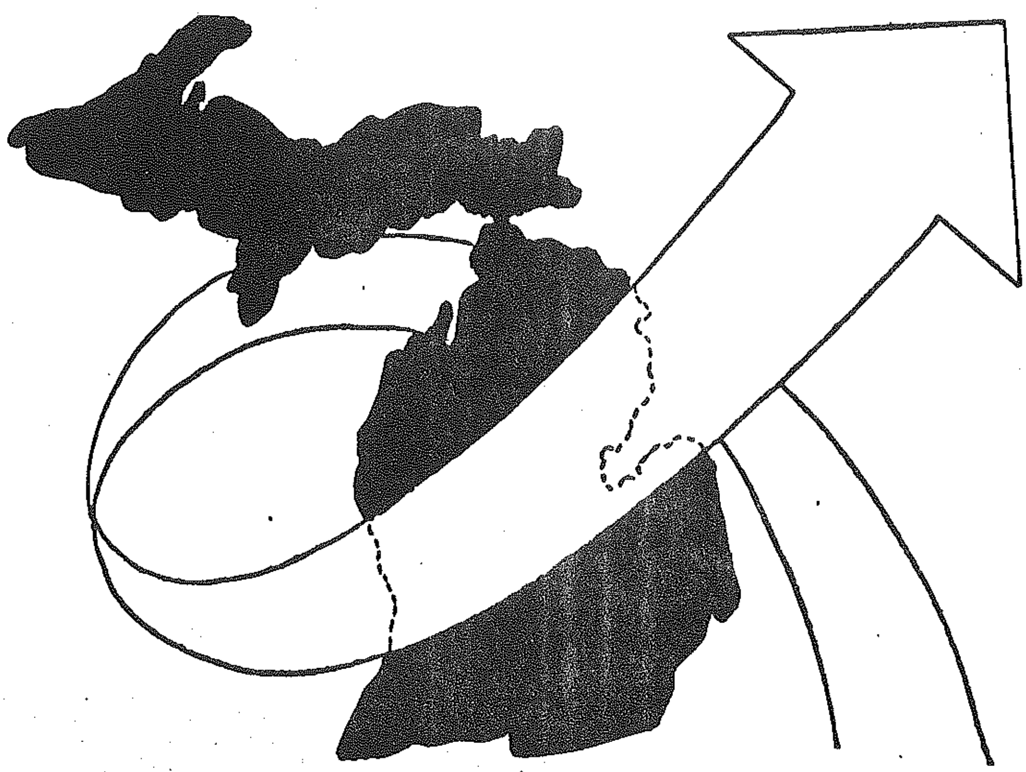
The desired simplicity of the original model, however, placed a limit on the degree of accuracy achieved in network assignment. Arthur D. Little Inc. Consultants felt at the time, however, "... that intelligent model employment rather than the seeking after a high degree of accuracy (was) the key to deriving utility." This was definitely true of the 510 zone system, but later technical developments proved the feasibility of more complex and accurate models.

The implementation of the larger and more comprehensive 2300 zone system came about, in part, as a result of problems encountered in the data collection portion of the aforementioned work program. Primarily, however, development of the 2300 zone system was advanced to its present position as a result of the desire for a more accurate and sophisticated network model.

This report deals with the definition and development of both the 510 and 2300 zone systems and their individual networks. The report does not deal with trip generation or network assignments as this material will be covered in forthcoming reports.

The 510 zone system was expanded to a 540 zone system late in 1970 due to acquisition and application of additional trip generation data. For report purposes, the 510 zone system will be referred to as such but some figures will carry the 540 zone designation for individual distribution purposes.

NETWORK DEVELOPMENT
510 ZONE MODEL



I. THE 510 ZONE STATEWIDE HIGHWAY NETWORK MODEL HISTORY

The application of scientific techniques and computer technology to the problems of transportation planning and traffic forecasting bear the burden of being labeled "something new and different." The theories and practical application of these fields has, in the past, been limited primarily to urban areas of transportation study. The initiation of inquiry into statewide areas of application is still an infant in the family of network model building.

As new as the area of study appears to be, remarkable strides in terms of progress are not to be overlooked. Michigan was among the first to recognize the potential of statewide model building and began application with the retention of Arthur D. Little Inc. Consultants early in 1965. A merging of talents created the original 510 zone system which is still being used today as a basis for reference in terms of larger model building activities.

At the inception of the original system, computer technology and capabilities necessarily limited the size and scope of the initial study. The number of zones, network definition, and other aspects of the study were purposely limited in order to fall within the range of computer capabilities. Since that time, computer technology has expanded and progressed to the point where larger and more comprehensive models could be developed.

With the future in mind, the original 510 zone system was initially designed for expansion to a larger and more comprehensive network model. According to Arthur D. Little Inc. Consultants, one of the primary purposes of the initial study was; "... to develop a model which can be improved over time rather than to develop a closed model where future growth might be limited."

II. NETWORK DEFINITION OF 510 ZONE SYSTEM

A. The Definition of Zones:

The 510 zone system displayed more heterogeneity in zone size and structure than the 2300 zone system. This was due, principally, to the fact that the 510 zone system used larger geographic areas for zone descriptions. Entire urban areas were often considered a single zone. In most cases, townships or combinations of townships were the standard zone base for the 510 zone system. Data gathering becomes easier when complete townships or cities are used for zones because demographic, economic, and other trip generation information is normally gathered at those levels.

All is not entirely well, however, for another consideration becomes apparent at this point. Zones must also be small enough to reflect the inter-zonal travel between them on a specified network. If, for example, the entire State of Michigan were considered a single zone, estimation of travel patterns within the zone or projections thereof would be impossible. Then again, if every household was considered a suitable zone, then the system would become too unwieldy to manage. So it is understood that a happy medium must be reached where collection of data per zone size is feasible while at the same time accurate indications of the inter-zonal travel can be represented on a reasonable network scale.

Heterogeneity and simplicity within zone structure, therefore, is important when a new system (like the 510) is being defined and coded. The smaller system was purposely limited for this reason along with other considerations. (The 2300 zone system, however, was not limited and the trip generation equations will necessarily become more discerning and complex.) Basically, within a statewide model, separation of zones into specific trip generation categories is simpler and the majority of zones" ... tend to merge into a single measure of traffic movement potential."(1) According to Arthur D. Little Inc. Consultants, ... "The criteria employed in choosing the zones lying within the State of Michigan were as follows:

- Zones should consist of an aggregation of one or more townships and/or cities which are contiguous.

- A zone should lie entirely within one county.

- All cities except Detroit with population exceeding 10,000 should form a single zone (Detroit was split into three zones).

(1) Arthur D. Little Inc.

- Any township or city with a population of 2500 or less should be combined with one or more adjacent townships or cities to form a zone.
- Zones should usually have a population of 2500 or more except where such zones would be unusually large in area.

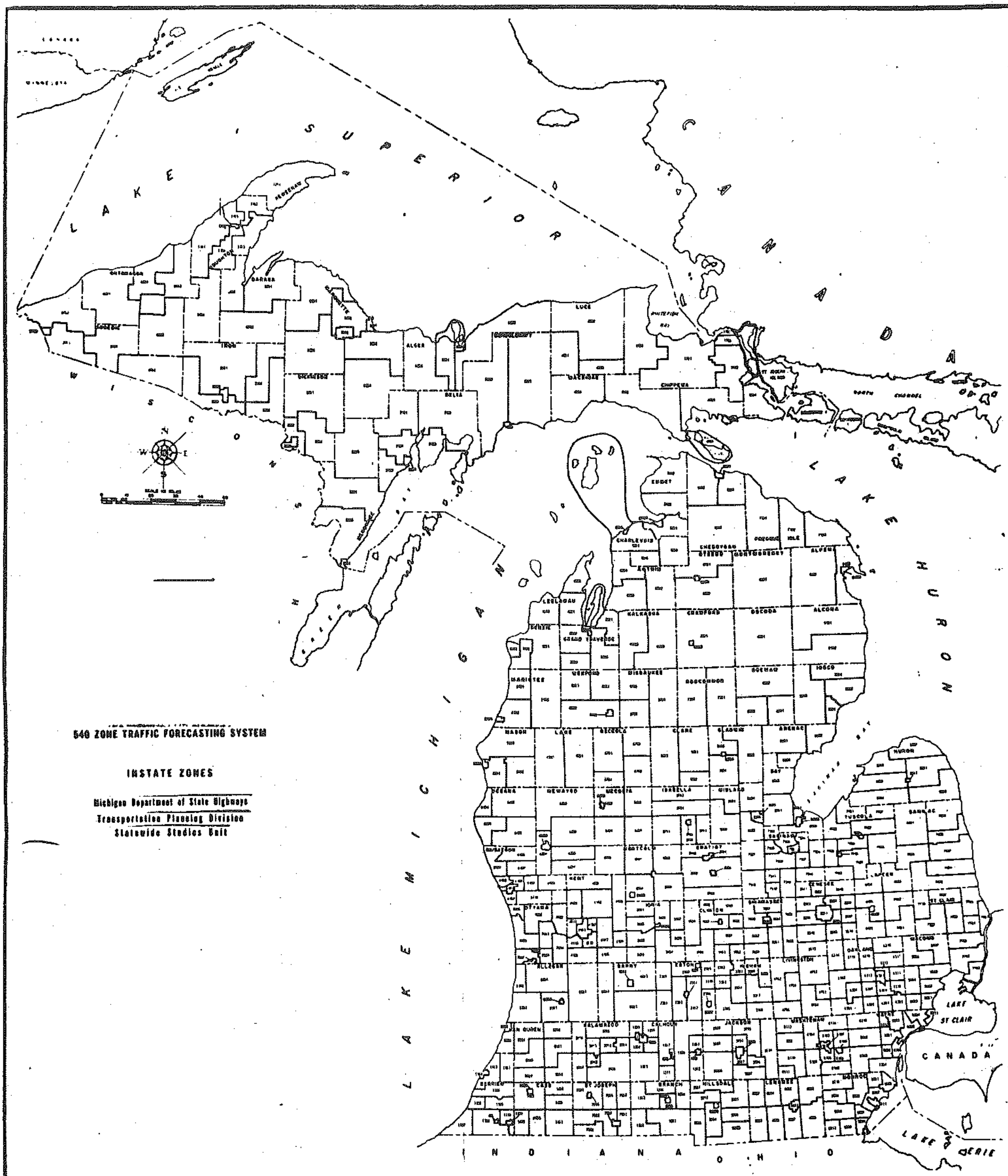
A total of approximately 480 zones within Michigan were selected in this manner. (See Figure 1) In addition, a set of 30 out-of-state zones were chosen to provide a mechanism for describing trips entering and leaving the state. The above criteria were not applied to these out-of-state zones, and they were considerably larger in size. (See Figure 2)

B. <u>Numbering the Zones</u>:

Briefly, a special coding system was selected in order to facilitate the identification of zones. It consists of the letter Z followed by a four-digit code; the first two digits consist of the code for the county in which the zone lies and the last two digits are used to identify the particular zone in that county. The county codes were derived by listing the counties in alphabetical order (where Saint Joseph County precedes Sanilac County, etc.) and numbering them from one to 83. Thus, Grand Traverse County is county number 28 and contains five zones. They are coded as zones Z2801. Z2802, Z2803, Z2804, and Z2805. All counties within the state were coded in this manner. (See Figure 3)

