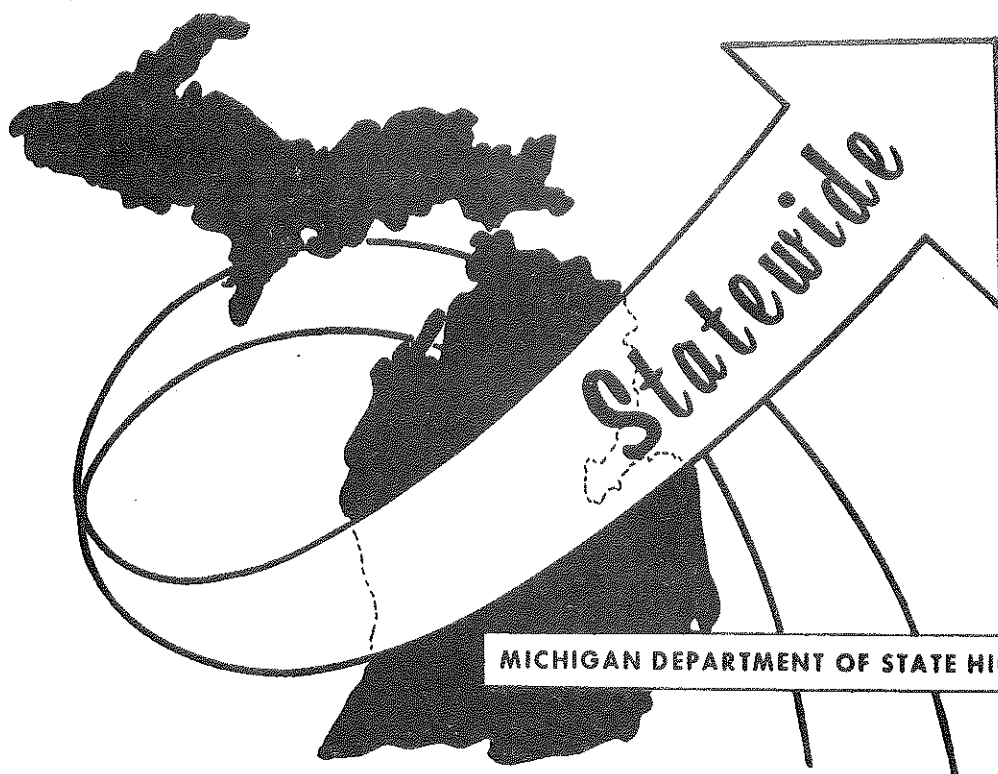# Statewide ★
Transportation
Analysis &
Research

MICHIGAN'S STATEWIDE
TRANSPORTATION MODELING SYSTEM

AUTOMATED DESIRE LINE PLOTTING

STATEWIDE TRANSPORTATION
PLANNING PROCEDURES
VOLUME X-A-1

Statewide

MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

BUREAU OF TRANSPORTATION PLANNING

MICHIGAN'S STATEWIDE
TRANSPORTATION MODELING SYSTEM

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POST OFFICE BOX 30050, LANSING, MICHIGAN 48909

JOHN P. WOODFORD, DIRECTOR

October 29, 1976

Mr. Sam F. Cryderman, Deputy Director
Michigan Department of State
  Highways and Transportation
Bureau of Transportation Planning
P.O. Box 30050
Lansing, Michigan 48909

Dear Mr. Cryderman:

The desire line diagram is a typical transportation analysis techni-
que used in the evaluation and display of transportation planning
data. This type of diagram is used to exhibit the distribution of
travel on a particular segment of road. In the past, this has
typically been a manual process because technology did not exist to
simplify the operation. This report is the documentation of a pro-
cess that will now allow the Bureau of Transportation Planning to
automate and therefore simplify the preparation of desire line diagrams
through the utilization of the Statewide Transportation Modeling
System.

This report was prepared by David Schade of the Statewide Transpor-
tation Planning Procedures Section under the supervision of Richard
E. Esch.

Sincerely,

R. J. Lilly, Administrator
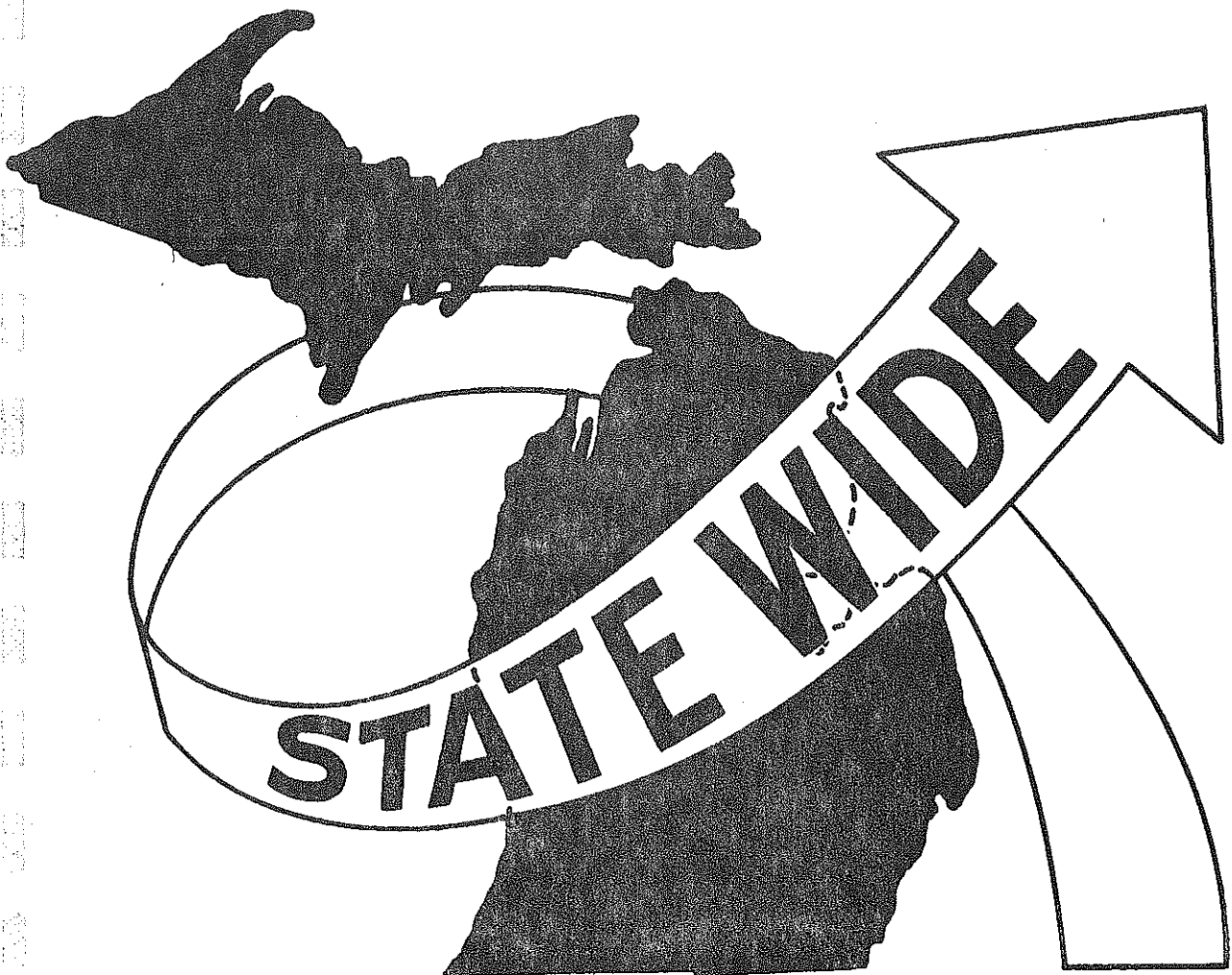Highway Planning Division

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AUTOMATED DESIRE LINE PLOTTING

