

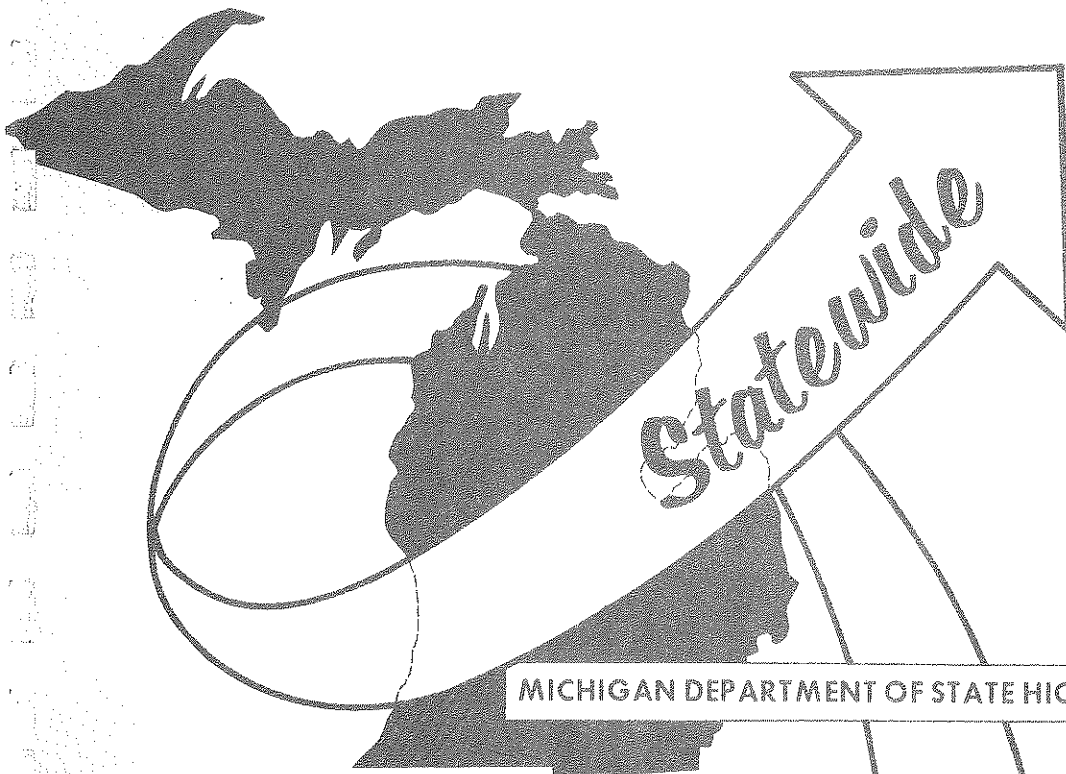
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# Statewide Transportation Analysis & Research

MICHIGAN'S STATEWIDE TRANSPORTATION  
MODELING SYSTEM

REPORT ABSTRACTS

STATEWIDE PROCEDURES SECTION  
September 1982



MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

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BUREAU OF TRANSPORTATION PLANNING

MICHIGAN'S STATEWIDE TRANSPORTATION  
MODELING SYSTEM

REPORT ABSTRACTS

STATEWIDE PROCEDURES SECTION  
September 1982

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# TABLE OF CONTENTS

**INTRODUCTION**

**ABSTRACTS**

**SYSTEM DEVELOPMENT REPORTS**

**SYSTEM APPLICATION REPORTS**

**SYSTEM REFERENCE HANDBOOKS**

# INTRODUCTION



## Introduction

When a report is published by members of the Statewide Transportation Planning Procedures Section, it has become a standard procedure to include a list of all previous reports published by this section. This list, one of which appears below, has been frequently relied upon to give the reader of each document an opportunity to become familiar with the work done in other areas of Michigan's Statewide Modeling Process. It, likewise, has been used as a means of introducing Statewide Transportation Planning Procedures Section visitors to the Statewide report series which, in recent years, has grown to be quite voluminous. While a report title indicates the general nature of the discussion contained in a document, it does not necessarily give one an idea of the specific topics discussed therein. It is, then, the purpose of this report to expand the titles of each report within the series; to present a more meaningful synopsis of their contents. The initial portion of this report reviews those documents which have been written to explain the development of the Statewide Modeling System or portions thereof. The following section reviews the contents of those reports which were published to demonstrate several of the many applications to which various system components may be or have been applied.

## STATEWIDE SYSTEM DEVELOPMENT REPORTS

- VOLUME I - OBJECTIVES AND WORK PROGRAM
- VOLUME I' - PLANNING PRODUCTIVITY: DEVELOPMENT OF MICHIGAN'S STATEWIDE STRATEGIC TRANSPORTATION MODELING SYSTEM
- VOLUME I-A - REGION 4 WORKSHOP TOPIC SUMMARIES
- VOLUME I-B - SINGLE AND MULTIPLE CORRIDOR ANALYSIS
- VOLUME I-B(2) - TRAVEL FORECASTING TECHNIQUES AND APPLICATIONS
- VOLUME I-C - MODEL APPLICATIONS: TURNBACKS
- VOLUME I-D - PROXIMITY ANALYSIS
- VOLUME I-E - MODEL APPLICATION: COST-BENEFIT ANALYSIS
- VOLUME I-F - AIR AND NOISE POLLUTION
- VOLUME I-G - PSYCHOLOGICAL IMPACT MODEL
- VOLUME I-H - LEVEL OF SERVICE MODEL
- VOLUME I-I - STATEWIDE SOCIO-ECONOMIC AND TRANSPORTATION RESOURCES
- VOLUME I-J - SERVICE AREA MODEL
- VOLUME I-K - EFFECTIVE SPEED MODEL
- VOLUME I-L - SYSTEM IMPACT ANALYSIS GRAPHIC DISPLAY
- VOLUME I-M - MODELING GASOLINE CONSUMPTION
- VOLUME I-O - ACCIDENT RATES 547 ZONE SYSTEM
- VOLUME I-P - POPULATION PROJECTIONS 547 ZONE SYSTEM
- VOLUME I-Q - APPLICATION OF AN INPUT-OUTPUT MODEL TO RAIL FREIGHT TRAFFIC FORECASTING
- VOLUME II - DEVELOPMENT OF NETWORK MODELS
- VOLUME II-A - EFFICIENT NETWORK UPDATING WITH INTERACTIVE GRAPHICS
- VOLUME II-B - TREE PLOTTING WITH INTERACTIVE GRAPHICS
- VOLUME II-C - INTERACTIVE GRAPHIC APPLICATIONS IN MICHIGAN'S STATEWIDE TRANSPORTATION MODELING SYSTEM
- VOLUME III - SEGMENTAL MODEL
- VOLUME III-A - SEMI-AUTOMATIC NETWORK GENERATOR USING A "DIGITIZER"
- VOLUME III-B - AUTOMATIC NETWORK GENERATOR USING INTERACTIVE GRAPHICS
- VOLUME IV - AASHTO REPORT: A STATEWIDE TRANSPORTATION MODELING SYSTEM EFFECTIVELY MEETS THE TRANSPORTATION CHALLENGE OF THE 70'S
- VOLUME IV-A - MICHIGAN'S STATEWIDE MODELING SYSTEM - SYNOPSIS
- VOLUME IV-B - CALIBRATION OF MICHIGAN'S STATEWIDE TRAFFIC FORECASTING MODEL
- VOLUME V - PART A: REFORMATION - TRIP DATA BANK PREPARATION
- VOLUME V - PART B: DEVELOPMENT OF SOCIO-ECONOMIC DATA BANK FOR TRIP GENERATION-DISTRIBUTION
- VOLUME V-A - SINGLE STATION O & D PROCEDURES MANUAL
- VOLUME V-B - EXTERNAL O & D PROCEDURES MANUAL
- VOLUME VI - CORRIDOR LOCATION DYNAMICS
- VOLUME VI-A - ENVIRONMENTAL SENSITIVITY COMPUTER MAPPING
- VOLUME VII - DESIGN HOUR VOLUME MODEL
- VOLUME VII-A - CAPACITY ADEQUACY FORECASTING MODEL
- VOLUME VII-B - MODELING MAJOR FACILITY OPENING IMPACT ON DHV

|               |  |
|---------------|--|
| VOLUME VIII   | - PUBLIC AND PRIVATE FACILITY FILE   |
| VOLUME VIII-A | - CONVERSION OF INDUSTRIAL EXPANSION FILE  |
| VOLUME IX     | - SOCIO-ECONOMIC DATA FILE   |
| VOLUME IX-A   | - MAPPING SOCIO-ECONOMIC DATA WITH SYMAP   |
| VOLUME IX-B   | - CONVERSION OF THE AGRICULTURAL CENSUS FILE   |
| VOLUME IX-C   | - TAX RATE AND ASSESSED VALUATION INFORMATION  |
| VOLUME IX-D   | - SCHOOL DISTRICT DATA FILE  |
| VOLUME X-A    | - TRAVEL IMPACT ANALYSIS PROCEDURES  |
| VOLUME X-A(1) | - AUTOMATED DESIRELINE PLOTTING  |
| VOLUME X-A(2) | - TRAFFIC FORECASTING FOR A SPECIAL GENERATOR  |
| VOLUME X-B    | - SOCIAL IMPACT ANALYSIS PROCEDURES  |
| VOLUME X-C    | - ECONOMIC IMPACT ANALYSIS PROCEDURES  |
| VOLUME X-C(1) | - ECONOMIC DEVELOPMENT ANALYSIS USING STATEWIDE<br>TRANSPORTATION MODELING           |
| VOLUME XI     | - COMPUTER RUN TIMES   |
| VOLUME XIII   | - MICHIGAN GOES MULTI-MODAL  |
| VOLUME XIII-A | - MULTI-MODAL MOBILITY AND ACCESSIBILITY ANALYSIS                                    |
| VOLUME XIII-B | - 1972 STATEWIDE RAIL NETWORK - SUMMARY TABULATIONS                                  |
| VOLUME XIII-C | - MICHIGAN'S RAIL CROSSING INVENTORY AND ANALYSIS<br>PROCESS                         |
| VOLUME XIII-D | - IMPACT OF POPULATION AND ENERGY ON TRANSPORTATION<br>NEEDS: A MULTI-MODAL APPROACH |
| VOLUME XIV-A  | - COMMODITY FLOW MATRIX: ANN ARBOR RAILROAD  |
| VOLUME XIV-B  | - COMMODITY FLOW MATRIX: PENN CENTRAL RAILROAD                                       |
| VOLUME XIV-C  | - COMMODITY FLOW MATRIX: MICHIGAN RAILROADS 1%<br>SAMPLE                             |
| VOLUME XV-A   | - RAILROAD FINANCIAL IMPACT ANALYSIS   |
| VOLUME XV-B   | - RAILROAD COMMUNITY IMPACT ANALYSIS   |
| VOLUME XVI    | - DIAL-A-RIDE  |
| VOLUME XVII   | - INTERMODAL IMPACT ANALYSIS: TRUCK AND RAILROAD                                     |
| VOLUME XVIII  | - CUTLINE ANALYSIS PROGRAM   |
| VOLUME XIX    | - LONG-RANGE TRANSPORTATION REVENUE FORECASTING                                      |
| VOLUME XIX-A  | - T.R.I.P. - REVENUE VS. NEEDS: AN ANALYTICAL<br>APPROACH                            |
| VOLUME XX     | - A FISCAL APPROACH TO RETIRING TRANSPORTATION NEEDS                                 |