This zone numbering system was selected so as to facilitate zone location and socio-economic data bank

FIGURE 1



LAKE SUPERIOR
CANADA
LAKE HURON
LAKE MICHIGAN
WISCONSIN
INDIANA
OHIO
CANADA
LAKE ST CLAIR
LAKE ERIE
540 ZONE TRAFFIC FORECASTING SYSTEM
INSTATE ZONES
Michigan Department of State Highways
Transportation Planning Division
Statewide Studies Unit

FIGURE 2

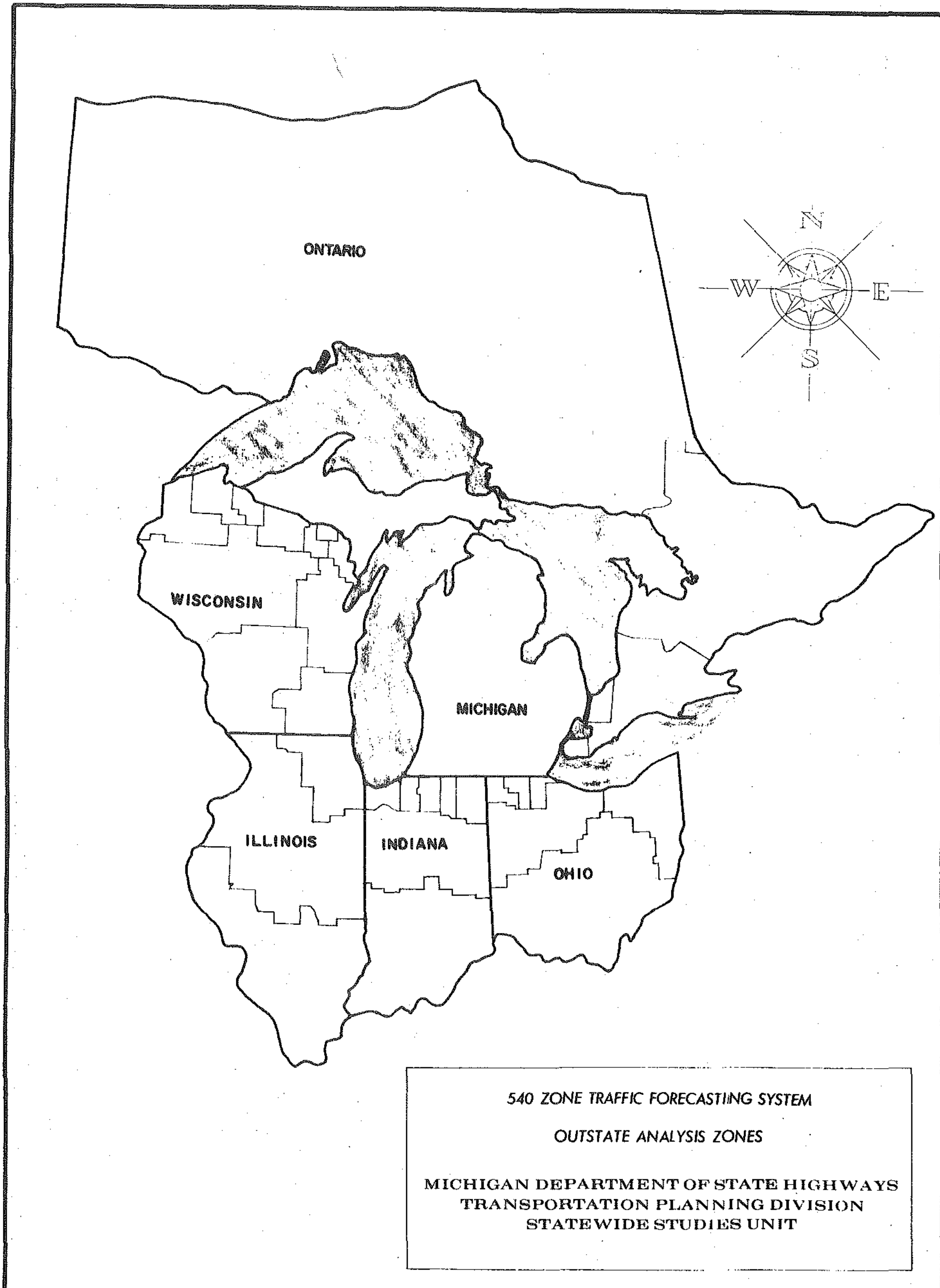
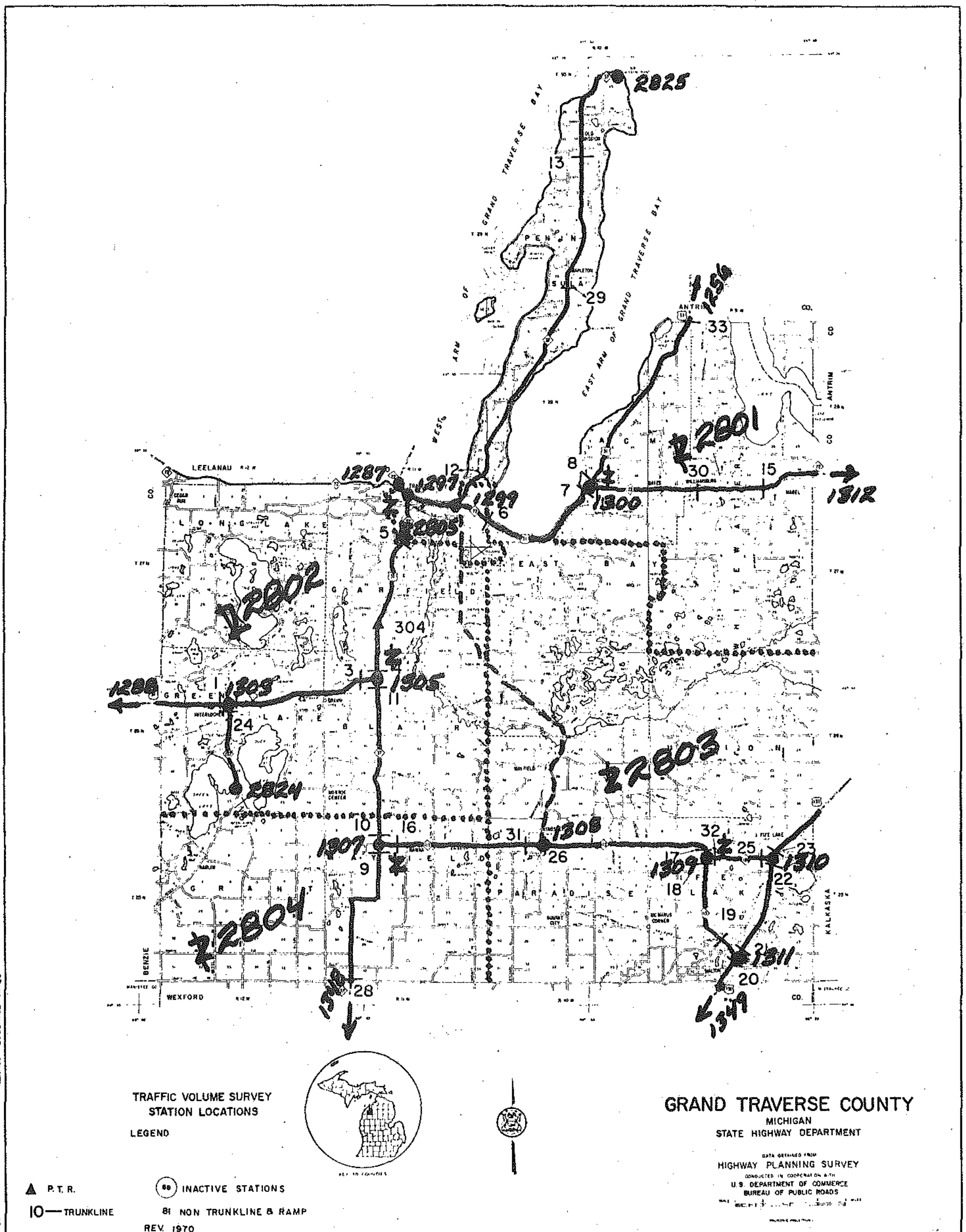

ONTARIO
N
W
E
S
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
540 ZONE TRAFFIC FORECASTING SYSTEM
OUTSTATE ANALYSIS ZONES
MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRANSPORTATION PLANNING DIVISION
STATEWIDE STUDIES UNIT

Figure 3



GRAND TRAVERSE BAY
WEST ARM OF GRAND TRAVERSE BAY
EAST ARM OF GRAND TRAVERSE BAY
PENINSULA
LEELANAU CO
LONG LAKE
GARFIELD
EAST BAY
WHITEWATER
ACME
GREEN LAKE
BLAIR
UNION
GRANT
MAYFIELD
PARADISE
FIFE LAKE
ANTRIM CO
KALKASKA
BENZIE
WEXFORD
TRAFFIC VOLUME SURVEY
STATION LOCATIONS
LEGEND
P. T. R.
10 — TRUNKLINE
INACTIVE STATIONS
81 NON TRUNKLINE & RAMP
REV. 1970
GRAND TRAVERSE COUNTY
MICHIGAN
STATE HIGHWAY DEPARTMENT
HIGHWAY PLANNING SURVEY
U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
GRAND TRAVERSE COUNTY

development during a later phase in the model development program. A computer program was defined which correlated these zone numbers to sequential zone numbers for use in the Federal Highway Administration's traffic assignment program.

C. Location of County Roads:

Zone size also affected the frequency of use of county roads within the 510 zone system. The larger the zones, the greater the probability that a major trunkline can accurately reflect the interchange of traffic between those zones. With this being the case, frequency of county road application was limited and necessarily kept to a minimum. When inter-zonal traffic could not be assigned to major trunklines, county roads were then used to accommodate the desired travel patterns. County roads used were generally of the Federal-Aid Secondary classification and reflected preferred routes of intra-county or intra-township travel. Calibration of the 510 zone model will supply additional information which may modify the original assumptions regarding network definition.