BY

DAVID SCHADE

PREFACE

Due to the increased emphasis on project justification and modal
divertibility, the thorough analysis of travel patterns is quite often
required in the development of transportation plans. In the analysis
of travel characteristics, the desire line diagram is frequently
used. The desire line diagram plotting process is a graphic method
of examining origin – destination data and the impact this type of
travel would have on trip divertibility to other modes and project
justification.

This report entitled "Desire Line Diagram Plotting" is Volume X
Part A-1 of the Statewide Travel Modeling series. It deals with
the simplication of the manual process involved in analyzing O & D
trip data using the desire line diagram. Previous reports in this
series appear on the following page.

SYSTEM DEVELOPMENT REPORTS

STATEWIDE SYSTEM APPLICATION REPORTS

Report #1   –   Community College Service - Area Analysis

Report #2   –   Proximity of People to General Purpose Hospitals

Report #3   –   Industrial Park Proximity Analysis

Report #4   –   Proximity of Automobile Injury Accidents to Hospitals

Report #5   –   Proximity of Airports with Scheduled Service to Population

Report #6   –   Regional Park Proximity Analysis

Report #7   –   Rifle Range Proximity Analysis

Report #8   –   Ambulance Service - Area Analysis

Report #9   –   Comprehensive Statewide Planning

Report #10   –   Graphic Display of Fixed-Object Accident Data

Report #11   –   Preliminary Investigation: A Technique for the Projection of Accident Rates

Report #12   –   Impact of 50, 55, or 60 M.P.H. Statewide Speed Limit

Report #13   –   A Method for Functionally Classifying Rural Arterial Highways

Report #14   –   Economic and Travel Impacts of Speed Limit Reduction Using a Statewide Transportation Modeling System

Report #15   –   I-69 Impact on the Accessibility of Health, Fire, and Ambulance Services to Residential Areas

Report #16   –   Crisis and Opportunity: Application of an Operational Statewide Transportation Modeling System

Report #17   –   US-23 Corridor Location Study - Preliminary Travel Impact Analysis

Report #19   –   Graphic Display of Accident Data

Report #20   –   Demographic Information for the Northwest Region

Report #21   –   AMTRAK Market Area Analysis - System Application

INTRODUCTION

STATE WIDE
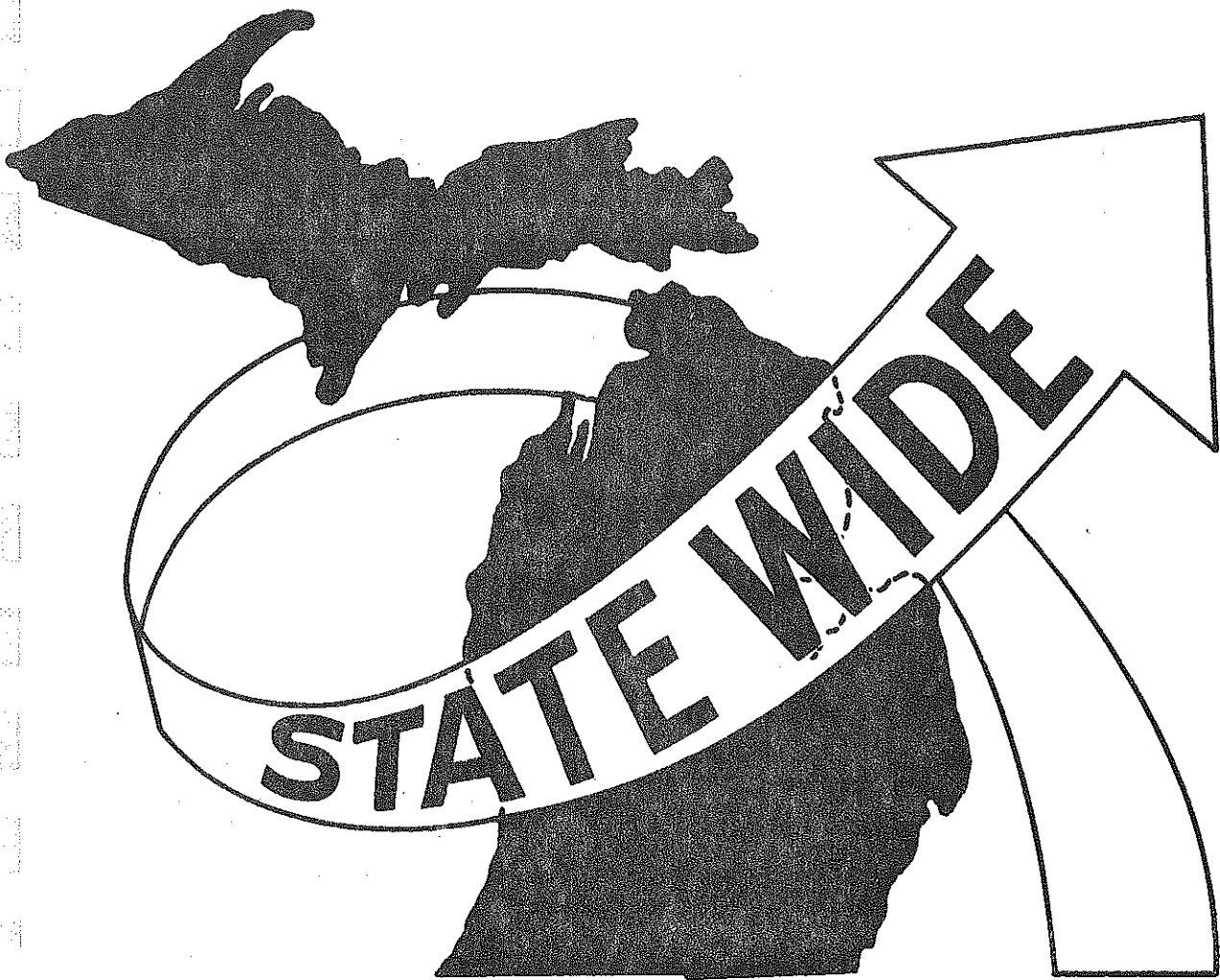
INTRODUCTION

Because of extensive involvement of many public and private organizations

in the development of regional transportation plans, more extensive analysis

of origin - destination data is often required. The need for justifying

the construction of new transportation facilities requires additional analy-

sis of the travel characteristics of existing facilities.