## 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 OR 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

## STATEWIDE SYSTEM REFERENCE HANDBOOKS

- REFERENCE HANDBOOK #1 - STATEWIDE BUS TICKET SURVEY TRAVEL CHARACTERISTICS
- REFERENCE HANDBOOK #2 - MICHIGAN'S PERMANENT TRAFFIC RECORDER TRENDS - POTENTIAL APPLICATION IN TRANSPORTATION PLANNING - ENERGY ANALYSIS
- REFERENCE HANDBOOK #3 - MINOR ORIGIN & DESTINATION TRAVEL CHARACTERISTICS - PART A
- REFERENCE HANDBOOK #4 - TRUCK COMMODITY SUMMARIES
- REFERENCE HANDBOOK #5 - STATE PARK ATTENDANCE TRENDS
- REFERENCE HANDBOOK #6 - 547 ZONE SYSTEM



# SYSTEM DEVELOPMENT REPORTS



Volume I

**OBJECTIVES AND WORK PROGRAM**

Objectives and Work Program (Volume I) was the first in what has grown to be a formidable series of reports which detail the development and application of Michigan's Statewide Traffic Forecasting Model. This report's basic purpose was threefold: 1) to present the then proposed model's objectives - stated in terms of and to be accomplished in four separate phases; 2) to define specific work programs needed to complete each phase of model development; and 3) to document the benefits to be received by the Department and other State agencies from a fully operational model. Staff requirements and a proposed time schedule were also discussed. Although shifting priorities over the last few years have made this report obsolete within the Statewide Transportation Planning Procedures Section, other groups interested in statewide modeling may find it of significant value.

Volume I'

**PLANNING PRODUCTIVITY: DEVELOPMENT OF MICHIGAN'S STATEWIDE STRATEGIC  
TRANSPORTATION MODELING SYSTEM**

Early in the development of Michigan's Statewide Travel Forecasting Model, it was decided that a system such as this should be designed so that the applications could be extensive serving both detailed analytical and administrative needs.

In order to serve many users and varied applications in the planning profession, the planning data base for this system would have to be extensive. The primary reason being the fact that in the time when this system was being developed, mathematical computer-oriented systems such as this were not too popular or successful.

This report deals with the data base that was developed to generate the many applications. A list of over 600 applications is included in this report along with a detailed explanation of several selected applications. A brief explanation of the philosophy that generated the productivity of this system is also included along with staff and cost estimates.

Volume I-A

**REGION 4 WORKSHOP TOPIC SUMMARIES**

Volume I-A presents a brief summary of the Statewide Traffic Forecasting Model Workshop sponsored by the Michigan Department of State Highways and Transportation and the Federal Highway Administration in November 1971. Specific aspects of statewide modeling which were discussed in the workshop's several sessions are reviewed. In addition, attachments include those exhibits referenced in each workshop discussion as well as other material of a general interest.

Volume I-B

### **SINGLE AND MULTIPLE CORRIDOR ANALYSIS**

This volume describes the statewide model's benefits over manual techniques in terms of speed, cost, reliability, and consistency. These advantages make it possible to analyze single and multiple corridor traffic patterns more efficiently than ever before. Several alternate proposals are used in an illustration of how the analysis process, which has been developed within the state's modeling framework, actually works. A brief discussion of the model's operation precedes the illustration while a discussion of future model applications is presented succeeding it.

## **TRAVEL FORECASTING TECHNIQUES AND APPLICATIONS**

During the late 1960's and early 1970's, Michigan was experiencing very dynamic growth in both residential and industrial areas. These growth patterns were dramatically different in urban, suburban, and rural areas. The end result of all this change placed a large responsibility on the travel forecasting demands within the Department of Transportation.

In order for the Michigan Department of Transportation to effectively meet the huge demand for the type of travel forecasts required to meet additional responsibilities identified in the report, the Department initiated the development of a statewide travel forecasting model.

This report includes a brief description of the operation of that system. It also explains the application of this forecasting process in four major planning areas, namely:

1. Project Level Travel Forecasting
2. Regional Planning System Analysis
3. Multi-Modal Travel Demand
4. Strategic Planning Travel Impacts

**MODEL APPLICATION: TURNBACKS**

The present turnback law explicitly states that agreement must be reached between the Michigan Department of Transportation and the local governmental unit regarding a change in jurisdiction in the state trunkline system. Significant effort has been expended by the Department to achieve a smooth running turnback program. In making its decision, the Department must consider the level and character of service, using the latest standards and criteria (accepted and recognized) available. Within these guidelines, the impact of the proposed turnback on state, regional, and local master plans must be considered.

This report describes how existing technology, used in conjunction with the statewide traffic forecasting model, can be used to provide a systematic and factual basis for evaluating the present level and character of service for any proposed trunkline establishment or abandonment.

This process will now allow the Department to concentrate a major portion of its effort on systems analysis and evaluation rather than data manipulation and summarization.

Volume I-D

**PROXIMITY ANALYSIS: SOCIAL IMPACTS OF ALTERNATE HIGHWAY  
PLANS ON PUBLIC FACILITIES**

In formulating equations and devising techniques to be used in the trip generation phase of the statewide modeling process, a methodology for monitoring the social consequences of implementing alternate highway schemes has been developed. Basically, this technique allows its user to determine how proposed highway plans might affect spatial relationships between social groups and public facilities by calculating the change in simulated driving time which may result from the actual implementation of a specific plan. Since this procedure has been developed within the statewide modeling system, it may use any of its extensive data files which include the Statewide Travel Data Bank, the Statewide Socio-Economic Data File, and the Statewide Public and Private Facility File. This data may be displayed in a number of ways without modification, but the most visually impressive technique has been the use of both two- and three-dimensional computer mapping routines.



Volume I-E

**MODEL APPLICATIONS: COST-BENEFIT ANALYSIS**

"Section 109(h) Guidelines" of Title 23, U.S. Code, stipulates that final decisions regarding highway projects must include consideration of the public's need for "fast, safe, and efficient" transportation. The computerized process defined in this report measures speed and efficiency as a dollar cost to the user on each of a number of alternative highway plans and compares the plans regarding safety by forecasting future accidents on the alternatives. Furthermore, the process considered herein contrasts value gained or lost by users and taxpayers through the implementation of a number of alternative highway plans. It also measures such intangibles as surplus benefits received by the user-community as a whole through a plan which makes travel cheaper and more efficient.

Volume I-F

**AIR AND NOISE POLLUTION SYSTEM ANALYSIS MODEL**

Federal legislation requires that the evaluation of each highway project include an estimate of the amount of noise and air pollution which will probably be generated with implementation. The traditional approach to an evaluation of this sort is to analyze the proposed road in isolation. The methodology described herein is superior in that it is able to account for system level impacts; that is, one is now able to monitor the environmental consequences of a single project on the pollution level of the entire system. The models modified for use within the Statewide System and described here are those originally designed by the Stanford Research Institute (SRI). The actual programs, and the technical information relating to their use can be found in SRI's battery of computer programs known as SNAP - i.e., Standard Network Analysis Package.

Volume I-G

### **TRANSPORTATION PLANNING PSYCHOLOGICAL IMPACT MODEL**

This report details the development of a means of measuring the relative "driving comfort" of its trunkline system or any route or combination of routes therein. The Statewide Transportation Planning Procedures Section has created an index system for measuring the psychological impact of highway improvements which has been labeled a HASSLE factor (Highway Annoyance Scale of Selected Logical Elements). This factor was derived from original efforts in this field by the Stanford Research Institute (SRI). SRI developed a scale that measured the relative congestion of a route by dividing the capacity of a route by its actual or anticipated volume (V/C ratio). The Statewide effort goes several steps further.

Volume I-H

**LEVEL OF SERVICE SYSTEMS ANALYSIS MODEL: A PUBLIC INTERACTION APPLICATION**

Recent legislation has made it the responsibility of each highway department to effectively communicate with the public in matters concerning future highway projects. The public must now be made aware of the total picture and what effects each project might have on them. Since the general public finds it difficult to understand the "jargon" of the highway engineers, techniques must be devised to communicate suspected impacts of alternate proposals to them in a meaningful, logical, and comprehensible manner. The level of service concept is one with which many are able to readily identify. This report is meant to illustrate how this concept may be employed as an effective device for public communication. The emphasis throughout is placed on its graphic use for public involvement rather than the actual principles of the concept itself.

Volume I-I

**STATEWIDE SOCIO-ECONOMIC AND TRANSPORTATION RESOURCES  
AND THEIR ROLE IN INTERCITY TRANSPORTATION DECISIONS**

If planning and financing of multi-modal transportation systems is to be effective, it is necessary to identify the extent of mobility of all population groups in the state. Once the geographic distribution of various mobility groups in the state is identified and defined, rational planning of transportation systems can proceed. The allocation of present and future transport development funds must emerge from sound decision making processes derived from transportation need and existing service. The current transportation modeling systems are built to forecast demand for travel based on predicted levels of population and surrounding population. Due to changing social priorities, as the result of the political process, there is a need for the transportation modeling to be flexible if statewide and regional goals are to be effectively met. This report deals with the discussion of mobility impact variables in the application of the statewide transportation modeling system to changing needs and priorities.