D. Link Selection and Data:

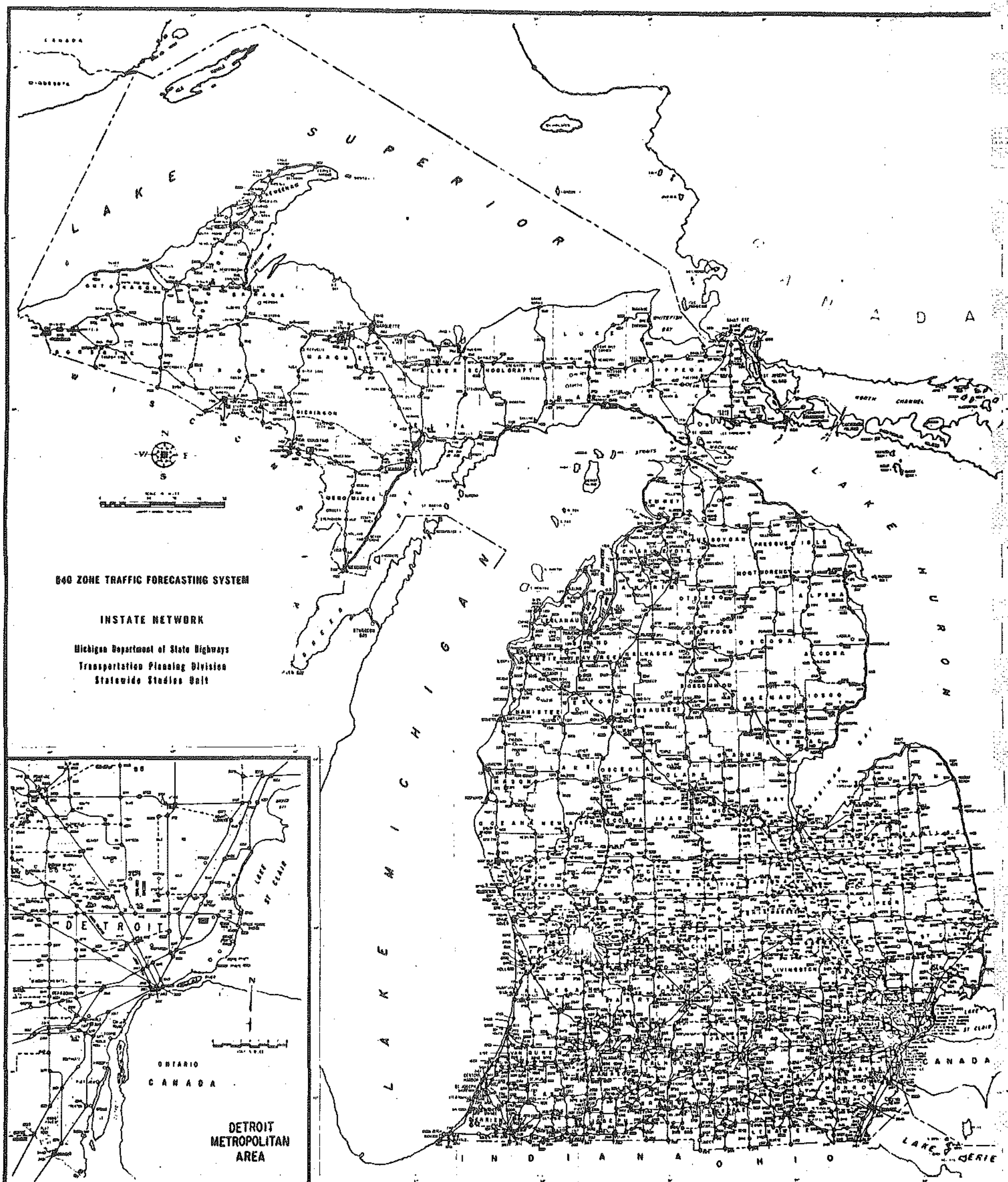
"The highway network under study was described in the computer model by a set of links and nodes. The nodes represent link intersections and are numbered. The location of a link was described by the node numbers for the two nodes it connects.

There are two basic types of links in the system: regular highway links and pseudo links were used to connect a zone centroid or loading node to a node in the regular highway network, and provided a mechanism for feeding the traffic to and from a zone off and onto the highway system. A regular highway link was used to describe a section of highway. Pseudo links were required because it is necessary to identify zone centroids or loading nodes separately from regular highway intersection nodes. (See Figure 3)

Selecting the highway links primarily involves the task of selecting the highways to be included in the system, depending on zone size and density. In the 510 zone system, these include all interstate, U.S., and Michigan routes as well as selected county roads in the state. The final Michigan statewide model highway network appears in Figure 4. In addition, a highway route around Lake Michigan through Wisconsin, Illinois, and Indiana was included in order to allow the traffic between the Upper and Lower Peninsula the option of taking this route in contrast to the Mackinac Bridge. (See Figure 5) The other major outstate highway link was the Indiana-Ohio Toll Road.

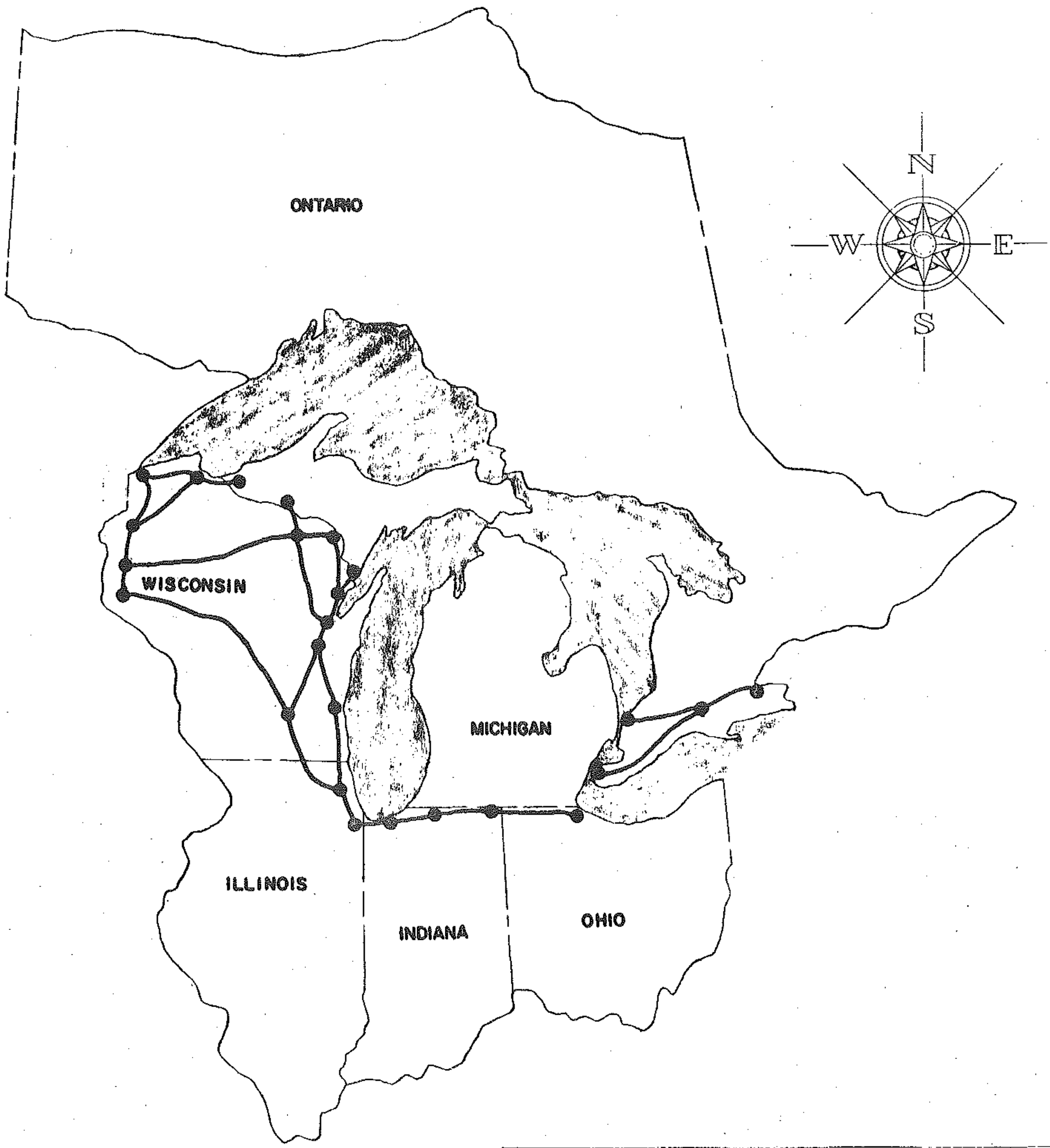
When the 510 zone system was defined, there were a number of constraints on the links in the system which were observed because of the computer programs used in the network analysis phase. First, no more than four links (including pseudo links) may be connected to a single node. Second, no link could have a travel time in excess of 31.5 minutes or

FIGURE 4



LAKE SUPERIOR
CANADA
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
INDIANA
OHIO
840 ZONE TRAFFIC FORECASTING SYSTEM
INSTATE NETWORK
Michigan Department of State Highways
Transportation Planning Division
Statewide Studies Unit
DETROIT
LAKE ST CLAIR
ONTARIO
CANADA
DETROIT METROPOLITAN AREA

FIGURE 5



540 ZONE TRAFFIC FORECASTING SYSTEM

OUTSTATE HIGHWAY NETWORK

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRANSPORTATION PLANNING DIVISION
STATEWIDE STUDIES UNIT

a distance in excess of 23 miles. Usually, a link consists of a section of highway between two intersections in the system. Thus, usually, a node has more than two links associated with it. In some cases, however, it was necessary to split such a section of highway into two or more links by the insertion of additional nodes in order to conform to the restriction on maximum link distance and travel time. Also, where more than four links, including pseudo links, converge at a single point, it was necessary to represent this point by two or more nodes properly connected."*

III. NETWORK CODING OF THE 510 ZONE SYSTEM

At the inception of the 510 zone system, the specific computer package to be used on the network was not known. Prior to determining a specific package, coding was initiated on the system. The code sheet in Figure 6 was the first highway link code-sheet to be used in the process. A description and format of the data used in the link code sheet is presented in Figure 7. After due consideration, the Federal Highway Administration's computer package was chosen as the easiest to implement. Their code sheet was somewhat different, however, and a computer program had to be designed to format the link data already coded to the Federal Highway Administration's specifications. (See Figure 8)

The actual coding process was very similar to the one

*Arthur D. Little Consultants, Inc.

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS
DATA PROCESSING SECTION

LINK DATA FILE CODING FORM

Form 2357-8

IDENT. NUMBER	9 OF Z	A NODE	B NODE	ROUTE NUMBER	SEQUENCE NUMBER	DISTANCE	HWY. TYPE	BEGIN CONTROL SECTION	END CONTROL SECTION (If Different)	LINK TYPE	CAPACITY	NUMBER TRAFFIC LANES	AVERAGE LANE WIDTH	T OR S	T/S VALUE	SIGN	FLAG	CON-VERSION ADT/VPH	CON-VERSION ADT/DHV	ADT (hundreds) 1965	
1–5	6	7–10	11–14	15–19	20–22	23–26	27	28–32	33–37	38	39–43	44–45	46–47	48	49–51	52	53	54–56	57–59	60–62	63–80

FIGURE 6

TABLE II A-6

MICHIGAN MASTER LINK FILE FORMAT

Column	
1-5	Identification number 10104
6	9 => a highway link Ƶ => zone or pseudo link
7-10	A node number
11-14	B node number
15-19	Route number For county roads: YY ƵƵƵ YY = County number of west or south end of route ƵƵƵ = County road number For other highways: Y --- Ƶ Y = prefix --- = route number (right justified) Ƶ = suffix <u>Prefix</u> M = > Michigan Trunkline U = > U. S. Trunkline I = > Interstate T = > To Interstate <u>Suffix</u> B = > Business route S = > Business spur L = > Business loop A = > Alternate C = > Connector X = > Open end trunkline
20-22	Sequence number for route number
23-26	Distance in miles and hundredths
27	Highway type code 1 = > Undivided roadway 2 = > Divided roadway with no access control 3 = > Divided roadway with partial access control 6 = > Divided roadway with full access control 9 = >County undivided roadway Blank - Unspecified

Figure 7

TABLE II A-6
(Continued)