The energy situation also has caused the Transportation Planning profession

to deal more directly with the divertibility of travel to modes other than

highway. This again requires more extensive analysis of existing travel

patterns. An illustration of typical desire line diagrams appears in Figures

1 - 3.

The desire line plot is one method of supplying much of the above required

travel analysis. The typical manual process of plotting travel desire line

diagrams is done by totaling up the number of trips to and from cities or

areas and manually drawing the travel desire lines. Each of these diagrams

requires additional work on the part of the graphics staff when preparaing

the final print. The total elapse time for the above process is frequently

several days and often more than a week. The Statewide Transportation Planning

Procedures Section has now put together an automated process for analyzing

present and future travel patterns using the desire line concept. This auto-

mated process should allow the Department to do a more extensive analysis of

travel patterns and their impact on project justification and travel divertibility

in a much shorter elapsed time. The next section will deal with the actual

FIGURE 1

TRAVERSE CITY AREA TRAFFIC STUDY

FIGURE 2

TRAVERSE CITY AREA TRAFFIC STUDY

FIGURE 3
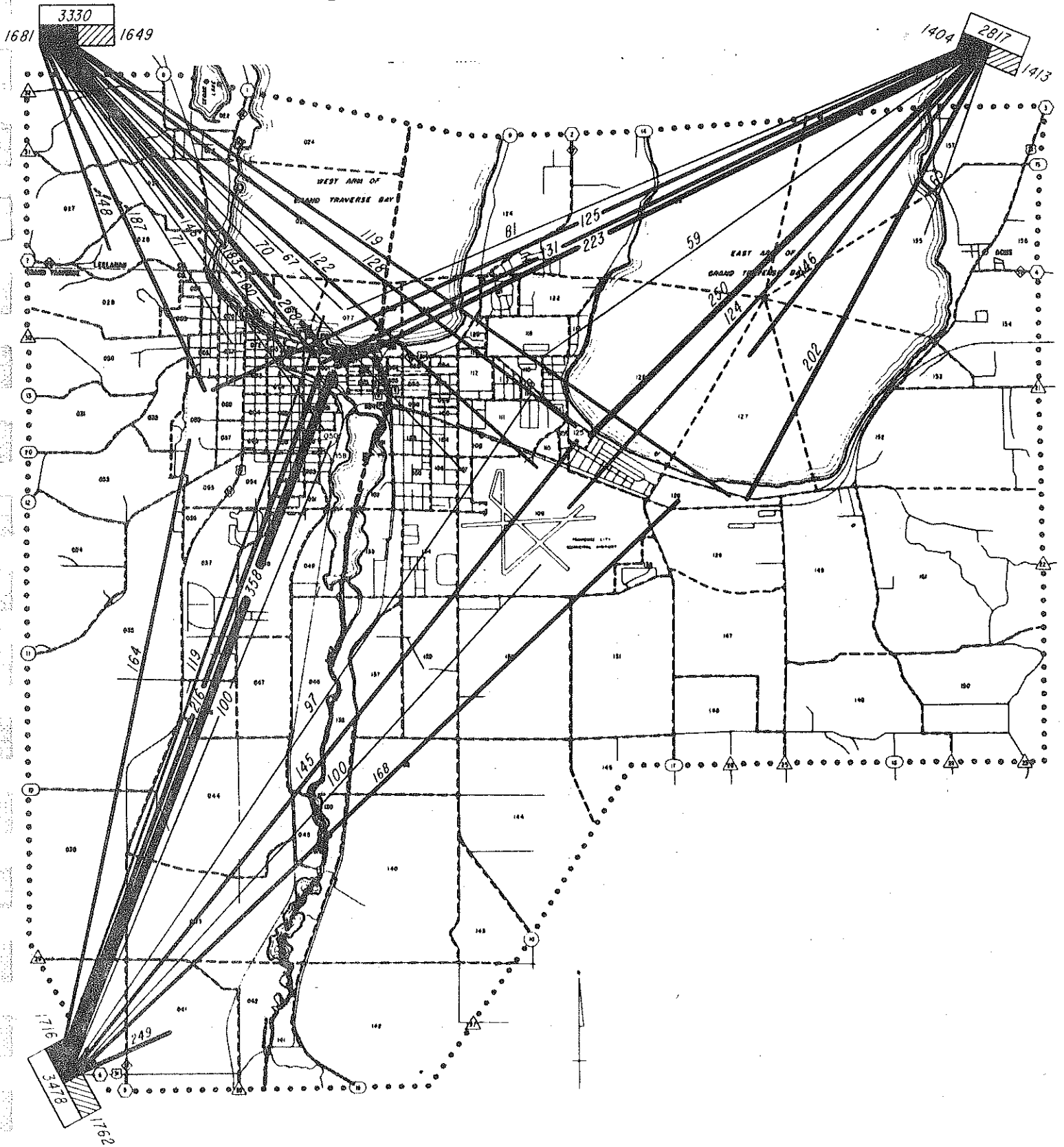
TRAVERSE CITY AREA TRAFFIC STUDY
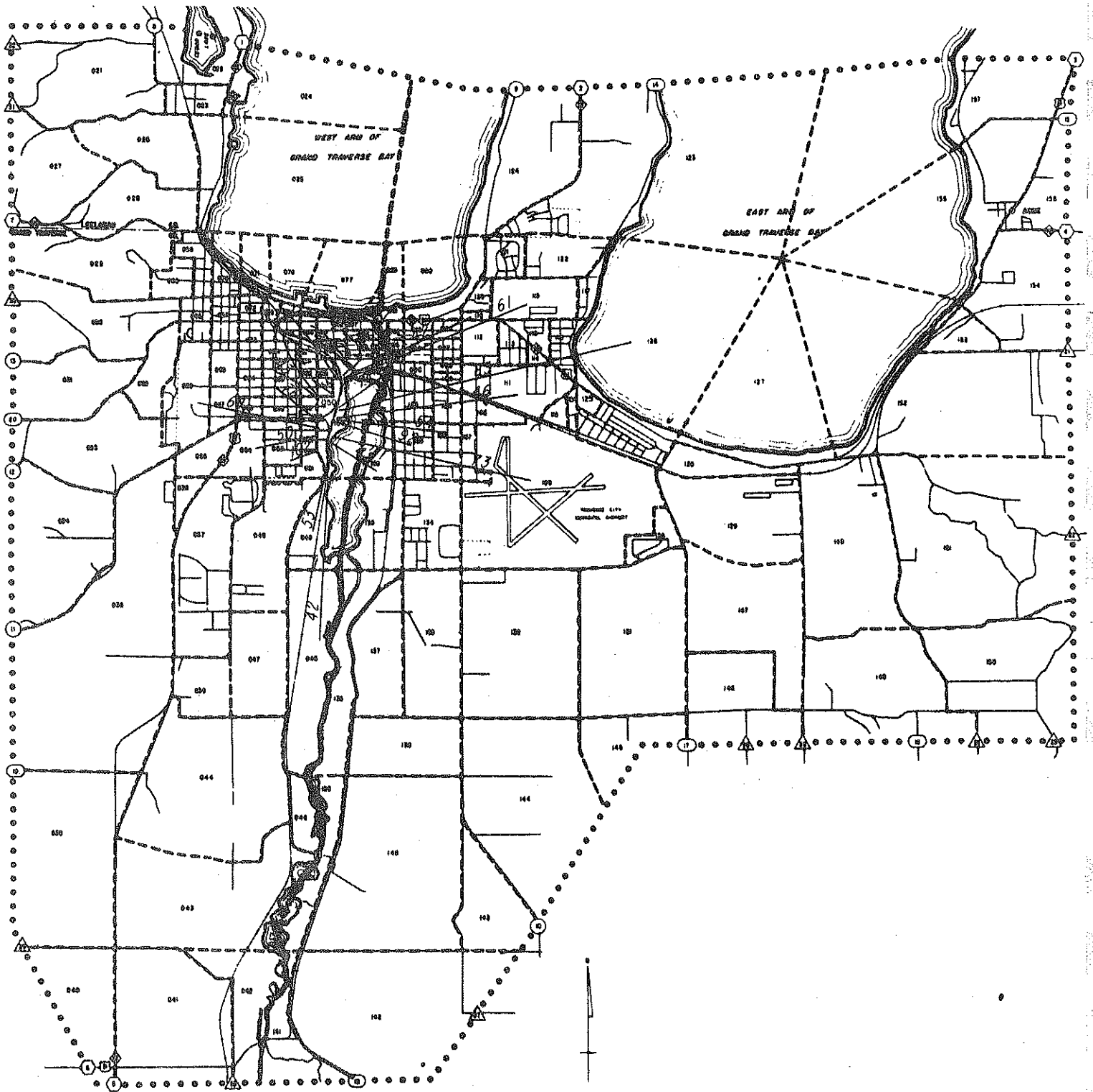
development of the automated desire line plotting process. The section fol-