Volume I-J

**SERVICE-AREA MODEL**

As an offshoot of the Proximity Analysis process, the Service-Area Model was developed to calculate the probable level of influence of each member of any facility group. It allows a planner to test rapidly the probable effects of adding or deleting a facility from his existing system. Used in conjunction with Proximity Analysis, the Service-Area Model can be a powerful tool in facility location planning.

Volume I-K

**EFFECTIVE SPEED MODEL: A PUBLIC INTERACTION TOOL**

This report documents the construction and testing of a model which is able to relate the congestion on a highway link to the effective running speed on that link. The model uses three separate sets of "curves" to relate link speed to its volume-to-capacity ratio. The actual choice of the function to be used on any given link is determined by, first, the type of road being studied and, secondly, by its number of lanes. Output from this model will be useful in communicating with the general public on various regional transportation projects and may be valuable in the development of a new capacity-restraint algorithm.

Volume I-L

### **SYSTEM IMPACT ANALYSIS GRAPHIC DISPLAY**

One function of the Statewide Modeling System is the evaluation of the travel, social, and economic impacts thought to be caused by alternate highway systems. The result of the impact analysis process is a computerized highway network file which contains impact analysis information on a link by link basis. With more than 3500 links in a statewide network, this scale is obviously too detailed to permit meaningful regional and statewide system comparisons. This report documents the steps performed to obtain graphic comparisons of system impact analysis. Included are annotated flow chart and examples of system level summary tables and graphic comparisons.



Volume I-M

### **MODELING GASOLINE CONSUMPTION**

This report describes an operational model with a capability which can be applied to evaluate alternate highway system proposals. The major parameters in the calculation are a measure of traffic volume on each link in the highway network, the speeds on the links, and an estimate for gasoline consumption at various speeds. The output of the gasoline consumption model is the projected number of gallons annually consumed on each alternate highway system proposal at whatever speeds are to be examined. The result is separated into interstate, federal and primary, and federal and secondary highways, and yields a total from all three, at county, regional, and statewide levels.

Volume I-0

**ACCIDENT RATES 547 ZONE SYSTEM**

This report was prepared in order to document the source of accident information and the standards now being used in the Statewide Transportation Modeling System to assist in the development and evaluation of regional transportation plans. In the area of safety, the number of accidents is presently being supplied.

Volume I-P

## POPULATION PROJECTIONS 547 ZONE SYSTEM

This report deals with the development of the zonal population projections used in the statewide traffic forecasting model. The modeling system presently being used was calibrated to a 1965 highway network. The population projections used in the model were initially completed by the Population Studies Center at the University of Michigan. These county level projections were then used as input to the small area projection study prepared by Donald E. Bailey entitled Preliminary Population Projection for Small Areas in Michigan - November, 1966. The present modeling system uses a zonal summarization of these population projections. The zonal summaries have been adjusted by 1970 county level census data and used as the basic input to the trip generation - distribution process. Because interest has been expressed in new county forecasts now available from the State of Michigan Bureau of the Budget, new zonal populations based on these forecasts are now available. The following report has been updated to reflect the additional work done with the Bureau of the Budget (B.O.E.) forecasts.

Volume I-Q

**APPLICATION OF AN INPUT-OUTPUT MODEL TO RAIL FREIGHT TRAFFIC FORECASTING**

This report summarizes a study by Jeffrey L. Jordan which demonstrated an application of input-output analysis in making rail freight traffic projections. The input-output model was a 20-sector version of a 44-sector Michigan model adapted from the United States Bureau of Economic Analysis' national tables for the Michigan Energy Administration by a consultant. Traffic flow data are from the one-percent railroad waybill samples. A test of the method matched the projected change in Michigan's output between 1976 and 1980 to changes in rail traffic over the same period. The 1976 waybills were factored by the projected changes in output by sector to yield projected traffic flows for 1980. The projected 1980 traffic total was within two-percent of the actual 1980 traffic represented in the waybill sample. Somewhat larger, but reasonable percentage differences prevailed for most major commodity sectors.

## Volume II

### DEVELOPMENT OF NETWORK MODELS

This volume describes the technical development of the now modified 510 zone network model and its more refined (and as of yet, experimental) 2300 zone system. The process of zone and network definition, coding procedures and network editions through the use of computer technique are all discussed in turn. A brief persentation of the technical differences between the 510 and the 2300 zone models is also included.

Volume II-A

**EFFICIENT NETWORK UPDATING WITH INTERACTIVE GRAPHICS**

Interactive network updating is a process in which an analyst and a computer respond to one another to create pictorial displays. These network "pictures" are drawn on a cathode-ray tube terminal; the analyst can make changes and receive instant feedback on the results of his decision. This report documents the development of such a system.

The interactive updating system is shown to decrease workload, shorten elapsed time, and increase accuracy as compared with the more traditional handcoding and batch processing method. Therefore, it is proving to be a real asset in a time when public demands for information is expanding dramatically, while budget allocations for manpower are shrinking. It is especially useful in rapidly forecasting impacts of proposed regional transportation plans.

### TREE PLOTTING WITH INTERACTIVE GRAPHICS

A large part of the time involved in model network calibration is usually reserved for verifying that the shortest driving-time paths between zones are correct. This traditionally involves plotting a "tree" (the set of travel paths between one zone and all other zones) for a large number of key zones. Because an agency usually has only one or two flat-bed or drum plotters to serve everybody, there is at least a day's delay between submission of the batch plot run and delivery of the finished plot. This contributes to one of the big arguments against model development, "We can't do it because it takes too long."

This report shows how a Tektronix full-graphic, cathode-ray-tube computer terminal can be used for tree plotting, cutting turnaround time from a day to a few minutes. Statewide's interactive tree plotter also gives the analyst the capability of quickly windowing in on parts of the tree he wants to explore in more detail. This becomes especially important when one realizes that each blowup necessitates a separate plot run in a batch-oriented system.

The ability to view a selected tree quickly is also useful in the day-to-day application of a modeling system. Questions such as, "Why are these links higher (or lower) than expected?" can often be answered with one or two tree plots. However, in this environment, the analyst often needs to plot several trees before the answer is apparent. Often, he does not even know for sure when he starts which trees he should be plotting.

Interactive graphics can shave the elapsed time between question and answer by up to 95%.

Volume II-C

**INTERACTIVE GRAPHIC APPLICATIONS IN MICHIGAN'S  
STATEWIDE TRANSPORTATION MODELING SYSTEM**

Modern transportation agencies face increasing responsibilities and decreasing revenues. The only viable solution is increased productivity and efficiency. NETEDIT, an operational interactive method of updating, displaying, and interrogating networks, has allowed Michigan's Department of Transportation to increase its analysis capabilities without sacrificing production time.

The utility of such a process is easily seen by contrasting manual coding and batch updating with the interactive update process. NETEDIT gives the user instant pictorial feedback, enabling errors to be corrected on the spot. This allows the average elapsed time for alternate generation to drop from two weeks to four hours. Additionally, the ability to vary the way a link is drawn based on its attributes -- solid, dotted, dashed, cross-hatched, even bandwidth -- lends versatility. The addition of a digitizer tablet has allowed creation of 2,000-node networks in two weeks. A tree plotting subroutine eliminates much of the elapsed time in network calibration.

Most importantly, NETEDIT, together with Michigan's Statewide Transportation Modeling System, has been used in over 350 actual planning applications over the past five years. As a result, NETEDIT has become a valuable transportation planning technique in Michigan.



### Volume III

#### **MULTI-LEVEL HIGHWAY NETWORK GENERATOR ("SEGMENTAL MODEL")**

Volume III presents a technique to generate multi-level highway network (Segmental Model). This technique deals with the automatic reduction of network details in areas remote to a particular study area to reduce computer run times in network analysis without significantly affecting the detailed study area. This report documents the segmental model techniques, defines and explains the model's computer programs, discusses the use of program and run times on a B-5500, present tests results on actual 2300 zone station model network and discusses future applications and program refinements.

Volume III-A

**SEMI-AUTOMATIC NETWORK GENERATOR USING A "DIGITIZER"**

Human errors are quite prevalent with the use of traditional network coding procedures because of the sheer size of the typical coding operation. Since most operations are manual they are quite lengthy which generates staff boredom which in turn, produces additional errors. This report diverts its attention to a process developed to: 1) drastically reduce network coding time by replacing manual tasks with machine operations 2) eliminate a tedious task through use of a Thompson Pencil follower and 3) improve network reliability by reducing coding errors.

### **AUTOMATIC NETWORK GENERATOR USING INTERACTIVE GRAPHICS**

Creating a modeling network typically involves coding each node and each link by hand, keypunching the resulting cards, and submitting a batch run to build the net. Then another batch plot run is needed to verify that the coding was done correctly, followed by another day's wait until the plot is delivered. If errors are discovered, corrections are coded and the cycle begins again. This tremendous time lag partially explains the resistance of many agencies in developing a modeling system; moreover, using an off-line digitizer in place of hand coding only partially solves the problem. It relieves some of the tedium involved, but does little to shorten the elapsed time.

Statewide has developed a process in which a network is digitized on-line on a Tektronix graphic tablet connected to a Tektronix full-graphic CRT computer terminal. The advantages of this system are obvious: 1) no boring coding is necessary, 2) a picture of each link appears on the screen as it is entered into the data base enabling instant error correction, and 3) since no keypunching, plotting, or other off-line processes are involved, turnaround is reduced by as much as 80%.

This type of system becomes very important in going from statewide or regional planning to project-level planning. Often, it is necessary to create several very detailed alternative networks. In a situation where quick answers are needed, these tablet routines can make the difference between getting answers and having to say, "We can't do that."

Volume IV

**A STATEWIDE TRANSPORTATION MODELING SYSTEM  
EFFECTIVELY MEETS THE TRANSPORTATION CHALLENGE OF THE '70'S**

This report was prepared for the AASHO committee on Computer Technology and was presented at the National Conference in June, 1973. The document reviews the "challenge" confronting all State Highway Departments as they entered this decade and discussed how a statewide modeling effort effectively meets this challenge. Specific discussions were included detailing Michigan's system as it existed then and suggested techniques to be developed which are now used in the daily operation of the model.