Column	
28-32	Control section at A node end of link, or control section for entire link, if only one.
33-37	Control section at B node end of link Blank if only one control section
38	Link Type
	T = > Two-way link with two directions combined. Hence, capacity and number of lanes refers to total for both directions.
	F = > Forward or A to B direction of a two-way link where the two directions are treated separately. Capacity and number of lanes, distance and time or speed refer to A B direction alone.
	R = > Reverse or B A direction of travel of a two-way link where the two directions are treated separately. Capacity, number of lanes, distance and time or speed refer to B A direction alone.
	S = > One-way (or single direction) street; must be in direction from A to B.
39-43	Hourly Practical Capacity Total two-way capacity if link type = T One-way capacity if link type = F, R, or Ø
44-45	Number of traffic lanes In both directions, if link type = T In one direction, if link type = F, R, Ø
46-47	Average Lane Width in Feet
48	T or S T => Time value provided S => Speed value provided
49-51	Time/Speed Value. Time value in minutes and tenths. Speed in miles/hour and tenths.
52	Sign (for future use)
53	Flag (for future use)
54-56	Conversion Factor ADT/VPH
57-59	Conversion Factor ADT/DHV
60-62	ADT in hundredths (1965)

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

Form 1572

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
FORM PR-1225 (WO)
(8-64)

DATE

CODER

TRAFFIC ASSIGNMENT
Node - Link Data

JURISDICTION		LINK: NODE A		LINK: NODE B		SIGN	FLAG		DISTANCE MILES 0.00		"T" OR "S"		A → B: FIELD 1	A → B: FIELD 2	A → B: AVG. MIN. 0.00 OR SPEED 00.0				T, S OR BL'NK		B → A: FIELD 1	B → A: FIELD 2	B → A: AVG. MIN. 0.00 OR SPEED 00.0				NODE B OF LINK TO BE CHANGED		CAPACITY	COUNT					
1	2	3 4 5 6	7	8 9 10 11	12	13	14	15	16 17 18	19	20	21	22 23 24	25 26 27	28 29 30	31	32 33	34	35	36	37 38 39	40 41 42	43 44 45	46	47 48	49	50 51 52 53	54	55 56 57 58 59 60	61 62 63 64 65 66	67 68	69 70 71	72	73 74 75 76	77 78 79 80
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COL. 1 (JURISDICTION)
1
2
3
0 ____________

NODE NUMBER RANGES
INTERNAL CENTROIDS ____________
STATION CENTROIDS ____________
ARTERIAL ____________
FREEWAY ____________

COL. 35
BLANK INDICATES A ONE-WAY LINK

PUNCHED ____________

USCOMM-DC 13152-P64

FIGURE 8

used on the 2300 zone system and actually set a precedent for that operation. Highway information to be coded to the system was gathered from the following sources: Link capacities, number of lanes and lane width, were gathered from the Department's sufficiency rating printout. A.A.D.T. (Annual Average Daily Traffic) was gathered from the Department's yearly county A.A.D.T. maps.

Highways were classified through the use of the Department's County Atlas of Federal-Aid Maps. The link classifications will be updated based on data available from both the state and federal needs studies. The control section information was obtained through the use of the Department's Control Section Atlas.

Master maps of the 510 zone system were displayed on three-eighths inch to the mile county maps. As each section of highway was coded with the above information and other specific data, as illustrated in Figure 7, a simple slash was entered on the appropriate link within the network. (This differed from the use of mylar overlays which were associated with the 2300 zone coding system. Black china markers were used to designate coding completion on a given segment of highway.) A simple check of the maps would indicate if all links were coded. If all links were coded on a node (dot)-(dash) pencil slash basis the analyst was reasonably sure that all network links had been coded.

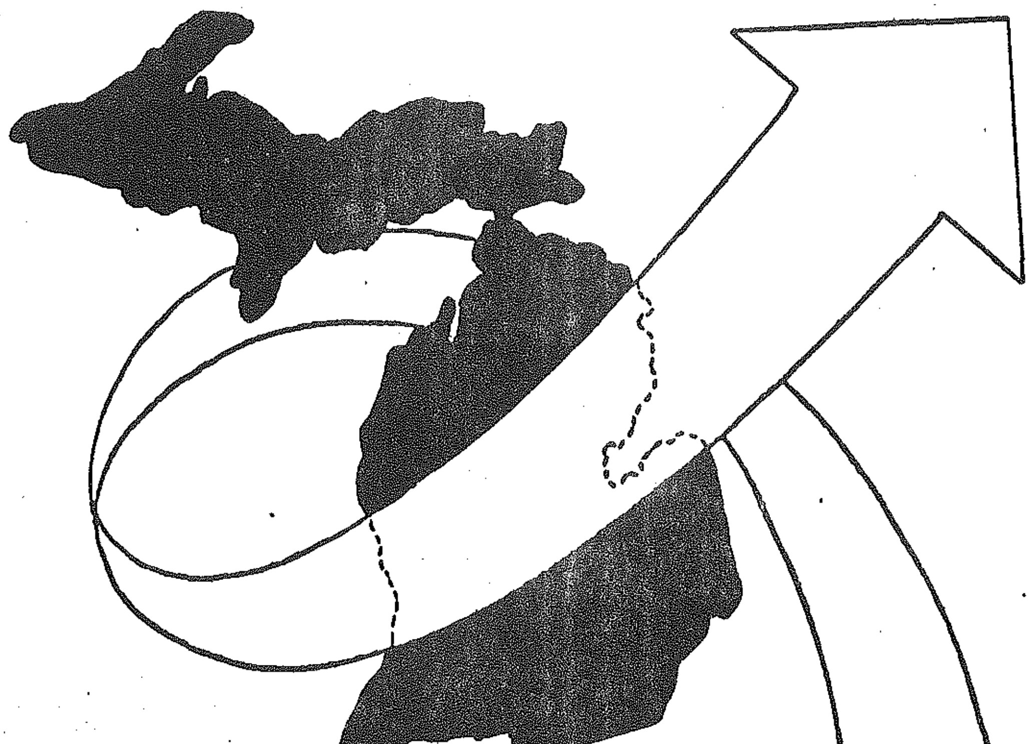
IV. EDITING THE NETWORK THROUGH THE USE OF COMPUTER TECHNIQUES

As mentioned, the Federal Highway Administration's computer program system was used to edit, build, and assign for the 510 zone system. A program referred to as 01100 was used as the initial computer edit of the system. This program would list the number of links entering or leaving each node. A check of the system could be undertaken by comparison of the coded highway link cards and the base maps. Also, the program would list the numbers of the inter-connecting nodes within the system.

By using these program features, the 510 zone network could be edited to identify a perfect system. (The 2300 zone system also used a similar program (T P Net 1402) to edit its system. A detailed review of the techniques will not be included in this section but will be explained in the 2300 zone chapter on network editing.)

Additional 510 zone highway network definition and development information may be obtained from the final report on Phase I model development entitled A Computer Model for Determining Future Highway Requirements of the State of Michigan, Vol.I by Arthur D. Little, Incorporated C-67672-2. December, 1966.

TECHNICAL DIFFERENCES 510 ZONE MODEL VS 2300 ZONE MODEL



TECHNICAL DIFFERENCES

510 ZONE MODEL vs. 2300 ZONE MODEL

As related by Arthur D. Little's description, the original 510 zone network was loaded by means of individual pseudo links. The pseudo link technique allows loading through a single point within a zone while the centroid technique permits loading through one or more points within a specified zone. As improvements were initiated, the 510 zone system adopted the multiple loading point technique. The 2300 zone system never used the pseudo link technique, but initially employed the multiple centroid link loading system. This allowed greater flexibility and necessarily added greater accuracy to the network loading procedure.

Centroid loading also allows greater description as to directional travel of trips from specific loading points. Multiple loading also aided in the task of network calibration and the assumptions underlying a multiple loading technique were more realistic in terms of trip distribution.

Another difference in technique and a decided improvement was the system employed to number nodes. In the 510 zone system, node numbers were assigned on a one to one basis without allowing additional numbers for future changes. If additions or deletions were to be made, node numbers were then taken from the end section of the total assignable numbers and placed in the needed county. This led to some difficulties in node numbering assignments and was abandoned in the 2300 zone node numbering effort. The 2300 zone system reserved additional node numbers for each county according to size, population and general urban density.

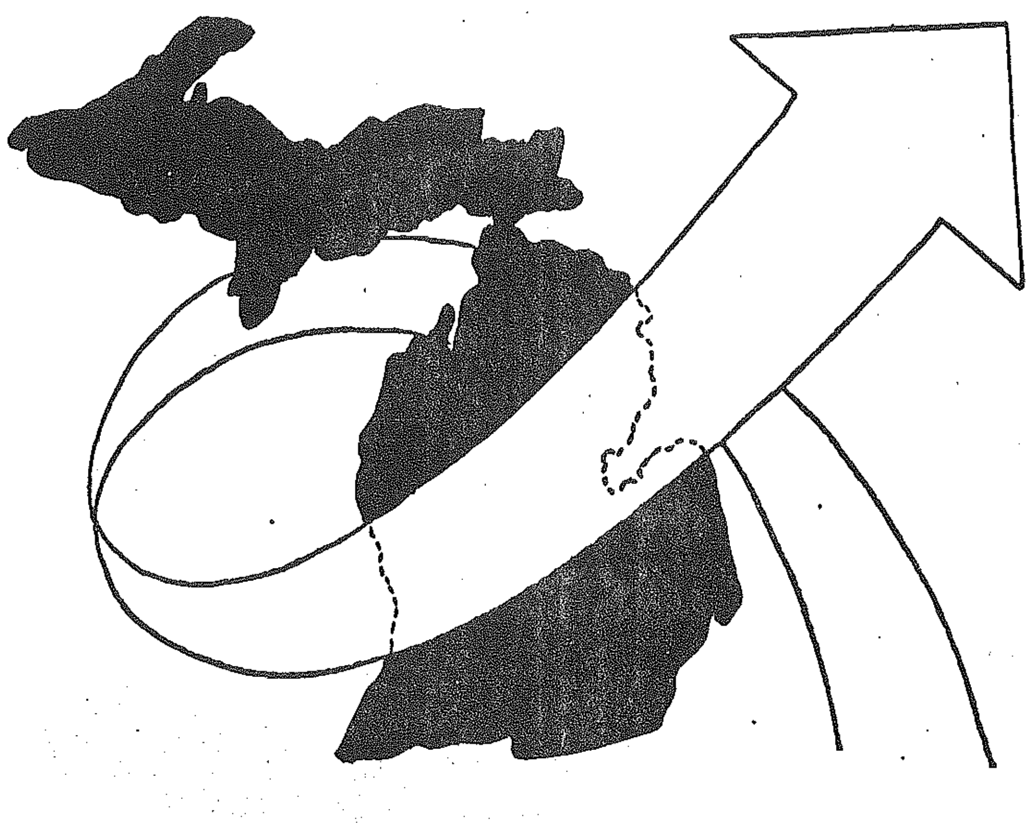
The assignment of a specified range of node numbers to a given county proved to aid tremendously in the many searches for individual nodes or links. It was always possible to determine where a node or link was located by simply looking for the county numbering range into which it fell; whereas with the 510 node numbering technique, it was difficult to tell where any given node or link was located.

Zones in the 2300 zone system are single townships or portions of townships. Therefore, the zone characteristics are more specialized which finally results in more homogeneity of zones within themselves and more heterogeneity of zones when compared to one another. This may influence the type of trip generation-distribution process selected when the development of the 2300 zone trip tables begins.