lowing the development is a discussion of an actual application of the auto-

mated desire line plotting process using US-2 travel data.

STATE WIDE

DESIRE LINE PROGRAM OPERATION

The manual desire line diagram analysis begins with the identification of the desired study area or zone location. The zone system used in Michigan's Statewide Transportation Modeling System appears in Figure 4. With the study area in mind, the analyst then goes to a trip table for the primary zone-to-zone trip information.

This information typically is taken from a trip table such as the one in Figure 5. This figure is a sample trip table showing trips to all zones from Zone 218 (Spring Arbor, Concord, Pulaski, Hanover). This is the same information the automated desire line plotting takes in as the primary source of trip data.

In the manual process, the number of trips are read from the trip table and recorded. For example: The sample trip table in Figure 5 shows all trips to all zones in the state from Zone 218. If a user is interested in trips going to Zone 221, he would follow the left-hand column down until Zone 220 is found and then proceed across until he arrives at Zone 221. In this trip table there are 28 trips occurring between Zone 218 and Zone 221. This process is repeated until all zones concerned are recorded. If the routes or city being analyzed serves large amounts of travel, this type of manual analysis requires a significant amount of manpower.

The automated desire line program uses this same trip table as the basic input. The program automatically picks off the zone and number of trips that the user is interested in evaluating. Using either the manual process or the

FIGURE 4
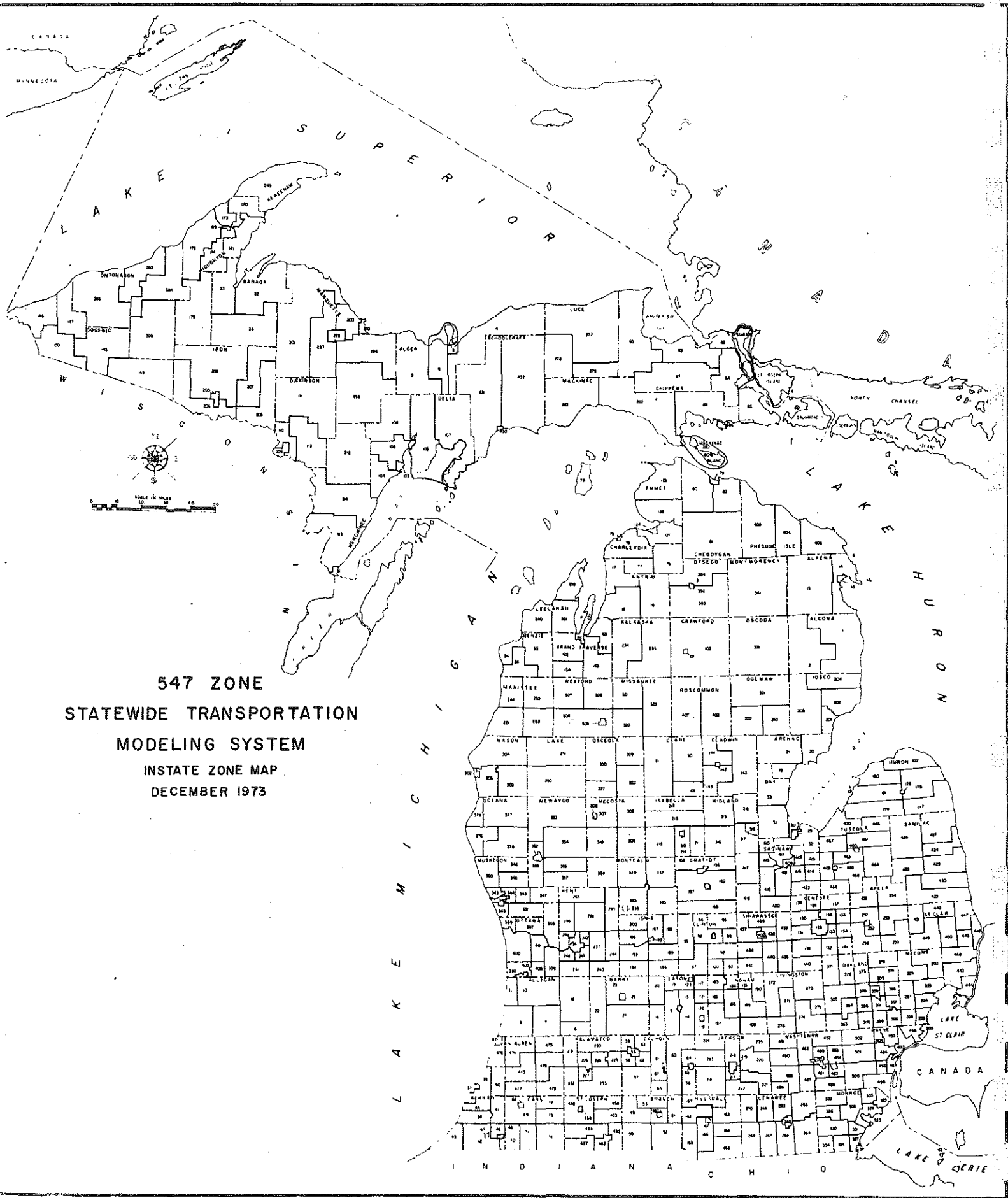
547 ZONE
STATEWIDE TRANSPORTATION
MODELING SYSTEM
INSTATE ZONE MAP
DECEMBER 1973