Volume IV-A

**MICHIGAN STATEWIDE MODELING SYSTEM: SYNOPSIS**

This brief document is a pictorial review of the AASHO report. The graphics contained herein are those which were used in a slide presentation of the original report.

Volume IV-B

**CALIBRATION OF MICHIGAN'S STATEWIDE TRAFFIC FORECASTING MODEL**

The Bureau of Transportation Planning, Michigan Department of State Highways and Transportation, is responsible for all planning and analysis relative to defining the future transportation needs of the state for all modes of transportation. This responsibility entails a broad range of both specific and general studies and analytical processes necessary to achieve plans for transportation projects. The major source of travel in the state has always been the automobile and only through reliable traffic forecasting can properly placed improvements be made to the transportation system to achieve solutions to current problems as well as to identify and plan for future problems. This report serves to explain a recent "recalibration" of the Statewide Traffic Forecasting Model using 1975 as the base year. It deals with an explanation of the network calibration process. Also included is a brief explanation of the calibration of the trip generation - distribution models and, finally, the steps required to complete final system calibration. This modeling process simultaneously forecasts future year traffic on all rural - state trunkline roads. This traffic forecasting process is integrated into a series of additional impact analytical processes which allows planners to generate various forms of traffic, social, environmental, and economic impact analysis required in the planning process.

Volume V

**PART A --TRAVEL MODEL DEVELOPMENT: REFORMATION--TRIP DATA  
BANK PREPARATION**

Volume V deals with the preparation of an origin-destination trip data bank, the development of a social-economic data bank, the the complex analysis process required to develop calibrated trip generation-distribution models at the state-wide level. Because of the complexity of this process, Volume V has been sub-divided into various parts. This portion (Part A) deals with the processes required to develop an origin-destination trip data bank. These processes are concerned with the deletion of the data to be used, the preparation of correctly formatted data, the problems incurred as the result of using multi-city urban data, and finally the reformation of the data for travel characteristics analysis.

Volume V

**PART B --DEVELOPMENT OF THE STATEWIDE SOCIO-ECONOMIC DATA  
BANK FOR TRIP GENERATION-DISTRIBUTION**

Part B of Volume V documents the development of a socio-economic data bank which has been used to strengthen and expand upon the original trip generation-distribution equations. It is now also intended as input to the proximity analysis process for measuring a large range of social, economic and environmental impacts of alternate highway plans. Indeed, the wide range of information included within this data bank has lent itself to "multi-department" applications.



Volume V-A

### **SINGLE STATION O & D PROCEDURES MANUAL**

This report describes the process for editing and expanding O&D data and producing several analysis reports using standard TP programs and utility programs. Input to the process is interviews taken on the single station origin and destination survey sheets. Reports are: General Purpose Standard Summary (by trip purpose and vehicle type), Selected trip tables (based upon 547 zone system), trip length frequency distribution, selected frequency distribution, selected tree plots (with trip ends [origins or destinations]), and a loaded network (with only trips from a particular study loaded along minimum cost paths from each origin zone to each destination zone).

Volume V-B

**EXTERNAL O & D PROCEDURES MANUAL**

External origin-destination surveys consist of interview stations on all major roads leading into a study area. The study area usually consists of a small city. Because the external surveys were so similar in nature to the single-station origin-destination studies, the procedures for the external studies manual are based upon a prior procedures manual for evaluating single-station surveys. The external manual outlines procedures for collecting, editing, and preparing standard evaluation tables. The origin and destinations are converted to the zone system of the statewide transportation model to take advantage of already existing techniques for display and evaluation of zone information. Five standard tables are proposed. These are: (1) trip-length frequency distribution, (2) a computer drawn plot showing the number of trip ends occurring in all zones around the state, (3) a trip-purpose versus vehicle type summary table for terminal, through, and all trips passing into or through the study area, and (4) a count of trip origins and destinations for each internal study zone. A sample report is contained in the appendix and was prepared using actual interview data and the procedures outlined in the manual.

Volume VI

**CORRIDOR LOCATION DYNAMICS**

The Corridor Location Dynamics Model described in this report has the ability of taking any socio-economic and environmental goals set by the planner as input and to generate an optional route between two points using a mathematical technique known as "dynamic programming".

This model has three important differences from the conventional process for choosing a highway alternate:

- 1) It allows goals to be quantified and weighed by various interest groups
- 2) It yields logically exhaustive, mathematically determined optional solutions according to any set of goals and
- 3) It is fully automated, requiring little or no human labor. The methodology is fully described and test results are included.

Volume VI-A

**ENVIRONMENTAL SENSITIVITY COMPUTER MAPPING**

This report deals with an automated method of producing shaded environmental-sensitivity maps from ERTS satellite data. The technique, which is a spinoff from the Corridor Location Model, is a good "first-cut" planning tool in that it allows planners to quickly rule out unfeasible corridors. Since its output is pictorial, it can translate the opinions, goals, and objectives of the residents of a region into a map of "sensitive" areas. People can thus see the effects of their opinions on the location of a proposed highway; environmental analysts may then restrict their attention to feasible corridors only, thus eliminating unnecessary work. The method of analysis and possible extensions are provided in addition to examples of the routine's output.

Volume VII

**DESIGN HOUR VOLUME MODEL DEVELOPMENT**

It has long been recognized that Design-Hour Volume or the 30th-Hour Volume is essential but hard to predict in the traffic forecasting process. Few comprehensive reports on this subject have been completed compared with efforts related to the analysis and prediction of annual average daily traffic (AADT). This report describes the efforts put into the development of a DHV model which is currently used to predict future design hour volumes on every link of the highway system. Some test samples on reliable data proves the validity of the model.

Volume VII-A

**CAPACITY ADEQUACY FORECASTING MODEL**

The capacity adequacy Forecasting Model is a computerized technique used in determining the number of days in a year a highway link will probably be congested beyond its practical capacity. The adequacy of a link in terms of capacity can be predicted as a function of two link-specific independent variables -- v/c ratio and Design Hour Volume (DHV). This report discusses the model's development through the use of contingency tables and correlation analysis. The forecasts from the model may serve as a complimentary criterion in evaluating future trunkline deficiencies.

Volume VII-B

**MODELING MAJOR FACILITY OPENING IMPACT ON DHV**

This report details an initial refinement to the Design Hour Volume model. The existing DHV model predicts DHV percentage trends for future years based on a DHV percentage for the base year and a statistically determined curve of typical behavior of DHV overtime. DHV as a percent of AADT typically declines with time and value changes. A significant exception seems to be when a major facility in the state opens, at which time DHV percents on nearby and otherwise related highway links sharply increase. The process described herein attempts to incorporate such increases into the DHV model.

Volume VIII

**STATEWIDE PUBLIC AND PRIVATE FACILITY FILE**

After developing preliminary trip generation - distribution equations for the statewide traffic forecasting model a socio-economic data bank was created in order to supply more input variables to update these equations in preparation for trip generation for the 2300 zone model. From trip generation and trip distribution development came the concept of proximity analysis. This report defines the techniques and information required in the development of the statewide public - private facility file. It shows that proximity analysis, in conjunction with the facility file can be a valuable tool in the analysis process of evaluating the impact of alternate highway plans on certain facilities throughout the state.



Volume VIII-A

**CONVERSION OF DEPARTMENT OF COMMERCE INDUSTRIAL EXPANSION FILE**

This report is presented in keeping with the Statewide Transportation Planning Procedures Section's policy of Inter-Departmental cooperation. It was prepared with the help of the Department of Commerce who supplied data tapes. The report examines industrial expansions in the State of Michigan for the years 1968 through 1973 with the emphasis on the graphic display capabilities for the purpose of comparing expansions and their impacts (costs and jobs) for the previously mentioned six year period. The conversion process to Statewide zones is covered in detail. Included as data for each year are: (1) company name, (2) location of expansion, (3) building costs, (4) machine cost, (5) total cost, and (6) employment change.

Volume IX

**STATEWIDE SOCIO-ECONOMIC DATA FILE**

Because of the increasing importance of the planning of highways and other state facilities and because of the integral relationship between highways and the planning of facilities, it was decided to expand the use of the census data from the original intent of improving trip-generation to that of creating a generalized socio-economic file which others in the department or other state agencies might also use. This report deals with the development and use of a system to obtain census information at the statewide model's 547 zone level. Zonal summaries of census information may be obtained with a minimum of manpower and cost through use of a computer program (QSIRP) and may be output in simple lists or graphic form through use of several statewide routines.

Volume IX-A

**MAPPING SOCIO-ECONOMIC DATA WITH SYMAP**

SYMAP is a computer program used to produce maps of geographic areas with shading of these areas dependent upon some quantitative information about the areas. The program can be purchased from the Laboratory for Computer Graphics and Spatial Analysis at Harvard University. In order to complete shaded maps of the State of Michigan, the Statewide Transportation Planning Procedures Section created the necessary data files to allow information based upon the statewide transportation modeling system's zones to be mapped. The manual prepared is not intended to be a complete SYMAP user's manual (already available from Harvard); but it is intended to briefly describe the types of maps available and to show some standard options and deck setups found to work well for mapping the statewide model socio-economic zone data.

Volume IX-B

**CONVERSION OF THE AGRICULTURAL CENSUS FILE**

The report details the actual conversion of the county-level Agricultural Census data obtained from Michigan State University to the Statewide Transportation Planning Procedures Section zone system and potential uses of the file. These uses include a discussion of establishing agricultural centers within the State and suggestions of possible transportation service to these regions in the way of rail lines or alternate highway routes. Examples of the data contained on the tape include: (1) number of acres of farmland, (2) harvested cropland, (3) farms by economic class (based on sales), and (4) information pertaining to types of grain harvested by: (a) number of farms, (b) number of bushels, and (c) number of acres.

Volume IX-C

**TAX RATE AND ASSESSED VALUATION INFORMATION**

When the Michigan Department of Treasury supplied this Section with a computer tape containing tax rate and assessed valuation data, it was quickly converted to the Statewide 547 zone system. This report documents its conversion through the use of specialized computer programs and its display through use of the statewide graphic display battery.

Volume IX-D

**SCHOOL DISTRICT DATA FILE**

Near the end of 1975, the Mass Transportation Planning Section needed some information regarding school buses on a statewide level. This report documents the preparation of a data file containing this information and other transportation related items for each school district in the state.