Along with technically defined differences in the two systems, objectives or goal differences should also be outlined. The 510 zone system was designed to be used for basic corridor analysis and as a coarse planning tool. The 2300 zone system was designed to provide greater sensitivity and accuracy to traffic fluctuations and thus greater reliability as a design tool in the construction and design process. The 510 zone system was basically a means to an end with the 2300 zone system providing the best of both systems. A thorough review of the 510 zone system and the calibration difficulties encountered logically leads to the conclusion that the development of a larger and more comprehensive system was absolutely necessary for the adequate implementation of a reliable statewide model.

The development and calibration of a 2300 zone statewide model will allow the Department to obtain detail design data as well as planning information from a single modeling effort.

NETWORK DEVELOPMENT
2300 ZONE MODEL



I. THE 2300 ZONE SYSTEM

In theory, the larger the number of zones within a forecasting model, the more sensitive the model's final forecast will be. This is to say that the increases and decreases of traffic assigned to the network will show finer degrees of variation through any given corridor if the number of zones within the model are increased or correspondingly made smaller. Models larger than the 2300 zone system are being contemplated at this time but until these models are developed, the 2300 zone system will achieve a majority of the proposed "super model" objectives.

The 2300 zone system will necessarily reflect more realistic travel patterns over a given network due to the greater level of detail. Calibration of the larger system will possibly be less difficult due to the greater flexibility of zone size, additional county and local roads, number of loading points, etc. A larger number of zones offers a greater opportunity to adjust loading patterns from centroids to a more feasible and realistic system or network. The more realistic the network, the closer the data output comes to answering design questions of link volumes, turning movements and individual ramp volumes.

These are some of the important considerations and justifications of and for a larger statewide forecasting model.

II. NETWORK DEFINITION OF 2300 ZONE SYSTEM

A. The Definition of Zones:

Zone size and definition are often determined and influenced by demographic and political boundary considerations. The 2300 zone system was no exception. The network zones were subdivided by townships, sections of townships, cities, and subsections of those given cities.

Two opposing considerations often plagued the network analyst when zone size was under determination: (1) The zone must be small enough to accurately reflect the traffic flow which occurs on the routes which connect them, and; (2) they must also be large enough to allow collection of demographic, economic and other trip generation information which is only available through given agencies and by certain area definitions.

Data is often only available at the township level and zone descriptions of a smaller nature will necessarily complicate the data gathering process. When rural townships are purposely divided, however, field surveys of the area will often solve the socio-economic distribution questions.

Origin-Destination and other independent studies such as T.A.L.U.S. and Tri-County often gather data by zones which are much smaller than the township or even city boundary level.

When this data was available, greater network definition within these areas became feasible and the final results more realistic. As a general rule, the 2300 zone system used townships as the basic zone description for rural areas and a combination of study zones in urban areas when such data were available.

Zones within the system did not cross county boundaries but necessarily became more heterogeneous than the 510 zone system as a result of smaller zone size and more specific descriptions. Other variation of zone size also appeared in the urban areas due, in part, to the availability of refined demographic data. Figure 9 is representative of the in-state 2300 zone system and Figure 10 represents the zones in the out-state area.

Specific rural township and city population data were gathered from the Michigan Department of Commerce Working Paper No. 9 as published by the State Resource Planning Program. Urban population data were gathered from three sources; (1) Major and Minor Origin and Destination Studies, (2) Independent City Planning Board Programs and (3) the Transportation and Land Use Study Program (TALUS) within the Detroit Metropolitan Region. Data were gathered for the base year of 1965 and projected to the design year of 1990. This process will be detailed in later reports.

B. Location of County Roads:

The majority of county roads used within the 2300 zone system were of the Federal Aid Secondary classification.

Figure 9

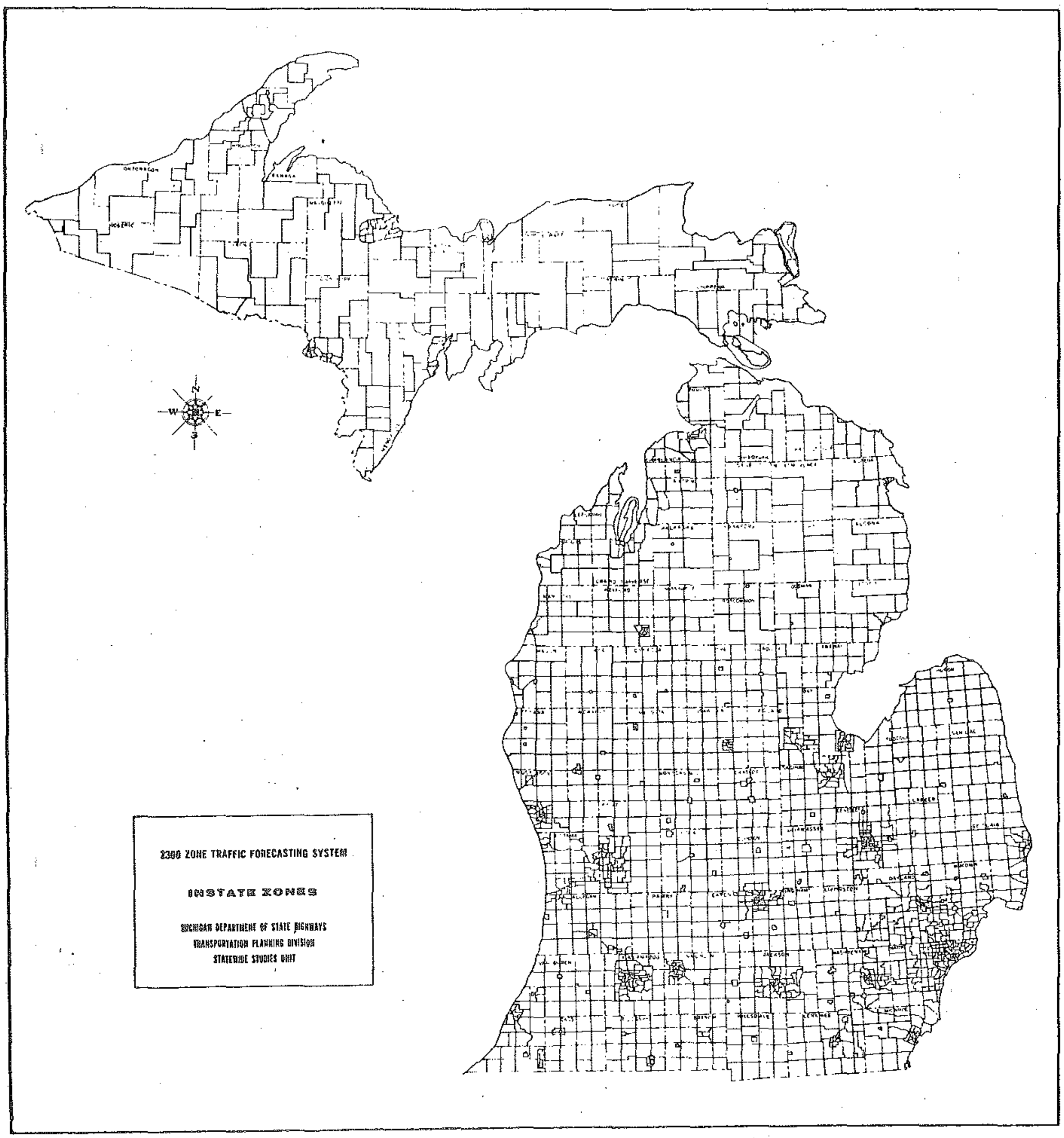

2300 ZONE TRAFFIC FORECASTING SYSTEM
INSTATE ZONES
MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRANSPORTATION PLANNING DIVISION
STATEWIDE STUDIES UNIT

FIGURE 10


ONTARIO
MINNESOTA
WISCONSIN
MICHIGAN
NEW YORK
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
MISSOURI
WEST VIRGINIA
KENTUCKY
W
E
S
2300 ZONE TRAFFIC FORECASTING SYSTEM
OUTSTATE ANALYSIS ZONES
MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRANSPORTATION PLANNING DIVISION
STATEWIDE STUDIES UNIT

Basically, county and local roads were used to augment the trunkline system when zones were to be connected for corridor travel purposes. Trunklines did not always accurately reflect corridors of travel between zones and therefore county roads were used to create a more representative travel system.

A secondary but necessary aspect of county road use is listed as follows: If trunklines alone were the only means of interaction between zones, this system would necessarily result in overloaded traffic assignments because in reality, many people use county roads as a means of travel and this would not be reflected on a "trunkline only" system. It is necessary, therefore, to achieve a realistic balance between secondary and primary routes of travel in order to obtain a representative traffic assignment on the state trunkline system.

The actual location of these secondary routes is a matter of art combined with a degree of science. When the addition of a county road is contemplated, the actual question is asked: How will people from zone "A" travel to zone "B"? If these are no primary trunkline routes to handle the situation, then a county or local road is added to the network which will allow travel from "A" to "B". The location and size of zones, consequently, also influences the location of secondary routes within the network.

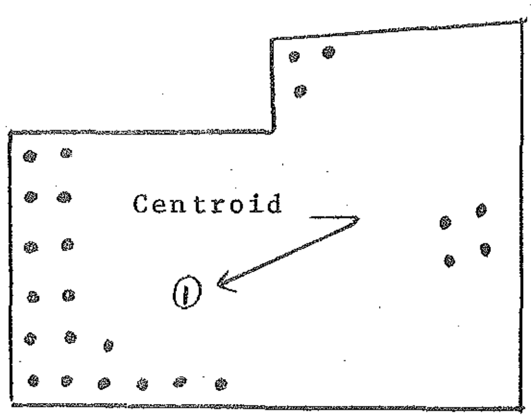
The smaller the zones within a network, the greater the need for county roads. County roads will not be added, however, if the network analyst feels the majority of people will sidestep county road travel in favor of a longer but primary route. Expressways for example, may offer a longer but initially quicker route of travel between zones. When situations of this type arise, the network analyst must subjectively determine the need for additional inter-zonal routes. Information obtained in the final calibration of the 510 zone model will also be useful in the final definition of the 2300 zone network model.

C. <u>Location of Centroids and Centroid Links</u>

Technically, centroids should be located at the weighted population center of any given zone. Centroids are often located at the geographic center of a zone, however, because actual population dispersion data are not available for the weighted placement of centroids. According to the Federal Highway Administration manual <u>Traffic Assignment Manual</u>; "In a traffic assignment, all trips are assumed to be loaded on the highway network from a single point established for each zone.

The point of loading for each zone, defined as a centroid or loading point, should be located at the center of activity for the zone. For a completely residential zone, the center of activity would be the center of gravity of the zone's population. For example, consider the typical zone shown below:

(FIGURE 11)



Assuming each spot represents 100 persons, the center of population or centroid, would be established approximately as shown. For mixed land-use zones, such as residential and commercial, the location of the centroid is determined to a large extent by judgment." The centroid links should be attached to logical points of network contact and entry in order for the zone to load its trips to the system in a realistic fashion.