SELECTED TRIP TABLE   ZONE 218

INTERCHANGE VALUES FROM ZONE 218 TO ALL OTHER ZONES   TABLES NUMBER 101

	0	1	2	3	4	5	6	7	8	9
0		0	0	0	0	0	0	0	0	0
1	0	0	0	2	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	25	1
5	1	10	0	1	0	19	130	2	0	0
6	6	1	0	0	4	12	89	9	0	0
8	0	0	0	2	0	0	0	0	0	0
9	0	0	2	0	0	0	0	0	0	0
10	2	0	1	0	0	0	0	0	0	0
11	0	0	0	2	1	0	1	0	0	0
12	0	1	6	1	0	0	0	0	12	0
13	2	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	1
16	0	87	89	2	8	14	4	175	82	3
18	0	0	0	48	2	10	19	20	2	6
20	0	0	0	0	0	3	0	0	0	0
21	0	3	0	0	0	0	4353	276	820	238
22	117	28	415	356	44	18	9	0	0	0
23	0	0	0	4	0	0	4	0	0	1
24	0	0	0	0	0	0	6	0	0	0
26	0	0	9	0	7	4	6	0	0	5
27	15	0	0	0	0	0	2	0	0	0
32	0	0	0	1	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	6	0
39	0	0	6	0	0	2	0	0	0	0
40	0	0	0	0	0	0	0	2	0	5
43	0	0	0	0	3	0	0	0	0	0
45	0	0	1	3	0	0	1	0	0	1
46	0	0	0	0	0	0	0	0	0	3
47	0	0	0	0	0	0	0	0	0	14
48	0	0	0	2	0	0	0	0	0	0
49	5	0	0	53	2	0	0	6	1	0
50	5	11	7	0	3	3	0	0	0	0
52	0	0	0	0	0	0	0	0	1	0
53	2	1	5	3	0	1	1	0	1	0
54	5	4	2	0	4	0	3	0	2	0

TOTAL = 7850   MEAN = 14.351

12

FIGURE 5

automated one, the data is taken off the same trip table; and, it must be understood that the trip table is the primary source of information.

The automated desire line program uses five parameters for pieces of control information. They are specified as follows: The direction of trips (DIR) could either be 1, 2, or 3*. The magnitude of trips interested in is specified as IMin and IMax. This being the minimum and maximum number of trips. For example: If the user is interested in zones that carry between 50 and 500 trips, he would go to the trip table (Figure 6) and manually select the zones which have trips in this specified range. These trips have been circled to indicate which zones have trips occurring in the proper range. IMin and IMax do this automatically. The study zone is entered as KORG. This zone number can be found by reviewing the zone map in Figure 4. This process was originally designed to operate on all statewide model trip tables which have trip values stored in whole numbers with implied decimals. Therefore, the parameter FACT is required and is set at 1000 in order to place the decimal in the correct location. The parameter END is entered last to indicate that all of the control parameters have been entered.

From the above control information, a highway network "type" computer link file is created with the study zone being the A-node end of a theoretical highway link and the destination zone being the B-node for those zones that fulfill the specified IMin – Imax range. The file is then plotted with a standard highway network computer plot program. Figure 7 is an actual example