So that existing analysis routines now used for the Statewide Transportation Modeling System could be used with the school district data, the school districts were equated to the zones used in the modeling system. Examples for graphic display of the data are shown. The appendix gives a detailed list of the school district data available. This information was obtained with the cooperation of the Michigan Department of Education.

Volume X-A

**STATEWIDE TRAVEL IMPACT ANALYSIS PROCEDURES**

A standard battery of sixteen travel impact indicators have been developed for use within the Statewide Modeling System. This report documents those computerized techniques which have been devised to monitor the effects that proposed transportation plans would probably have upon regional travel patterns if actually implemented. These indicators allow public officials to test alternate schemes in search for an optional solution to particular transportation problems before actually submitting a single plan for adoption.

### **AUTOMATED DESIRELINE PLOTTING**

A typical transportation analysis technique used in the evaluation and display of transportation planning data is the desire line diagram. This type of diagram is used to display 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 process that will now allow the transportation planner to automate and therefore simplify the preparation and analysis of statewide travel characteristics.

The process uses actual origin - destination trip tables from the statewide model. The actual desire line plot uses the trip data in the matrix to create a highway network plot that has only centroid links in it to represent the desire lines.



### TRAFFIC FORECASTING FOR A SPECIAL GENERATOR

The planning required to forecast the effect a "special generator" has on a transportation network is a common task faced by most transportation agencies. "Special generators" are often classified as those proposed construction projects that are large enough to have a regional or statewide impact on the transportation system. During the last two years, several transportation impact tools have been designed which appear to be applicable when analyzing this variable in relationship to the overall transportation scheme. This report discusses these techniques developed in conjunction with the Statewide Transportation Modeling System which will be useful in analyzing special generators. This process supplies the following types of impact analyses:

1. Average daily traffic on state trunkline before and after project.
2. Percent change in travel and effect on level of service.
3. Desireline diagram showing potential distribution of travel to and from special generator.
4. Trip length frequency of traffic.

Volume X-B

## **STATEWIDE SOCIAL IMPACT ANALYSIS PROCEDURES**

This report documents how the model and related analyses tools can be applied to the problem of determining the relative social impacts of alternative highway patterns at the statewide and regional analyses levels. Specifically, the report contains an explanation of how seven analysis techniques can be applied to measure the relative social impacts of three highway alternatives in the Northwest Region of Michigan's lower peninsula. The emphasis is not on making definitive selection of one of the alternates relative to the others based on social criteria, rather it is on explaining how the Modeling System can be utilized to provide the information needed to make various social impact analyses as required by Federal law.

Volume X-C

**STATEWIDE ECONOMIC IMPACT ANALYSIS PROCEDURES**

This document like its companion reports, stresses the application of the statewide modeling system in determining those effects most probably caused by the implementation of a specific regional transportation plan. The direct and indirect cost of highway construction may be estimated and compared to alternate proposals through use of two computerized techniques: 1) Proximity Analysis and 2) Cost Benefit Analysis. The methodology of both techniques have been fully documented in other reports within the statewide system. Emphasis here is placed upon their usefulness in evaluating a number of plans in terms of nine economic indicators which have been developed using key concepts embodied within these two original procedures.

Volume X-C(1)

**ECONOMIC DEVELOPMENT ANALYSIS USING STATEWIDE TRANSPORTATION MODELING**

Michigan's Transportation Modeling System represents an operational system which has many elements directly usable for economic development analysis. Several hundred items of socio-economic data are available for each of 508 transportation zones which are defined around city and township boundaries. Over 8,000 public and private facilities are tagged with this zone identifier and stored on computer files. An example of these facilities would be hospitals, truck terminals, industrial sites, and state parks. The key to using this information lies with the computerized transportation networks used in forecasting future travel demand. A proximity analysis used in transportation planning can be utilized as a market-area process to relate socio-economic characteristics to the facilities via the transportation system. For example, one could find the amount of labor force within 60 minutes driving time to industrial sites. This would be for all sites on a statewide basis.

Finally, the graphic presentation using computer-produced density maps provide a powerful tool for statewide analysis. The report includes many concrete examples along with computer-produced maps.

Volume XI

**COMPUTER RUN TIMES – AN AID IN SELECTING STATEWIDE TRAVEL  
MODEL SYSTEM SIZE**

This volume documents the computer run times of alternate assignments for both the 547 and the 2300 zone systems. This has been done so that each of the planning teams within the Bureau might become more familiar with the statewide modeling process. By comparing the differences in run times between the two systems, it was also hoped that other states would obtain a better idea of the size of system they may wish to use for the "uping" of their own statewide models.

Volume XIII

**MICHIGAN GOES MULTI-MODAL**

This report details the preparation of an automated battery of computer programs which will become the basis for the evaluation of passenger travel and commodity flow by four modes - highway, bus, rail and air - at the statewide or regional level. Recent Federal legislation, the energy crisis, and financial difficulties besetting carriers in all modes make it imperative that departments of transportation be equipped to do multi-modal statewide transportation planning. A modeling system such as the one described herein seems to be an important step in achieving this capability. The basic programs in Michigan's package of routines were originally developed by Stanford Research Institute.

Volume XIII-A

**MULTI-MODAL MOBILITY AND ACCESSIBILITY ANALYSIS**

This volume documents an analysis procedure which enables one to measure the accessibility of selected groups of the population to travel modes such as rail, bus and air. The process utilizes existing tools created for use with the statewide highway model, adjusting the analysis procedure so as to better deal with and resolve such multi-modal transportation issues as improvement of public mobility and goods movement, abandonment of stations or lines, etc. In view of the growing concern for improved public transportation and freight service, such procedures should be of special interest to transportation planners.

Volume XIII-B

**1972 STATEWIDE RAIL NETWORK: SUMMARY TABULATIONS**

This report consists of several summary tables which were requested by the Rail Planning Section during the fall of 1974. The tables summarize link data on the Michigan railroad network. Much of this data was collected and coded by Chuck Eisle of Consad Research Corporation. The tables summarize mileage, and 1972 FRA carloads and tonnages by railroad and by various planning classifications.



Volume XIII-C

**MICHIGAN'S RAIL CROSSING INVENTORY AND ANALYSIS PROCESS**

Due to the Regional Reorganization Act of 1973, state government must progressively plan, program, and implement the provision of rail service on bankrupt carrier trackage throughout the state. The establishment of a railroad planning function adds an entirely new dimension to the Michigan Department of State Highways and Transportation's role. In the past, the Department concerned itself with railroads only where they interphased with highways, at railroad - highway crossings. Under this expanded role, the state must be concerned with the entire rail system as well as all crossings from a system perspective. Additionally, deferred maintenance has resulted in decreasingly poor physical conditions with safety at crossings becoming a real concern. Information on grade crossings in the past has been collected in various formats and generally stored in file cabinets. While the form and content of this past information system was adequate in meeting the needs of the past, the expanded role requires a more complete and accessible data inventory on all crossings within the state. This report documents the creation of the rail crossing data base and its conversion to the Statewide Transportation Modeling System.

Volume XIII-D

**IMPACT OF POPULATION AND ENERGY ON TRANSPORTATION NEEDS -  
A MULTI MODAL APPROACH**

Until recently, alternative modes of transportation have had seemingly little impact upon highway travel. Many people now feel this will soon change. The present emphasis upon energy conservation, together with increased energy and transportation costs may affect travel in many significant ways. The problem of defining future transportation needs and identifying possible deficiencies is further complicated by considering the interaction between energy costs, population shifts and growth, and the availability and efficiency of alternative modes. Until recently, it has been practically impossible to effectively address all of these issues and their interaction. Now, by combining information and tools from three existing major impact analysis sources described in this volume, a process has been developed which can measure the impacts various multi-modal proposals have on highway deficiencies.

Volume XIV-A

**COMMODITY FLOW MATRIX - ANN ARBOR RAILROAD**

This report documents an important addition to Michigan's planning data base: railroad commodity flow information. The basic ingredient of transportation planning is the origin-destination survey. This volume presents a commodity O-D data from the Ann Arbor Railroad (100% sample), summarized into a matrix of zone-to-zone flows. The zones used are those of Michigan's Statewide Transportation Modeling System. Thus, the potential has been created for railroad planning and analysis based on reliable O-D information, using the extensive capabilities of the Statewide System, which insures compatibility with previous and future highway and other modal analyses performed on the Statewide System.

Volume XIV-B

**COMMODITY FLOW MATRIX – PENN CENTRAL RAILROAD**

This portion of Volume XIV is identical to part A with the exception that the matrices presented are specific to the Penn Central Railroad. A 100% sample was, again, the basis of development.

Volume XIV-C

**COMMODITY FLOW MATRIX MICHIGAN RAILROADS 1% SAMPLE**

Part A and B of this volume has detailed the development of commodity flow matrixes, based on a 100% sample, for the bankrupt Ann Arbor and Penn Central Railroads. This portion of Volume XIV documents the development of such matrixes for all movements which have either or both their origin and/or destination within the State. The data used herein is based on a 1% sample.

Volume XV-A

**RAILROAD FINANCIAL IMPACT ANALYSIS**

The United States Railroad Association (USRA) developed a computerized technique to be used as an aid in determining which of the bankrupt light-density branch lines should be included in the Federal rail corporation (Con Rail). The technique known as viability analysis, was adopted by this Department to be utilized in the development of a short-term State Rail Plan. Certain modifications were necessary before the procedure would be accepted by State rail planners. This volume reviews the original technique as received from the USRA and as it has been modified for use in the state rail planning process.

Volume XV-B

### **RAILROAD COMMUNITY IMPACT ANALYSIS**

One important area of multi-modal planning, namely railroad planning, has become of extreme importance due largely to the Rail Reorganization Act of 1973. Many tools were devised to permit quick, effective analysis of Michigan's railroad system. A procedure for determining community impacts is one of these tools. The original procedure was developed by R.L. Banks and Associates, Inc. - and Creightons, Hamburg, Inc. It was altered by this Department to permit estimates of community impacts based upon carloads per branch line. This report describes the revised community impact procedure.