III. NETWORK CODING

The description of a network involves the application of pertinent traffic and highway data to given links as defined by assigned node numbers. Network definition necessarily follows two methods of descriptions: (1) The actual outlined highways which are located and drawn on a given map, and; (2) the coded segmental information describing the route and traffic which are to be fed into the computer for future analysis. The 2300 zone system satisfied both of these description methods.

General base maps of the counties within Michigan (three-eighths inch to the mile) were taped together in sections and the business of network definition and coding began. Major routes were assigned with solid red lines and county roads were added with broken red lines. Zones were outlined in yellow and centroids were displayed as large red dots within the zones. Centroid links were drawn in blue.

As the process approached an urban area where origin-destination data were available, detailed enlarged maps of the area were drawn to capture the network detailed within the study limits. Nodes were drawn as black dots, ...

(1) at all highway network interchanges;

(2) at the end of control sections, and;

(3) at specified points on a major trunkline to mark its entrance or exit from a county or origin-destination study area.

The process was then continued as follows:

A. <u>Zone Numbering:</u>

All counties within Michigan are assigned a number (beginning with 1) according to their alphabetical position on a list naming all counties. There are 83 counties in Michigan and therefore Alcona county will assume the number "01" and Wexford county will consequently assume the number "83". All counties in between were consecutively numbered accordingly.

On the 2300 zone system, Alcona county contained 9 zones; therefore, Alcona's zones will be numbered from 0101 to 0109. As shown, the zone number consists of four digits. The first two being the number of the county and the second two being numbers of a consecutive nature. The first zone number to be used within the county was located at the center of the county and preferably within a city that rests within an intersection of major trunklines. This was done to accommodate the assignment demands of the

"Segmental Model".[1] The remaining zones were numbered from left to right beginning at the top of the county and proceeding to the bottom. All counties within the 2300 zone system were numbered in this manner.

(To satisfy a computer program requirement, all nodes, once numbered, were co-numbered in a sequential manner beginning with the number 0001 and proceeding to 2262*...* the actual number of zones within the network.) Figure 12 is the resulting finalized network for the 2300 zone system. Figure 13 presents the out-state network.

B. Node Numbering:

The node numbering process began with the counting of all nodes located within each county. To avoid double counting, all nodes situated on the northern and western boundaries were assigned to the county under tabulation. After all nodes were counted and assigned to the respective counties, they were added to determine the total number of nodes within the system. This total was then subtracted from 5891 (The difference between 2300 and 8191) 8191 being the absolute number of nodes allowable for computer program purposes on the Burroughs 5500 computer and 2300 being the number of digits assigned the aforementioned zones. Extra space was left for addition of new zones if necessary. The total number of nodes within the counties was then subtracted

(1) A segmented network technique will be defined in a later report but basically this process will allow the network model user to select the level of network detail required for a specific area of the state when doing a traffic forecast. This will provide the user with substantial savings in computer run times.

FIGURE 12

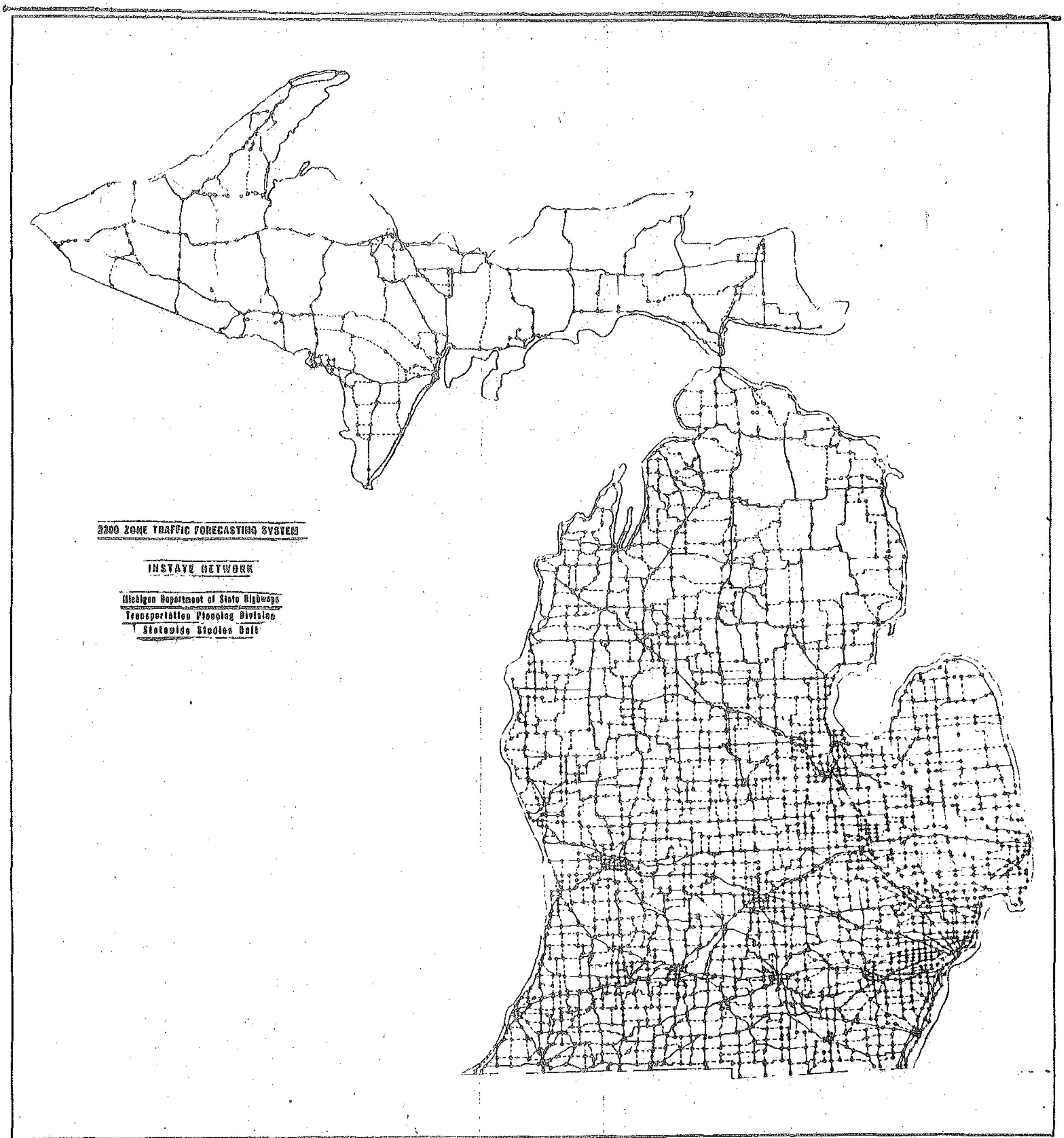
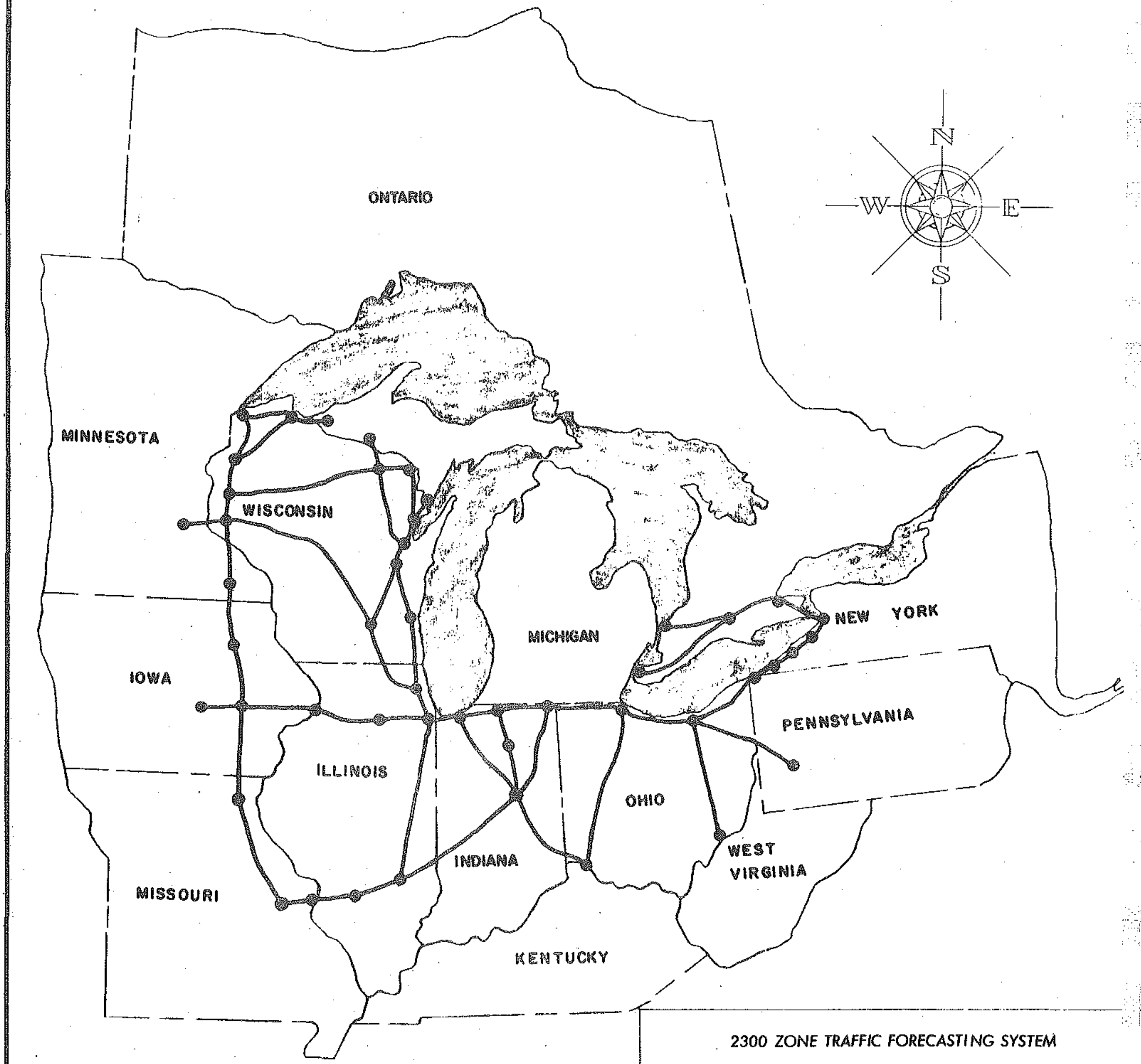

2300 ZONE TRAFFIC FORECASTING SYSTEM
INSTATE NETWORK
Michigan Department of State Highways
Transportation Planning Division
Statewide Studies Unit

FIGURE 13



2300 ZONE TRAFFIC FORECASTING SYSTEM

OUTSTATE HIGHWAY NETWORK

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRANSPORTATION PLANNING DIVISION
STATEWIDE STUDIES UNIT

from 5891 and the remainder divided by 83 (the number of counties within Michigan) to determine the average extra number of assignable mode numbers still available per county.

These extra mode numbers would be used to add proposed alternate routes through any given county. Some counties received more "extra numbers" due to their size and population density. The average "extra number" amount averaged to approximately 15; 9-10 for the smaller counties and 20-30 for the larger counties. The range of node numbers from 2301 to 8191 was then assigned to the counties in a geographic manner. Numbering began in the Upper Peninsula and proceeded to the Lower Peninsula in a sweeping manner. This was done to allow quicker and easier identification of node locations and sequences. (See Figure 14)

C. <u>Link Data Coding</u>:

Plastic mylar sheets were laid over the segments of network maps and taped down. China marking pencils were then used to mark the progress of the coding procedure. As each segment of network was coded on code sheets, a line was drawn over the respective route with a marking pencil to signify its completion. The link code sheet used in the network coding procedure is listed in Figure 15.