* 1 = Outbound Travel Only
  2 = Inbound Travel Only
  3 = Total Travel

25NOV75   SELECTED TRIP TABLE   ZONE 218

INTERCHANGE VALUES FROM ZONE 218 TO ALL OTHER ZONES   TABLES NUMBER 101

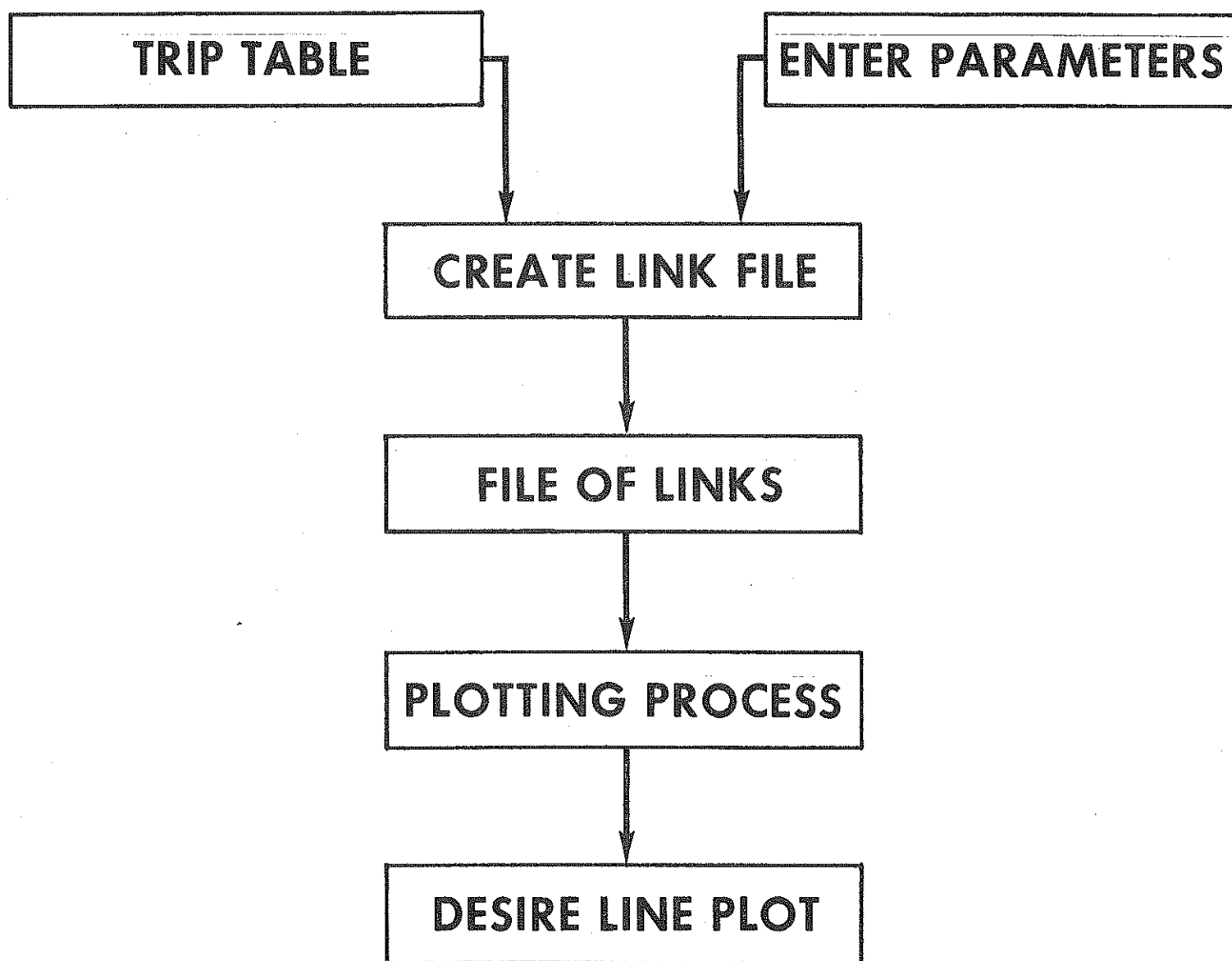|	0	1	2	3	4	5	6	7	8	9
0		0	0	0	0	0	0	0	0	0
1	0	0	0	2	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	25	1
5	1	10	0	1	0	19	130	2	0	0
6	6	1	0	0	4	12	0	9	0	0
8	0	0	0	2	0	0	0	0	0	0
9	0	0	2	0	0	0	0	0	0	0
10	2	0	1	0	0	0	0	0	0	0
11	0	0	0	2	1	0	1	0	0	0
12	0	1	6	1	0	0	0	0	12	0
13	2	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	1
16	0	87	39	2	8	14	4	175	82	3
18	0	0	0	48	2	10	19	20	2	6
20	0	0	0	0	0	3	0	0	3	0
21	0	3	0	0	0	0	4353	276	820	238
22	117	23	415	356	44	18	9	0	0	0
23	0	0	0	4	0	0	4	0	0	1
24	0	0	0	0	0	0	6	0	0	0
26	0	0	9	0	7	4	6	0	0	5
27	15	0	0	0	0	0	2	0	0	0
32	0	0	0	1	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	6	0
39	0	0	6	0	0	2	0	0	0	0
40	0	0	0	0	0	0	0	1	0	5
43	0	0	0	0	3	0	0	0	0	0
45	0	0	1	3	0	0	1	0	0	1
46	0	0	0	0	0	0	0	0	0	3
47	0	0	0	0	0	0	0	0	0	14
48	0	0	0	2	0	0	0	0	0	0
49	5	0	0	53	2	0	0	6	1	0
50	5	11	7	0	3	3	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0
53	2	1	5	3	0	1	1	4	2	0
54	5	4	2	0	4	0	3	0	0	

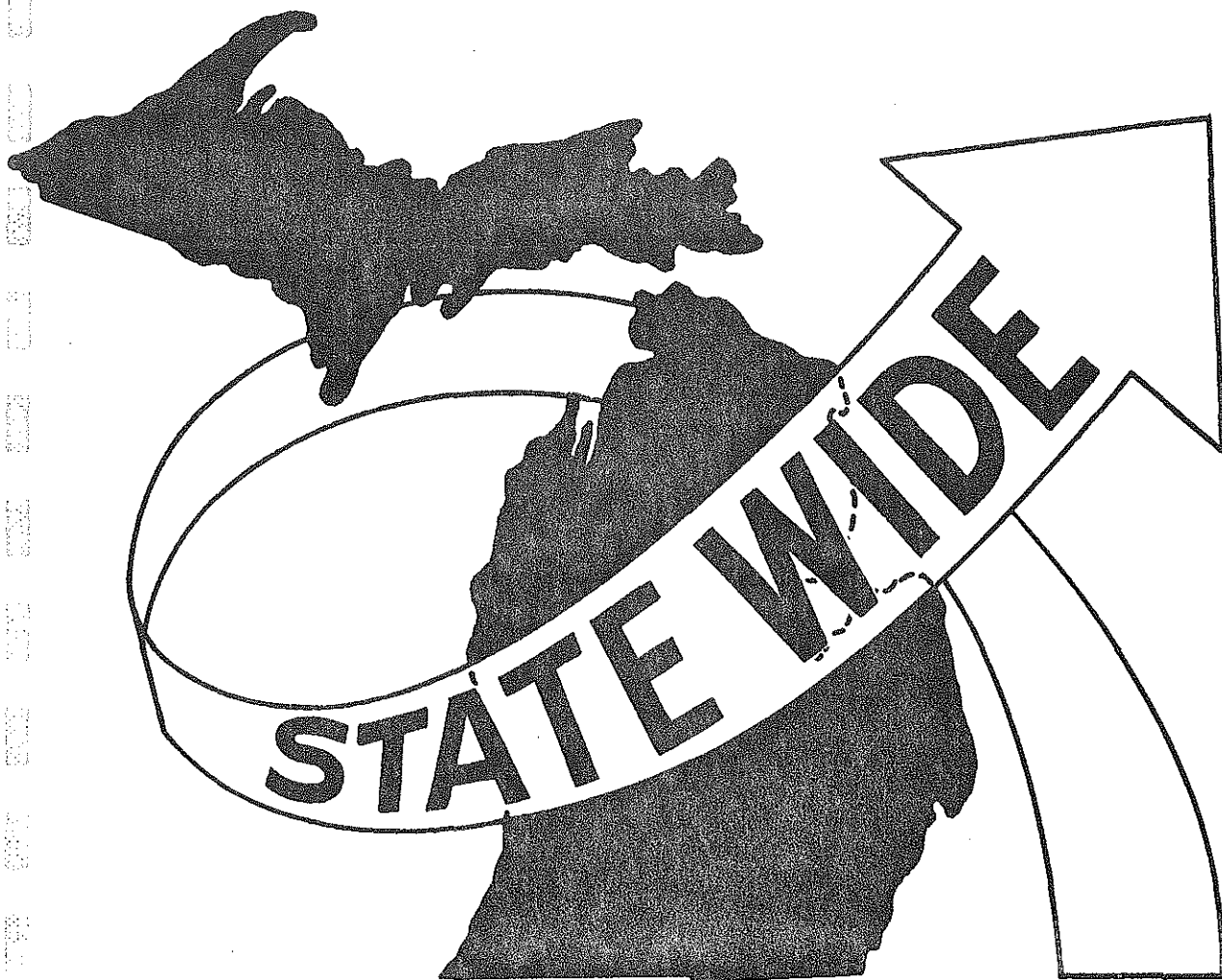TOTAL = 7350   MEAN = 14.351

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FIGURE 6

FIGURE 7

```
#RUNNING 9999
PLZ  ENTER  A  BLANK  &PARAM  A  BLANK,DIR=?,
IMIN=?,IMAX=?,FACT=?,&END
#?
 &PARAM  DIR=1,IMIN=100,IMAX=1000,KORG=282,FACT=1000,
&END
&PARAM  DIR  =  3.0000000000,IMIN  =  100.00000000,IMAX  =
1000.0000000,KORG  =  282,FACT  =  1000.0000000,&END
#ET=1:32.3  PT=0.3  IO=0.4
```

of how these parameters are entered on a computer terminal. A diagram of the automated desire line process appears in Figure 8. The next section is a complete run of the automated desire line program using actual statewide model data for US-2 in the Upper Peninsula.