Volume XVI

**MULTI-MODAL ANALYSIS: DIAL-A-RIDE**

Because of increased public demand for such service as Dial-a-Ride coupled with the necessity of using every tax dollar to the fullest measure, multi-modal planners have a responsibility to the public to use all available information in choosing communities in which they plan to spend money. The process documented in this report is offered as a possible first step in providing an additional dimension in Dial-a-Ride site selection. A process of this nature could also be useful in formulating a state-wide Dial-a-Ride plan. This report should be regarded more as a working paper than as a finished product. Feedback from potential users, it is hoped, will strengthen it until it can be used as a day-to-day planning tool.



Volume XVII

**INTERMODAL IMPACT ANALYSIS - TRUCK AND RAILROAD**

Because of recent Federal legislation and renewed public involvement, particularly concerning other transportation modes and environmental impacts, it has become imperative to develop efficient methods of providing answers to intermodal problems. Before any transportation decision can be finalized, it must be shown that the decision is the best solution, among all possible modes, to the problem being studied. The process described in this report should aid transportation planners in analyzing the possible intermodal impacts of highway planning upon the railroad system. It will also help determine the possible effects rail planning may have upon highway sufficiencies.

Volume XVIII

**CUTLINE ANALYSIS**

The cutline program was initially developed to assist in the evaluation of regional transportation plans. The process will also be of help when calibrating traffic forecasting models.

The process uses a standard Transportation Planning Network with loaded traffic volumes. The user specifies the coordinates of the end points of a cutline. Traffic volumes are automatically accumulated whenever the cutline crosses a road. The program may be run for several different alternate plans. The cutline information for each alternate is stored on a master disk file. The second part of the process is then executed to display in bar graph form each of the cutlines and a total for all cutlines. This process allows quick and effective visual comparison of traffic volumes into an area for various alternate plans.

The report contains user instructions and shows samples from an actual run.

## LONG RANGE TRANSPORTATION REVENUE FORECASTING

Transportation financing has relied heavily on user fees such as the fixed per-gallon fuel taxes and the vehicle weight taxes. In many states, these tax structures have contributed to a decline in revenues because of lighter, more fuel-efficient vehicles, energy conservation, and high fuel prices. It has become increasingly important to monitor expected revenue and to propose changes in tax schemes to offset declining revenue.

Michigan's long term revenue forecasting for transportation is a computerized process using forecasts of vehicle registration, miles of travel, fuel consumption rates, and a fuel and weight tax scheme. Not only tax schemes can be tested, but also economic and travel alternatives such as "what happens to revenue if people drive less?" or "what if people buy fewer cars than we expect?".

The forecasting process is not isolated from the rest of transportation planning. All output is available on computer files for later use by computerized report, graphing, and analysis programs. Many computer graphic examples are presented. Recent work in Michigan on a State Transportation Plan integrated the revenue forecasting work with a prioritized needs analysis to compare expected revenues on a year-by-year basis to 1990. The long-range transportation revenue forecasting process is a valuable tool to use in developing a strategy for dealing with the changing environment of transportation financing.

**REVENUE VS. NEEDS: AN ANALYTICAL APPROACH (TRIP)**

To examine the difficult choices created by growing transportation needs and falling revenue, the Michigan Department of Transportation developed a comprehensive State Transportation Plan. Within the Plan, matching prioritized transportation needs with available revenue was accomplished with a planning process called the Transportation Revenue Investment Plan (TRIP).

TRIP begins with the highest prioritized need and continues retiring needs until all allocated revenue is spent or all needs are met. Accurate costs for the needs are determined by inflating the base year cost to the year of revenue that is attempting to retire it. TRIP contains decision rules by transportation mode that regulate the method in which needs are retired and needs not met.

TRIP output can be summarized in reports by transportation mode, year, and various other factors. Its highest utility can be seen when these summaries are displayed with bar charts, CALFORM maps, or network plotting. The ease in analyzing the graphic display and summarized output of TRIP is beneficial in the State Transportation Plan and within the strategic planning process. In both cases, TRIP can help in evaluating the effects of alternate revenue levels and spending patterns.

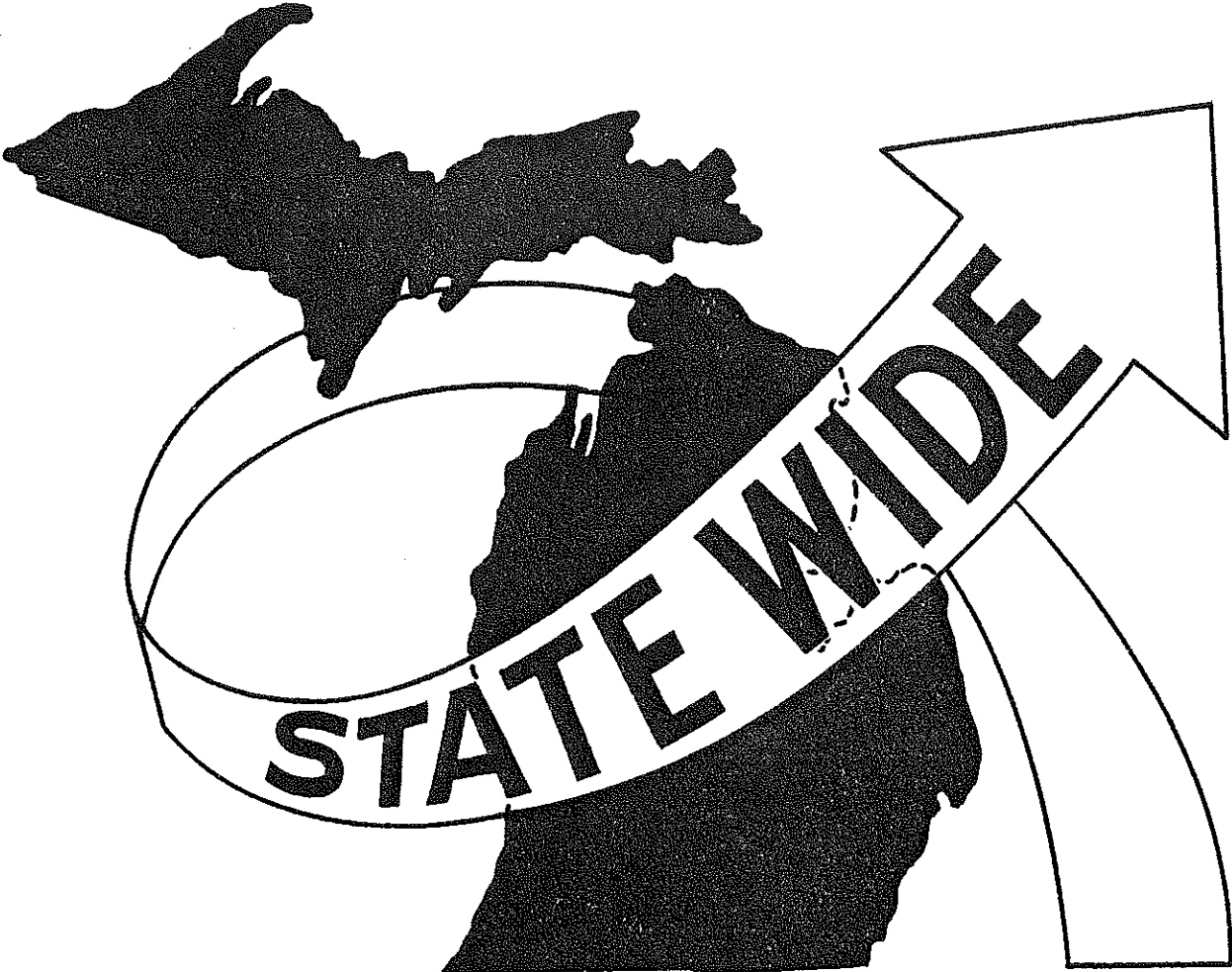
## **A FISCAL APPROACH TO RETIRING TRANSPORTATION NEEDS**

State transportation agencies are faced with continued public expectations for improved transportation services. The interrelated issues of projecting revenues and inflation, anticipating the effectiveness of alternative investment maintenance programs, prioritizing future service level requirements, insuring equity, and preserving the benefits from past investments impact the ability of states to formulate responsive policy.

An historic framework for planning has been the periodic state transportation needs study. This process has, however, fallen into disfavor as the disparity between ever increasing needs and the ability to retire deficiencies has grown.

Michigan's Department of Transportation has restructured the needs study through a procedure for disaggregating, stratifying, and prioritizing transportation needs as input to the preparation of the state's first transportation plan. Michigan's process is basically zero-based budgeting done for each mode for each year of a study period -- in this case, 1982 to 1990. Each defined deficiency is examined to see whether or not its cost is avoidable; if avoidable, the deficiency is placed into a hierarchy of classification. A set of prioritization rules defined by each mode is then applied. This results in the ranked decision packages necessary to be able to evaluate the implications of a particular fiscal policy on the ability to retire transportation deficiencies.

**SYSTEM APPLICATION REPORTS**



Report #1

**COMMUNITY COLLEGE SERVICE-AREA ANALYSIS**

This report was completed to assist the Michigan Department of Education in evaluating two different proposed schemes for statewide community college districts. Information was used from three basic information files - the statewide socio-economic file, statewide facility file, and statewide highway network file. Socio-economic data used includes labor force, employment by industry, family income, and education completed. Histograms and shaded density maps (SYMAP) were used to graphically display this type of information. Proximity analysis procedures were used to show the proximity (15 minute time bands from 0 to 60 minutes) of persons with various educational levels to community colleges. Most data presented was summarized to school district (two schemes) as well as the statewide model zone system.

Report #2

**PROXIMITY OF PEOPLE TO GENERAL-PURPOSE HOSPITALS**

This report is another demonstration of how the social impacts of alternative transportation plans can be monitored quickly with a Statewide Transportation Modeling System. Using Proximity Analysis, the Department of Public Health can compare alternative plans using two illustrated criteria: the possible shift in service potential of each hospital and the degree to which the system of hospitals serves all areas of the state. As a sample of the first criterion, the concentration of people within specified driving times around each hospital is measured. For the second, each subarea of Michigan is examined to see how many hospitals its residents can reach in twenty, forty, and sixty minutes. This sort of information facilitates input to the transportation planning process in its early stages, as required by recent Federal legislation.