The "A" node of the "A" and "B" node segment was to have always been the lower of the two node numbers. This was done to aid in the recovery of link cards when manual correction of the network was necessary. The next bit of

COUNTY ORDER FOR NODE NUMBERING SEQUENCE

Figure 14

Co.#	County	Range of Nodes	Co.#	County	Range of Nodes
27	GOGEBIC	2301-2324	15	CHARLEVOIX	3017-3049
66	ONTONAGON	2325-2348	5	ANTRIM	3050-3092
31	HOUGHTON	2349-2384	45	LELANAU	3093-3120
42	KEWEENAW	2385-2397	10	BENZIE	3121-3151
7	BARAGA	2398-2417	28	GRD.TRAVERSE	3152-3221
36	IRON	2418-2449	40	KALKASKA	3222-3252
52	MARQUETTE	2450-2543	20	CRAWFORD	3253-3286
22	DICKINSON	2544-2593	68	OSCODA	3287-3305
55	MENOMINEE	2594-2626	1	ALCONA	3306-3334
21	DELTA	2627-2664	35	IOSCO	3335-3366
2	ALGER	2665-2693	65	OGEMAW	3367-3399
75	SCHOOLCRAFT	2694-2723	72	ROSCOMMON	3400-3437
48	LUCE	2724-2740	57	MISSAUKEE	3438-3479
17	CHIPPEWA	2741-2778	83	WEXFORD	3480-3555
49	MACKINAC	2779-2815	51	MANISTEE	3556-3615
24	EMMET	2816-2856	53	MASON	3616-3650
16	CHEBOYGAN	2857-2897	43	LAKE	3651-3679
71	PRESQUE ISLE	2898-2931	67	OSCEOLA	3680-3716
4	ALPENA	2932-2972	18	CLARE	3717-3756
60	MONTMORENCY	2973-2990	26	GLADWIN	3757-3786
69	OTSEGO	2991-3016	6	ARENAC	3787-3817

County Order For Node Numbering Sequence (Continued)

Co.#	County	Range of Nodes	Co.#	County	Range of Nodes
32	HURON	3818-3869	3	ALLEGAN	5562-5634
9	BAY	3870-3955	8	BARRY	5635-5694
56	MIDLAND	3956-4034	23	EATON	5695-5781
37	ISABELLA	4035-4093	33	INGHAM	5782-5946
54	MECOSTA	4094-4145	47	LIVINGSTON	5947-5997
62	NEWAYGO	4146-4210	63	OAKLAND	5998-6212
64	OCEANA	4211-4248	50	MACOMB	6213-6320
61	MUSKEGON	4249-4345	82	WAYNE	6321-6585
59	MONTCALM	4346-4398	81	WASHTENAW	6586-6718
29	GRATIOT	4399-4453	38	JACKSON	6719-6891
73	SAGINAW	4454-4597	13	CALHOUN	6892-7042
79	TUSCOLA	4598-4659	39	KALAMAZOO	7043-7164
74	SANILAC	4669-4721	80	VAN BUREN	7165-7232
77	ST. CLAIR	4722-4845	11	BERRIEN	7233-7391
44	LAPEER	4846-4898	14	CASS	7392-7451
25	GENESEE	4899-5098	78	ST. JOSEPH	7452-7525
76	SHIAWASEE	5099-5147	12	BRANCH	7526-7576
19	CLINTON	5148-4199	30	HILLSDALE	7577-7626
34	IONIA	5200-5262	46	LENAWEE	7627-7772
41	KENT	5263-5474	58	MONROE	7773-7900
70	OTTAWA	5475-5561		OUTSTATE	7901-8191

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

B-5500 LINK DATA CARD

Form 1720

CARD TYPE		A NODE		B NODE		DISTANCE XX.XX	T OR S	A → B TIME OR SPEED X.XX XX.X AM	A → B TIME OR SPEED PM	A → B TIME OR SPEED OFF	CAPACITY IN 10'S	COUNT		DIRECTION	T OR S	B → A TIME OR SPEED X.XX XX.X AM	B → A TIME OR SPEED PM	B → A TIME OR SPEED OFF	CAPACITY IN 10'S	COUNT		LINK TYPE	LINK JURISDICTION	CAPACITY CLASS		DELETE
	2	3 4 5 6	7 8	9 10 11 12	13	14 15 16 17	18	19 20 21	22 23 24	25 26 27	28 29 30 31	32 33 34 35 36	37 38 39	40	41	42 43 44	45 46 47	48 49 50	51 52 53 54	55 56 57 58 59	60 61 62 63 64 65 66 67 68	69 70	71 72	73 74	75 76 77 78 79	80
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FIGURE 15

information required was distance or specifically the distance in miles between the two nodes under consideration. The exact distance was determined through the use of a mechanical instrument called a "Circular Map Measurer". This instrument contained a wheel which could be run along a given route. The distance the wheel traveled indicated the appropriate distance of the network segment. Link distances within control sections (which listed exact mileage) were adjusted to conform to the precise control section distances. (A control section and its given number is merely a system used to identify given measured segments of highway.) This procedure was initiated to guaranteeeexact total mileage figures for various types of highways within the state and as a base for filing highway data by route.

The next bit of information to be coded was the "T" or "S" designation as indicated on the code sheet example in Figure 15. The "T" indicates time and the "S" indicates speed, both of which are network indicators of link distance. The "T" indicating the time it takes to traverse the assigned distance on the link. To indicate either "T" or "S" on the code sheets designates whether either link speed or time is to be used in the computer program computations.

The next piece of information to be coded is speed as this was selected as the unit to measure link distance. This shows the average speed assigned to each link. The speeds shown were determined by the particular classification of road under consideration. Figure 16 outlines the highway classifications and related speeds. Speeds were

FIGURE 16

NETWORK MODEL SPEEDS - 2300 ZONE
SYSTEM STATEWIDE MODEL

	Rural	Urban	OD
Outstate 40 MPH Centroid Links (Co. Local)	30	20	20
County Roads	35	25	
City Streets	+	25	25
M-or US-Routes 2 Lane	45	30	
M-or US-Routes 4 Lane (Undivided)	50	35	
M-or US-Routes 4 Lane (Divided) Non Limited Access	55	40	
Interstate & Freeway Limited Access	60	50	

also related to the number of lanes on the highway, the proximity to urban areas and other environmental conditions. Results of post-calibration experiences on the 510 zone system aided in the finalization of this chart.

Columns 29 through 31 were used to indicate the capacity of the highway links. This information was obtained through the use of the 1965 Michigan Department of State Highways' sufficiency rating printout. The last zero on the respective capacities was dropped and the remaining numbers entered in the appropriate spaces. Again, this operation was due to specific computer program demands. In the future, it will be possible to obtain more specific capacity information by using suggestions made in the Federal Highway Administration's manual on highway capacities.

Columns 32 through 36 were used to denote the Annual Average Daily Traffic (A.A.D.T.) for each segment of highway. This information was taken from the Department's 1965 county A.A.D.T. maps. Due to the fact that the computer program deals with directional travel, the actual A.A.D.T. was halved and placed in the indicated coding sheet spaces. The 1965 A.A.D.T. was used as this will be the base year used in the model calibration process.

The "2S" designations in columns 40 and 41 indicate that the link is a two-way route and the "S" again indicates that speed was to be used in the computer computations. Columns 67 and 68 were used to show the sequence under which the network links were coded within a given highway control section. The designations 01, 02, 03, etc., were used to list the network link sequences. This was done so that specialized reports dealing with certain sections of given routes could be portrayed in a sequential manner based on control section number and sequence number.

Columns 69 and 70 designated basic link types or the specific classifications of the link. Four link types existed and were given the following numerical classifications.

00 = Trunkline links

01 = Centroid links

02 = County road links

03 = Out-state links

Columns 71 through 72 were entitled link jurisdiction and described in greater detail the specific types of routes under classification. These classifications indicate more accurately the differences in routes as determined by urban and rural specifications. Coded differences in route classifications can then be used for specialized vehicle miles studies and highway needs studies. This will aid tremendously in highway inventory investigations when all routes are listed by specific distances, types,and classifications. Out-of-state and centroid links were also precisely defined. Figure 17 lists the numerical designations of the various links. These highways were classified according to the information obtained from the Department's <u>County Atlas of Federal-Aid Maps</u>. When the 1970 Federal Needs Study is completed, the 2300 zone link file will be updated using functional classification data from this study.

Columns 75 through 79 are to indicate the number of the highway control section from which the particular link segment originated. The control section information was obtained through the use of the Department's <u>Control Section Atlas</u>. County roads, though not represented by a complete control section number, were indicated by coding the county number in the first two spaces followed by corresponding zeros. This was also true of centroid links and out-of-state link data.

LINK JURISDICTION CLASSIFICATIONS

Figure 17

01	INTERSTATE RURAL	
02	INTERSTATE URBAN	
03	FEDERAL AID PRIMARY RURAL	US-ROUTES
04	FEDERAL AID PRIMARY URBAN	
05	(STATE) FEDERAL AID SECONDARY RURAL	
06	(STATE) FEDERAL AID SECONDARY URBAN	
07	(LOCAL) FEDERAL AID SECONDARY RURAL	
08	(LOCAL) FEDERAL AID SECONDARY URBAN	
09	STATE TRUNK-LINE NON-FEDERAL AID RURAL	
10	STATE TRUNK-LINE NON-FEDERAL AID URBAN	
11	LOCAL RURAL	
12	LOCAL URBAN	
13	CENTROID LINKS	
14	OUTSTATE CENTROID LINKS	
15	OUTSTATE HIGHWAY LINKS	

IV. EDITING THE NETWORK THROUGH THE USE OF COMPUTER TECHNIQUES

Now that the network has been coded, the business begins of transferring the network to computer tape and of editing this particular network. In order to accomplish this, in 1969, the Michigan Department of State Highways, in cooperation with the Pennsylvania Department of State Highways and Alan M.Voorhees Consultants, initiated the development of a transportation planning package of network computer programs. These programs were designed to handle and process the multitude of network jobs associated with the building, updating, and assignment work of the traffic estimating continuum. One of these programs, (TP-Net Q01402) was used to build the 2300 zone network and aid in the editing process.