FIGURE 8

DESIRE LINE PLOTTING PROCESS FLOW CHART

| TRIP TABLE | | ENTER PARAMETERS |

CREATE LINK FILE

FILE OF LINKS

PLOTTING PROCESS

DESIRE LINE PLOT

APPLICATION

STATE WIDE

APPLICATION

This section will deal with the actual application of the automated desire line diagram process. The project selected is the detailed analysis of origin and destination data for a US-2 project in the Upper Peninsula of Michigan.

When operating the desire line program, the user must specify each of the parameters discussed in the previous section. The resulting desire line plot for the US-2 corridor appears in Figure 9. For this plot (Figure 9), the study zone was specified as 282 (Brevort). The number of trips are in the range of 100 - 1000. This analysis dealt with just the outbound travel only. For this run, the parameters are as follows.

    DIR = 1
   IMin = 100
    IMax = 1000
    KORG = 282
    FACT = 1000

With the above parameters, a highway "type" link file was created which was put through a standard network plot program. Plotting was done using the 547 zone map to identify origin and destination locations. Figure 4 is an illustration of that zone map.
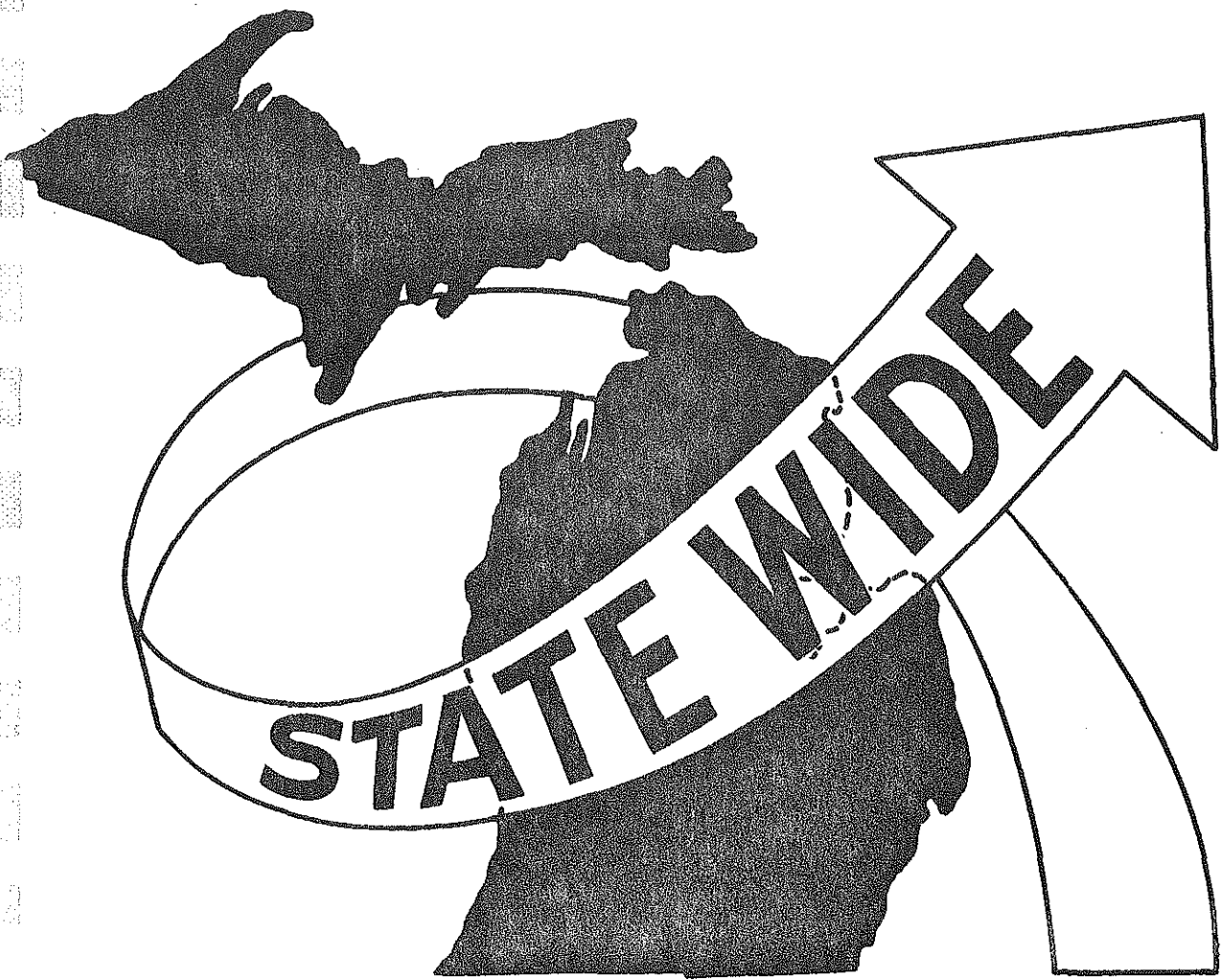
The desire line plot shows all zones affected by the parameters entered. This plot is an systematic process to examine the possibility of diverting trips to other modes. It shows where the heavily concentrated areas are that would be looked at for mass transit.