Report #3

**INDUSTRIAL PARK PROXIMITY ANALYSIS**

Two necessary characteristics of a successful manufacturing location are 1) ready access to people who will run the machines and 2) a means of bringing in raw materials and distributing finished goods. This report demonstrates how the Proximity Analysis process could be used effectively by the Department of Commerce for two distinct purposes. First, it facilitates site selection for a potential client. And second, it allows the Department of Commerce to measure the impact of several proposed transportation plans on its present facilities, thereby providing feedback to the Department of Transportation. As a simple test, the number of people in the labor force was retrieved by zone from the Statewide Socio-Economic File; the Statewide Facility File was the source of the number of airports by zone. The concentration of these data around each industrial park certified by the Department of Commerce was then calculated, using the Statewide Transportation Modeling Network to determine driving times. The Office of Economic Expansion, Michigan Department of Commerce, was so pleased with this application that it distributed the report to all of its field personnel.

Report #4

**PROXIMITY OF AUTOMOBILE INJURY ACCIDENTS TO HOSPITALS**

A unified system such as the Statewide Transportation Modeling System can be used to bring together data files not only from different areas of the Department of Transportation, but from other departments as well. In this application, the Statewide Modeling Network and Proximity Analysis were used to relate accidents from MDOT's accident master to the hospitals catalogued by the Michigan Department of Public Health. This sort of analysis can serve both departments. For example, if there is a high-accident area which is more than twenty minutes from the nearest hospital, two possible courses of action could alleviate the problem. The road can be relocated or improved, or a health care facility could be built nearer the site. Cooperative analyses such as this could result in greater interdepartmental coordination.

Report #5

**PROXIMITY OF AIRPORTS WITH SCHEDULED SERVICE TO POPULATION**

Proximity Analysis can be a valuable tool in allowing a service organization to monitor three distinct service characteristics: potential demand on existing facilities, areas which are unserved in the existing system, and overlapping of service areas. Each of these is a function of the transportation system which connects the server with the people to be served. Examples are given of how these impacts can be assessed using the Statewide Facility File, Socio-Economic File, Transportation Modeling System network, and Proximity Analysis process. Each area of impact is discussed in some detail. Some insight is also given into how changes in these service measures can be measured relative to proposed modifications in the highway network.

Report #6

### **REGIONAL PARK PROXIMITY ANALYSIS**

This is another example of how a Statewide Transportation Modeling System can serve multi-departmental needs. In response to a request from the Department of Natural Resources, the System was used in selecting a site for a proposed Huron-Clinton Metropolitan Authority park.

The analysis takes two forms. First, computer plots of driving paths away from the proposed facility allow a planner to see at a glance the park's probable service area. Second, analyses of population proximity, calculated in incremental driving-time bands, serve as an indicator of the potential demand on the proposed park.

Report #7

### **RIFLE-RANGE PROXIMITY ANALYSIS**

At the request of the Michigan Department of Natural Resources, the Statewide Modeling System was used to select a site for a new state-sponsored rifle range. The DNR had chosen eleven possible sites and wanted to know both the places and the number of people accessible to each site within one hour's driving time. The first question was answered graphically. Computer plots of minimum time driving paths away from each site are a natural by-product of the Statewide Transportation Modeling process. These plots are annotated with cumulative driving times, so that the reader can quickly determine the extent of a one-hour radius. For demographic data, the Statewide Socio-Economic File provided population figures by zone. These were accumulated using Proximity Analysis in isochronic bands around each proposed site.

### AMBULANCE SERVICE--AREA ANALYSIS

This report was completed for the Office of Health and Medical Affairs to assist them in evaluating how well the present system of emergency ambulance facilities are serving the state. Information was keyed to the zone system of the statewide transportation modeling system. Those files used were an ambulance facility file and the statewide highway network. Since a large portion of ambulance use is for automobile accidents, a statewide file of auto injuries by zone was used. Also, population and population density was used. To investigate the relationship between people and the number of vehicles in an area, a table was made for each statewide model zone in the state and include the following: (1) number of ambulance facilities, (2) number of vehicles, (3) population, (4) population density, and (5) ratio of population to number-of-vehicles. For a better statewide picture, a state map (SYMAP) showing the persons-per-ambulance density around the state was produced. An area may not have an ambulance facility in the immediate area but may still be served well since it is close via an expressway to an adjacent facility. Therefore, proximity analysis was used to show the facilities within 20 minutes driving time to every zone in the state. Also, from another perspective, the number of injuries within 20 minutes driving time of each facility was found. Information is displayed in list form as well as SYMAP form.

Report #9

**COMPREHENSIVE STATEWIDE PLANNING**  
**A MULTIPLE BENEFIT OF A STATEWIDE TRANSPORTATION MODELING SYSTEM**

This report is first in a series that deal with issues directed at the multi-benefits a state may expect to receive as the direct result of the development of a statewide transportation modeling system. Many states have experienced difficulty in attempting to develop a comprehensive statewide planning operation. This report directs itself at some of the issues in this area. The idea being that certain elements within a statewide transportation modeling system will allow many states which select this technique to systematically eliminate many of the typical difficulties.

Report #10

**GRAPHIC DISPLAY OF FIXED-OBJECT ACCIDENT DATA**

Pursuant to a request made by the Traffic and Safety Division of this Department, this report was prepared to assist them in their roadside safety improvement program. Graphics display of fixed-object accidents and a special subset of fixed-object accidents, guard-rail accidents, were provided using elements of the Statewide Transportation Modeling System.



Report #11

**PRELIMINARY INVESTIGATION: A TECHNIQUE FOR THE PROJECTION OF ACCIDENT RATES**

On July 30, 1974, the Statewide Transportation Planning Procedures Section published a brief report explaining how base accident rates for old and newly proposed routes are calculated within the Statewide Transportation Modeling System. Since no technique was then available for the projection of these base year accident rates, they, out of necessity, were assumed to remain constant. Although an obvious flaw in this type of reasoning was apparent, it nevertheless gave the Department a means of evaluating alternate transportation plans until a better method could be devised. This report documents a serious attempt to find a more logical means of calculating base and future year accident rates on a link-by-link basis from variables which "physically" describe a roadway - e.g., its right-of-way, sight distance and/or surface condition.

Report #12

**IMPACT OF 50, 55 OR 60 M.P.H. STATEWIDE SPEED LIMIT**

The analysis documented in this report was completed in order to determine the probable impact that a statewide speed limit might have on motor fuel consumption in the State of Michigan. For the purposes of this study, it was assumed that the most likely speed limit would be 50 M.P.H. Additional analyses were also completed for both a 55 M.P.H. speed limit and also a 60 M.P.H. speed limit. The analysis is intended solely as an initial inquiry. The results obtained are based upon several judgmental assumptions and use of this information must be based upon full knowledge of these assumptions.

Report #13

**A METHOD FOR FUNCTIONALLY CLASSIFYING RURAL ARTERIAL HIGHWAYS**

This report is directed at the application of the Statewide Transportation Modeling System in assisting the process of functional classification of rural highways in any typical highway planning organization. The report documents the application using two basic elements: (1) population centers and other travel generators, and (2) highway travel characteristics.

Report #14

**ECONOMIC AND TRAVEL IMPACTS OF SPEED LIMIT REDUCTION  
USING A STATEWIDE TRANSPORTATION MODELING SYSTEM**

This report documents a process now being used in the Statewide Transportation Modeling System to predict three impacts of speed limit reduction which were previously difficult to address at the system level; the additional driving times necessitated by slower speeds, the value of the time lost, and a comparison of the probable number of trips made before and after speed limit reduction. Such calculations are particularly valuable in gauging the possible effects of a speed reduction before it is actually implemented.

Report #15

**I-69 IMPACT ON THE ACCESSIBILITY OF  
HEALTH, FIRE, AND AMBULANCE SERVICES TO RESIDENTIAL AREAS**

The construction and utilization of a transportation corridor has been recognized as having a tremendous effect upon a region's political, economic, social, psychological and environmental framework. In compliance with Section (109h) of Title 23, U.S. Code, state departments of transportation are now required to study fully the economic, social, and environmental impacts of new road alternatives in relation to the existing road system. This report deals with the application of statewide transportation modeling system concepts as related to social impact analysis. The process developed in this document deals with the measurement of change in accessibility to public services a proposed construction project may have on a study area. The Statewide Model has been used to predict impacts based on statewide and regional transportation plans. Even though this report deals more specifically to a project area, rather than a regional corridor system, the principles and concepts used in the Statewide Model can also be utilized here.

Report #16

**CRISIS AND OPPORTUNITY:  
APPLICATION OF AN OPERATIONAL  
STATEWIDE TRANSPORTATION MODELING SYSTEM**

During the 70's, highway departments have experienced a rapid and dramatic change in regards to the responsibilities they are required to carry out. Whereas once once a highway department was concerned with highway related problems and their travel impacts, they must now consider varying modes of transportation and social, economic, environmental, etc., impacts. Many states are creating departments of transportation in order to meet and coordinate these increasing demands, but this is proving to be a costly and difficult task.

This report briefly describes Michigan's efforts in this area through the development of an operational Statewide Transportation Modeling System. Time has not been taken in this report to deal with the step-by-step processes needed to develop such a system but, instead, stresses actual applications of this system. Actual applications are listed showing the varying methods of utilization. The report also deals with the future use of the system as a potential statewide data base for interdepartmental usage.

Report #17

**US-23 CORRIDOR LOCATION STUDY  
PRELIMINARY TRAVEL IMPACT ANALYSIS**

This report was produced in connection with the analysis of alternative plans for upgrading US-23 in Michigan's northeast lower peninsula.

The analysis deals with the grain one impacts of various alternates on the traffic congestion problems which are forecast for that area in the year 2000. Most emphasis in this "first-cut" analysis is placed upon level of service and bandwidth plotting.

This is an excellent example of how much useful data can be gained from only a small part of the Statewide Transportation Modeling System.

It shows some good applications of the system in answering real-world questions.

Report #19

**GRAPHIC DISPLAY OF ACCIDENT DATA**

This report was prepared in December of 1972 to assist the Accident Analysis Unit in analyzing accidents occurring on a wet road surface. Accidents were selected from the accident master file and summarized to the statewide model network links. Once in this form the information (number of accidents and accident rates) was easily graphically displayed through the use of computer plotting.

The state trunkline system was plotted in map form with the number of accidents or accident rate indicated for each section of road. Also, "band width" plotting was helpful in obtaining a quick diagnostic glance at the entire state.