A. "Ins" and "Outs" Corrections:

Program Q01402 lists basic coding errors found on network cards as well as printing the number of links entering and leaving each node. By checking the number of links listed as entering a node against the actual base map, errors in coding could easily be detected. The basic discrepancies encountered were simply ones of too few links entering a node or too many links entering a node. When these errors were detected, further checks were made to determine if the link had simply been overlooked or if it had been assigned to another node erroneously by the transposition of a node number (See Figure 18)

NO OF LINKS IN AND OUT OF EACH NODE

IN	NODE	OUT	IN	NODE	OUT	IN	NODE	OUT	IN	NODE	OUT	IN	NODE	OUT	IN	NODE	OUT	IN	NODE	OUT	IN	NODE	OUT	IN	NODE	OUT	IN	NODE	OUT
5	4060	5	3	4108	3	3	4157	3	3	4197	3	3	4255	3	2	4295	2	3	4350	3	2	4399	2	5	4439	5	4	4489	4
3	4061	3	3	4109	3	4	4158	4	3	4198	3	4	4256	4	3	4296	3	2	4351	2	4	4400	4	3	4440	3	4	4490	4
4	4062	4	4	4110	4	4	4159	4	4	4199	4	4	4257	4	3	4297	3	4	4352	4	3	4401	3	4	4441	4	3	4491	3
4	4063	4	4	4111	4	4	4160	4	4	4200	4	4	4258	4	3	4298	3	5	4353	5	3	4402	3	3	4442	3	3	4492	3
4	4064	4	3	4112	3	3	4161	3	4	4201	4	4	4259	4	5	4299	5	2	4354	2	2	4403	2	5	4443	5	3	4493	3
5	4065	5	3	4113	3	4	4162	4	4	4211	4	3	4260	3	5	4300	5	5	4355	5	4	4404	4	3	4454	3	3	4494	3
5	4066	5	5	4114	5	4	4163	4	4	4212	4	3	4261	3	3	4301	3	3	4356	3	3	4405	3	4	4455	4	4	4495	4
3	4067	3	3	4115	3	4	4164	4	4	4213	4	4	4262	4	2	4302	2	5	4357	5	4	4406	4	4	4456	4	3	4496	3
4	4068	4	4	4116	4	4	4165	4	5	4214	5	4	4263	4	6	4303	6	5	4358	5	3	4407	3	2	4457	2	3	4497	3
3	4069	3	3	4117	3	3	4166	3	3	4215	3	4	4264	4	2	4304	2	3	4359	3	4	4408	4	4	4458	4	3	4498	3
4	4070	4	4	4118	4	4	4167	4	5	4216	5	5	4265	5	4	4305	4	3	4360	3	4	4409	4	5	4459	5	7	4499	7
4	4071	4	5	4119	5	5	4168	5	3	4217	3	3	4266	3	3	4306	3	4	4361	4	2	4410	2	5	4460	5	3	4500	3
3	4072	3	4	4120	4	3	4169	3	3	4218	3	3	4267	3	4	4307	4	2	4362	2	5	4411	5	4	4461	4	3	4501	3
4	4073	4	3	4121	3	4	4170	4	5	4219	5	3	4268	3	4	4308	4	3	4363	3	3	4412	3	3	4462	3	6	4502	6
3	4074	3	4	4122	4	4	4171	4	3	4220	3	3	4269	3	4	4309	4	4	4364	4	3	4413	3	3	4463	3	5	4503	5
3	4075	3	4	4123	4	3	4172	3	3	4221	3	3	4270	3	4	4310	4	4	4365	4	5	4414	5	3	4464	3	5	4504	5
2	4076	2	3	4124	3	3	4173	3	4	4222	4	4	4271	4	4	4311	4	3	4366	3	4	4415	4	3	4465	3	3	4505	3
3	4077	3	4	4125	4	3	4174	3	3	4223	3	3	4272	3	5	4312	5	4	4367	4	3	4416	3	5	4466	5	4	4506	4
2	4078	2	3	4126	3	4	4175	4	3	4224	3	4	4273	4	5	4313	5	5	4368	5	3	4417	3	5	4467	5	5	4507	5
4	4079	4	3	4127	3	3	4176	3	3	4225	3	6	4274	6	4	4314	4	4	4369	4	5	4418	5	4	4468	4	2	4508	2
4	4080	4	3	4128	3	5	4177	5	4	4226	4	4	4275	4	3	4315	3	3	4370	3	5	4419	5	6	4469	6	2	4509	2
5	4081	5	3	4129	3	3	4178	3	4	4227	4	6	4276	6	3	4316	3	4	4371	4	4	4420	4	4	4470	4	5	4510	5
5	4082	5	2	4130	2	5	4179	5	3	4228	3	4	4277	4	3	4317	3	4	4372	4	4	4421	4	5	4471	5	3	4511	3
5	4083	5	5	4131	5	4	4180	4	4	4229	4	4	4278	4	6	4318	6	3	4373	3	5	4422	5	2	4472	2	4	4512	4
4	4084	4	4	4132	4	3	4181	3	3	4230	3	4	4279	4	4	4319	4	4	4374	4	5	4423	5	4	4473	4	4	4513	4
5	4085	5	3	4133	3	3	4182	3	4	4231	4	2	4280	2	3	4320	3	4	4375	4	3	4424	3	4	4474	4	4	4514	4
2	4094	2	5	4134	5	5	4183	5	3	4232	3	4	4281	4	4	4321	4	3	4376	3	4	4425	4	6	4475	6	5	4515	5
2	4095	2	3	4135	3	2	4184	2	3	4233	3	5	4282	5	4	4322	4	5	4377	5	3	4426	3	7	4476	7	4	4516	4
3	4096	3	4	4136	4	3	4185	3	4	4234	4	5	4283	5	4	4323	4	4	4378	4	5	4427	5	4	4477	4	4	4517	4
5	4097	5	3	4146	3	4	4186	4	3	4235	3	4	4284	4	3	4324	3	3	4379	3	4	4428	4	3	4478	3	4	4518	4
4	4098	4	4	4147	4	3	4187	3	4	4236	4	3	4285	3	4	4325	4	3	4380	3	4	4429	4	4	4479	4	5	4519	5
4	4099	4	5	4148	5	4	4188	4	5	4237	5	4	4286	4	4	4326	4	3	4381	3	3	4430	3	4	4480	4	2	4520	2
3	4100	3	5	4149	5	4	4189	4	5	4238	5	2	4287	2	4	4327	4	4	4382	4	3	4431	3	4	4481	4	5	4521	5
2	4101	2	5	4150	5	5	4190	5	3	4239	3	3	4288	3	4	4328	4	4	4383	4	3	4432	3	3	4482	3	3	4522	3
5	4102	5	4	4151	4	3	4191	3	3	4249	3	4	4289	4	3	4329	3	4	4384	4	3	4433	3	4	4483	4	5	4523	5
3	4103	3	4	4152	4	3	4192	3	3	4250	3	3	4290	3	2	4331	2	3	4385	3	4	4434	4	4	4484	4	5	4524	5
3	4104	3	4	4153	4	3	4193	3	2	4251	2	4	4291	4	2	4346	2	5	4386	5	3	4435	3	4	4485	4	3	4525	3
2	4105	2	2	4154	2	3	4194	3	5	4252	5	2	4292	2	3	4347	3	3	4387	3	3	4436	3	4	4486	4	2	4526	2
2	4106	2	2	4155	2	5	4195	5	3	4253	3	4	4293	4	5	4348	5	3	4388	3	3	4437	3	4	4487	4	5	4527	5
2	4107	2	4	4156	4	3	4196	3	3	4254	3	2	4294	2	4	4349	4	5	4389	5	3	4438	3	4	4488	4	2	4528	2

FIGURE 18

In the majority of instances, the latter held true and nodes with too few and too many links attached to them were often found in close proximity. One node with too many links would usually contain a link that belonged to a neighbor node which respectively contained an inadequate number of assigned links. Once the exact nature of the error was detected, the links were re-coded to conform to base map specifications.

B. Printout Node Listing Check:

A more tedious but thorough accuracy check was then conducted after the "ins" and "outs" procedure was completed. To begin, program Q01402 also prints the assigned numbers of nodes which are attached to each individual node. See Figure 19 for details. For example, node 2315 would be listed as being attached to nodes 2312, 2314, 2316, and 2418 respectively. The base maps for each county were then checked to see if node 2315 was indeed attached to the nodes outlined previously. This was done for each node in every county. This procedure was enacted to:

(1) insure absolute accuracy of the statewide network;

(2) guard against an overlapping of node links which would not be detected in the "ins" and "outs" check procedure;

(3) assure the accuracy of the primary master network maps.

The procedure took longer to complete but benefits received outweighed the time and effort expended.

N E T W O R K   D E S C R I P T I O N

A-NODE	B-NODE	JU	LC	CI	SF	DIST	TIME	SPEED	VOLUME
	2305	3	0	0		1.62	2.78	35.0	13070 2500
2305	607	13	1	0		6.10	12.20	30.1	0 0
	610	13	1	0		2.45	4.90	30.1	0 0
	2304	3	0	0		1.62	2.78	35.0	13070 2500
	2306	3	0	0		5.10	7.65	40.1	16330 2250
2306	606	13	1	0		3.00	6.00	30.1	0 0
	2305	3	0	0		5.10	7.65	40.1	16330 2250
	2308	3	0	0		13.69	18.25	45.1	3580 550
	2326	3	0	0		11.87	15.83	45.0	3810 600
2307	2232	14	1	0		23.70	31.60	45.1	0 0
	2308	7	0	0		9.44	12.59	45.0	3640 120
2308	2306	3	0	0		13.69	18.25	45.1	3580 550
	2307	7	0	0		9.44	12.59	45.0	3640 120
	2309	3	0	0		1.94	2.59	45.0	3770 600
2309	611	13	1	0		4.50	9.00	30.1	0 0
	2308	3	0	0		1.94	2.59	45.0	3770 600
	2311	5	0	0		5.16	6.88	45.1	3610 200
	2312	3	0	0		7.36	9.81	45.1	3490

A-NODE	B-NODE	JU	LC	CI	SF	DIST	TIME	SPEED	VOLUME
									450
2310	2311	5	0	0		7.59	10.12	45.1	3610 200
	2327	5	0	0		5.09	6.79	45.0	3730 170
2311	2309	5	0	0		5.16	6.88	45.1	3610 200
	2310	5	0	0		7.59	10.12	45.1	3610 200
	2312	7	2	0		5.90	10.11	35.1	0 0
2312	2309	3	0	0		7.36	9.81	45.1	3490 450
	2311	7	2	0		5.90	10.11	35.1	0 0
	2315	3	0	0		18.48	24.64	45.1	3960 350
2313	2314	3	0	0		4.21	5.61	45.1	3290 500
	2339	3	0	0		5.40	7.20	45.1	3520 300
2314	612	13	1	0		2.50	5.00	30.1	0 0
	2313	3	0	0		4.21	5.61	45.1	3290 500
	2315	3	0	0		0.56	0.75	44.9	3290 500
* 2315	2312	3	0	0		18.48	24.64	45.1	3960 350
	2314	3	0	0		0.56	0.75	44.9	3290 500
	2316	3	0	0		7.69	10.25	45.1	3680 550
	2418	3	0	0		10.55	14.07	45.0	3690

FIGURE 19

CONCLUSION

CONCLUSION

The statewide model can be seen to bring a new dimension to the rural transportation planning process. The 510 zone system has presented the framework for improvement and the 2300 zone system has provided even more evidence of things to come. Delving into the future traffic patterns for an entire state has been a monumental if not impossible task in the past but now the computerized model places statewide analysis within the grasp of reality.

The two systems, as presented, show marked differences in terms of zone size, network loading, and other technical aspects. With the differences overlooked, however, both systems have presented a common framework for future improvements and a vast array of pertinent facts and information. Volume I of this series thoroughly reviews the new uses and benefits of a statewide traffic forecasting model. The task at hand appears to be the challenge of implementing both systems to their greatest potential within the framework of current and future departmental needs.