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FIGURE 9

DESIRE LINE PLOT

US-2 SOUTH EAST OF BREVORT

BREVORT(OUT TRIPS;100-1000)
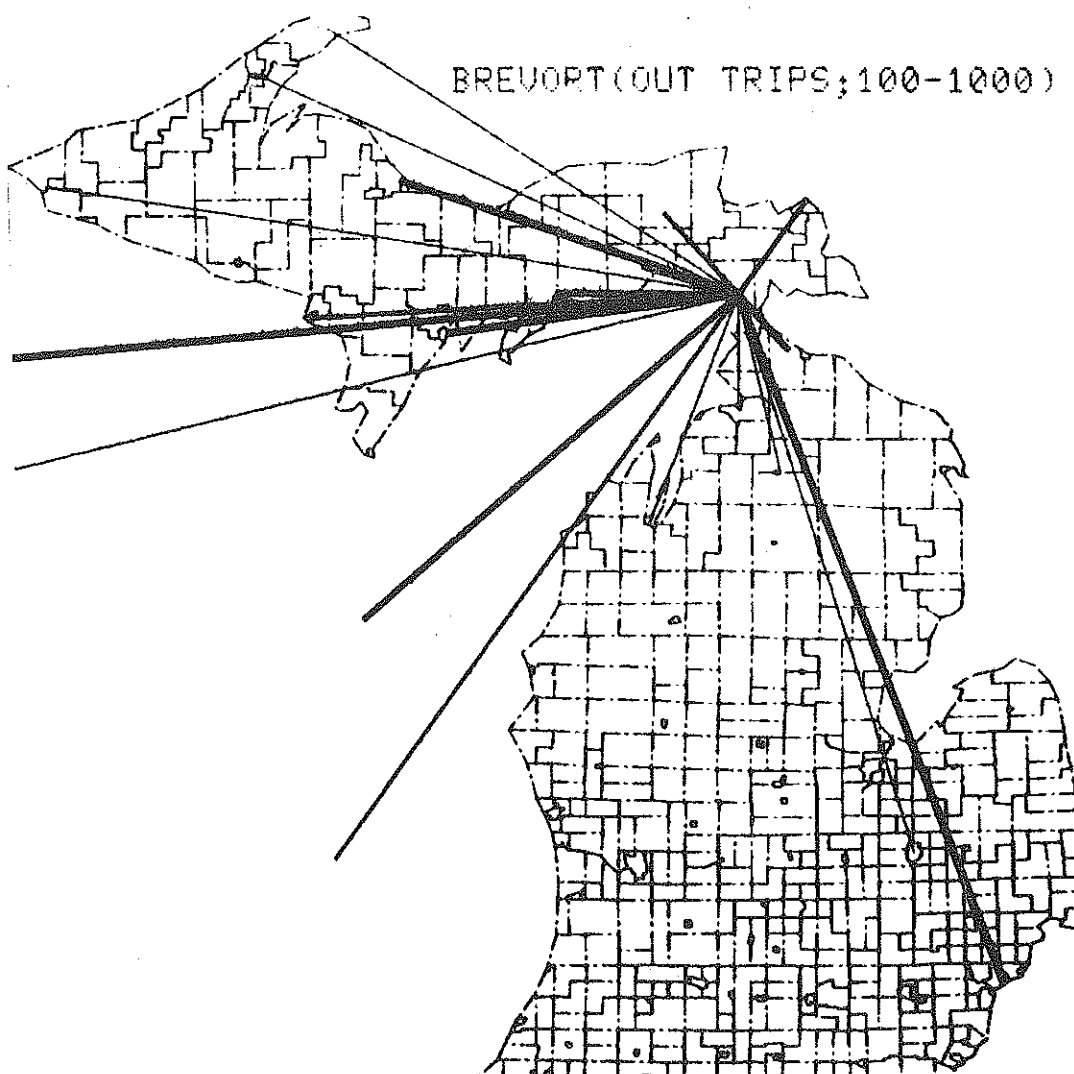
CONCLUSION

CONCLUSION

We are faced today with a growing need for an efficient multi-modal transportation network in Michigan. The reason for this need is an increasing concern over environmental and energy factors. The public has realized that our environment and natural resources are not boundless and the time has now come for conversation. Another aspect of this problem is the realization that our financial resources are also not endless.
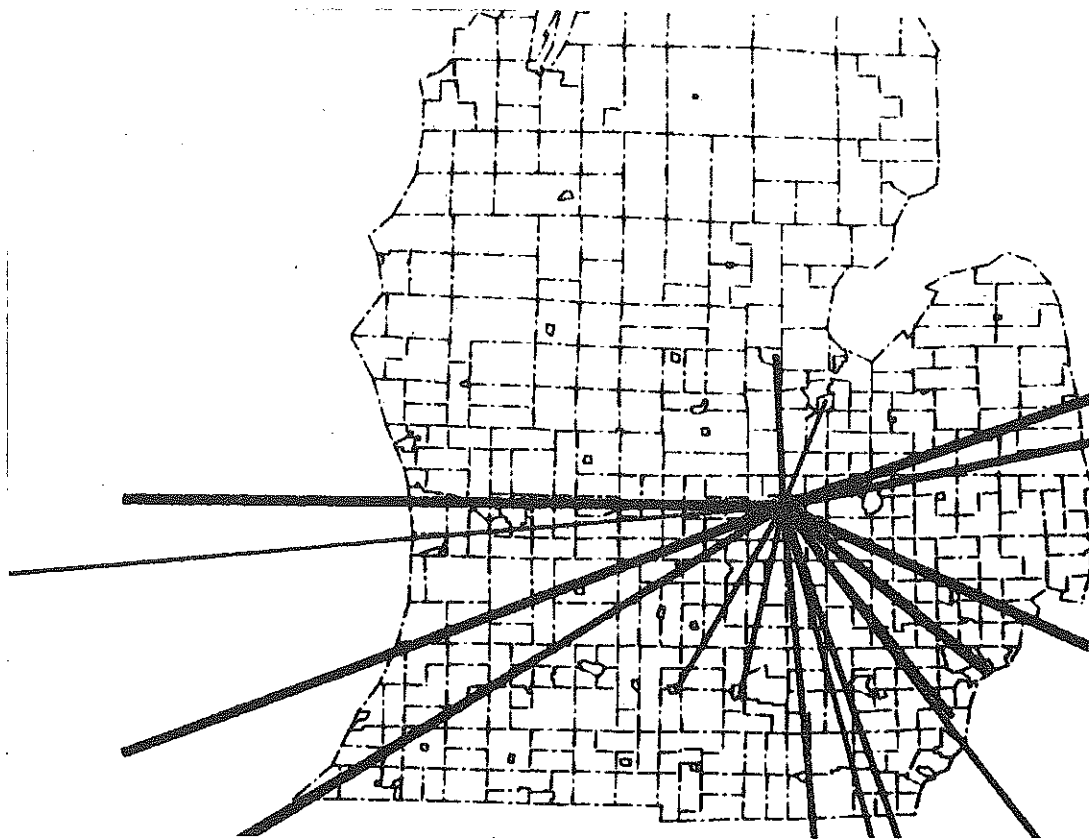
These factors have placed a great deal of pressure on the field of transportation planning. In the past, transportation planners dealt mainly with highways. They must now analysis all forms of transportation such as air, rail, bus, etc.; they must also take into consideration environmental issues; and they must come up with accurate answers quickly.

Automated desire line plotting is a new tool to aid planners in meeting the above mentioned responsibilities. It is faster and more accurate then the old manual process and can be used in both rural and urban studies. While this report deals with vehicular origin and destination data, automated desire line plotting has also been utilized in plotting rail commodity flow as illustrated in Figure 10.

For more information regarding this report or other applications of the Statewide Transportation Modeling System, contact:

Richard E. Esch
Michigan Department of State
  Highways and Transportation
Transportation Planning
P.O. Box 30050
Lansing, Michigan 48909

FIGURE 10

RAIL COMMODITY FLOW
TOTAL CARLOAD TRIPS

OWOSSO, MICHIGAN