Report #20

**DEMOGRAPHIC INFORMATION FOR THE NORTHWEST REGION**

As a part of the analysis of alternates for upgrading US-31 and US-131 in Michigan's northwest lower peninsula, the Statewide Socio-Economic Data File was used to provide demographic data quickly. This data was gathered into a report as another example of how the Statewide Modeling System can be used to solve real-world questions. Without the Socio-Economic File, the data contained here could have taken several man days to accumulate instead of only a few minutes.

**AMTRAK MARKET AREA ANALYSIS - SYSTEM APPLICATION**

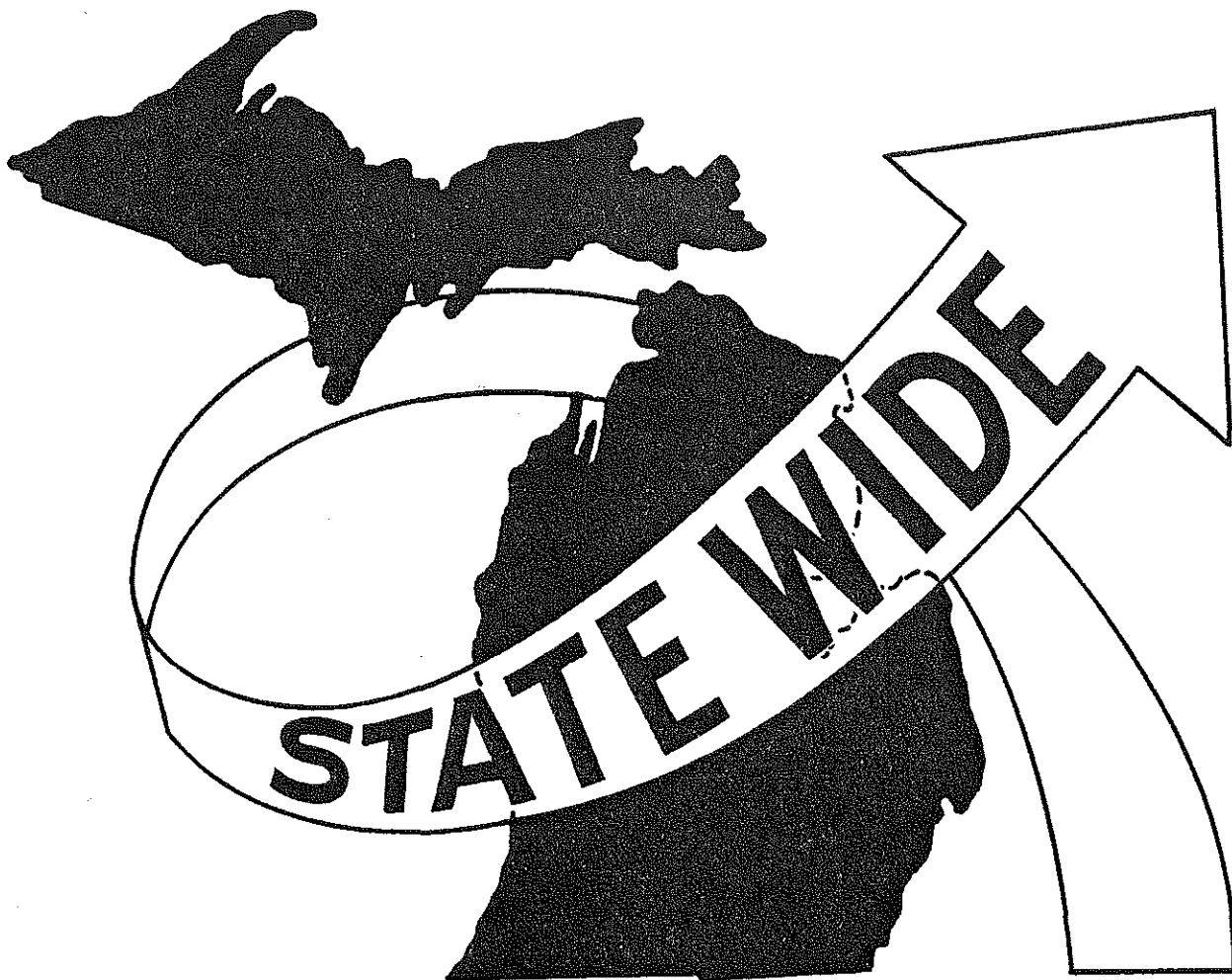
Interest in passenger rail service in the United States has been on a decline over the past few decades. AMTRAK was created with the hope that passenger rail service could become a more systematically fun railroad operation.

Michigan has experienced some growth in rail passenger use following this organizational change. Other states have also had some success which often creates interest in the addition of other rail service. If any state desires to add additional AMTRAK service, they must complete a market area study for the proposed corridor as stated in Section 403(b) of the Rail Passenger Act. This market area study identifies eight or nine analysis processes which require reasonably extensive manpower if accessibility to proposed rail stations is considered.

During the past four years, Michigan has developed a statewide transportation modeling system which has been used to analyze proposed regional transportation plans. Most of the information, such as the socio-economic characteristics of the population, the proposed location of rail stations, and the existing transportation network are immediately available for analysis from the system. Finally, the system will also allow any user to rapidly analysis the accessibility of any proposed rail station to various socio-economic statistics.

This report deals with the actual application of Michigan's Statewide Transportation Modeling System as related to the analysis of two proposed AMTRAK corridors in the State of Michigan. This analysis will also serve to demonstrate the multiple benefits available as the result of the development of a system such as this.

# SYSTEM REFERENCE HANDBOOKS



## Reference Handbook #1

### STATEWIDE BUS TICKET SURVEY TRAVEL CHARACTERISTICS

To effectively develop a statewide mass transit system for Michigan, planners must analyze all forms of transportation and their relationship in the overall transportation network. This handbook deals with present bus utilization in Michigan and the analysis is based on a bus ticket survey taken in 35 cities across Michigan. This survey was organized and compiled by the Mass Transportation Planning Section, Bureau of Transportation Planning. The survey data was collected by going to individual stations and collecting trip tickets which supplied origin and destination information. These travel characteristics can prove to be vital links in planning future transit systems and also as a data base for updating the trip generation-distribution model in Michigan's multi-modal analysis system.

Reference Handbook #2

**MICHIGAN'S PERMANENT TRAFFIC RECORDER TRENDS -  
POTENTIAL APPLICATION IN TRANSPORTATION PLANNING - ENERGY ANALYSIS**

This report examines the trends in ADT (Average Daily Traffic) counts throughout Michigan with emphasis on the 1973-74 oil embargo period. There is a general concern today that the United States is facing an energy problem and future energy-need projections show this country requiring greater quantities of energy to satisfy its needs. The transportation sector of our society is the major consumer of petroleum, accounting for over half of the petroleum consumed in the United States, and is the first to feel the effects of an energy shortage. This handbook was published with the idea that planners could analyze what roads in Michigan were affected and to what degree during the 1973-74 period. This data can be of value when planning for an energy short future. The information is graphically displayed for easy analysis and can also be used to modify the traffic forecasting process presently used in the Statewide Transportation Model. Another utilization of this data would be in using the trends to validate future travel projections generated by the model.

## Reference Handbook #3

### MINOR ORIGIN & DESTINATION TRAVEL CHARACTERISTICS - PART A

The Statewide Procedures Section, Bureau of Transportation Planning, Department of State Highways and Transportation, has prepared a travel characteristics handbook in order to fully utilize all minor O&D studies. The conversion of minor O&D studies to a single format made this handbook possible and it is intended to supply the user with travel characteristics about a specific minor O&D study or a group of studies by region. This handbook was organized at the regional level with an individual handbook for each of the 14 planning regions and consists of minor O&D data for each region. This format will allow the user to compare one region to another. There were no minor O&D studies taken in regions 6 and 14; thus, no handbook is presently available for these regions. Information supplied in this handbook deals with:

1. Trip Purpose
2. Trip Length
3. Vehicle Occupancy
4. Vehicle Type

## Reference Handbook #4

### TRUCK COMMODITY SUMMARIES

This report deals with commodity flow statistics for studies completed in 1974, 1975, and 1978 at selected sites throughout the State of Michigan. The origin-destination collection process is based upon the 547 zone system. The geographical locations of the O&D studies are listed. The commodities are classified under 20 different categories. A complete listing of commodity code categories can be found in the report.

The data in this handbook is organized so that for each site the number of trips carrying any given commodity is listed. The different commodities are also shown as a percentage of the total number of trips carrying commodities for each study. The total of all commodity trips is shown as a percentage of the total number of all trips for each study. No attempt was made to eliminate the possibility of trips between studies being counted twice.

To analyze trip lengths, a trip length-frequency diagram was produced for all commodity trips. The trip lengths were measured in minutes.

Reference Handbook #5

**STATE PARK ATTENDANCE TRENDS**

A possible indication of how the energy crisis may have affected recreational travel in Michigan is by examining the attendance at state parks over time. The parks showing an increase in attendance are located away from the urban centers whereas the parks showing a decrease in attendance are nearer the urban areas. This report suggests that people are still driving long distances for recreational purposes, but that the energy situation may have affected short distance travel.

Graphs of attendance levels were produced using the same minimum and maximum parameters in order to facilitate comparisons. They are grouped according to the state planning regions in which they are located. An alphabetic listing and location map for all the parks are also included. The attendance levels at the majority of the parks have remained constant leading to an additional conclusion that the energy crisis did not significantly impact recreational travel in Michigan to the extent that state park attendance is representative of it.



## Reference Handbook #6

### 547 ZONE SYSTEM

Michigan's transportation modeling system is based on geographic areas within Michigan and surrounding states. These areas are called zones. Michigan is divided into 508 of these zones. Zone boundaries coincide with political boundaries.

There are 39 other zones which are divided into 32 for neighboring states and Canada, and an outer ring of seven zones.

This report shows the location of zone boundaries and describes which political subdivisions are in each zone. The sections of the report are:

1. Zone Maps - Three maps showing geographic boundaries of the zone system.
2. County/State Zone List - List of the zones contained in each county of Michigan and the zones in each state.
3. Zone Place List - For each zone in Michigan, a list of townships which comprise that zone. Zones which are a city are identified as such. For outstate zones, the counties which comprise each zone are listed.