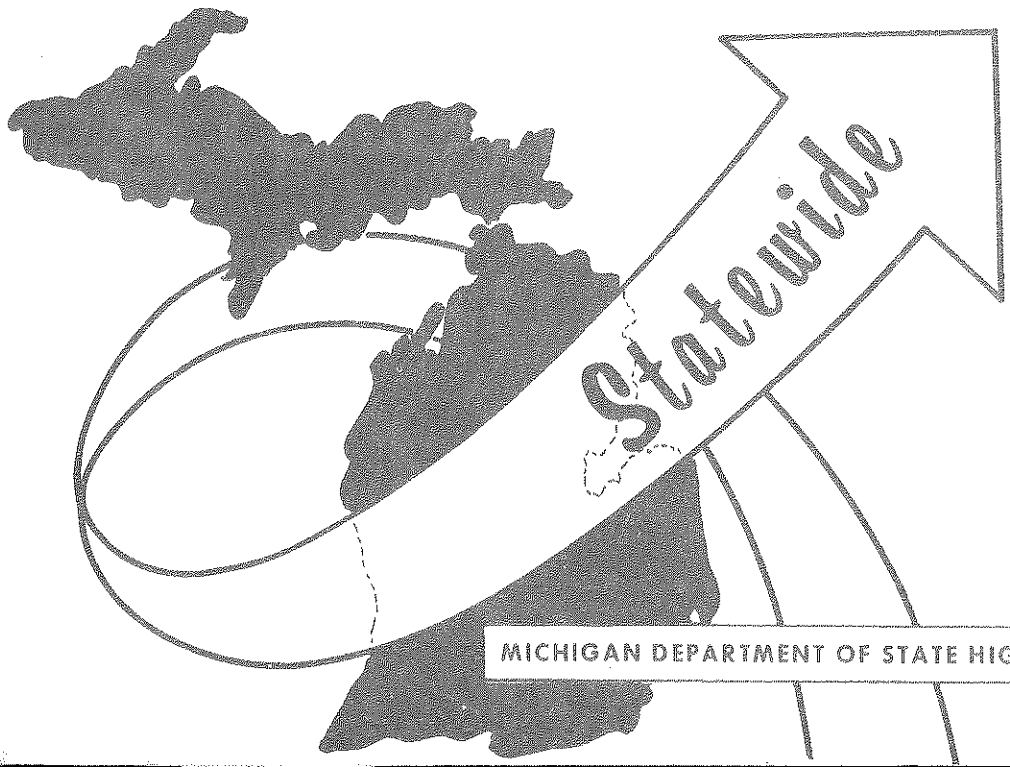
Statewide Transportation Analysis & Research

Michigan's
Statewide Transportation
Modeling System

Volume X-C

STATEWIDE ECONOMIC IMPACT
ANALYSIS PROCEDURES
Statewide Studies Unit
January 18, 1974



MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

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Michigan's
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January 18, 1974

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, GOVERNOR

DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

STATE HIGHWAYS BUILDING - POST OFFICE DRAWER K - LANSING, MICHIGAN 48904

JOHN P. WOODFORD, DIRECTOR

March 11, 1974

Mr. Sam F. Cryderman
Deputy Director
Bureau of Transportation Planning

Dear Mr. Cryderman:

The Transportation Survey and Analysis Section of the Transportation Planning Division is pleased to present Volume X-C in a series of reports dealing with "Michigan's Statewide Transportation Model". This volume documents the application of the model and related analysis tools to the problem of alternate route economic impact evaluation at the regional and statewide level.

The Statewide Model was used as a common element for the application of two system components, Proximity Analysis and Cost-Benefit Analysis. This operational system was used to illustrate and measure the economic impact of three "real world" alternate highway plans at multiple levels of regional concern.

The entire process was documented, not to select the actual route, but to provide illustrative examples of the economic impact analysis procedures.

The Michigan Department of State Highways and Transportation could begin to effectively supply a portion of the economic analysis required in recent federal highway legislation using this process. We feel this technique is unlimited in its potential and we present it at this time with the hope that future application or refinement will substantiate this belief.

This report was prepared by Mr. Lawrence J. Swick of the Statewide Studies Unit with the supervision of Mr. Richard E. Esch.

Sincerely,

Keith E. Bushnell

Keith E. Bushnell
Engineer of Transportation
Survey and Analysis Section

MICHIGAN
THE GREAT LAKE STATE

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STATEWIDE ECONOMIC IMPACT ANALYSIS PROCEDURES

BY

Lawrence J. Swick

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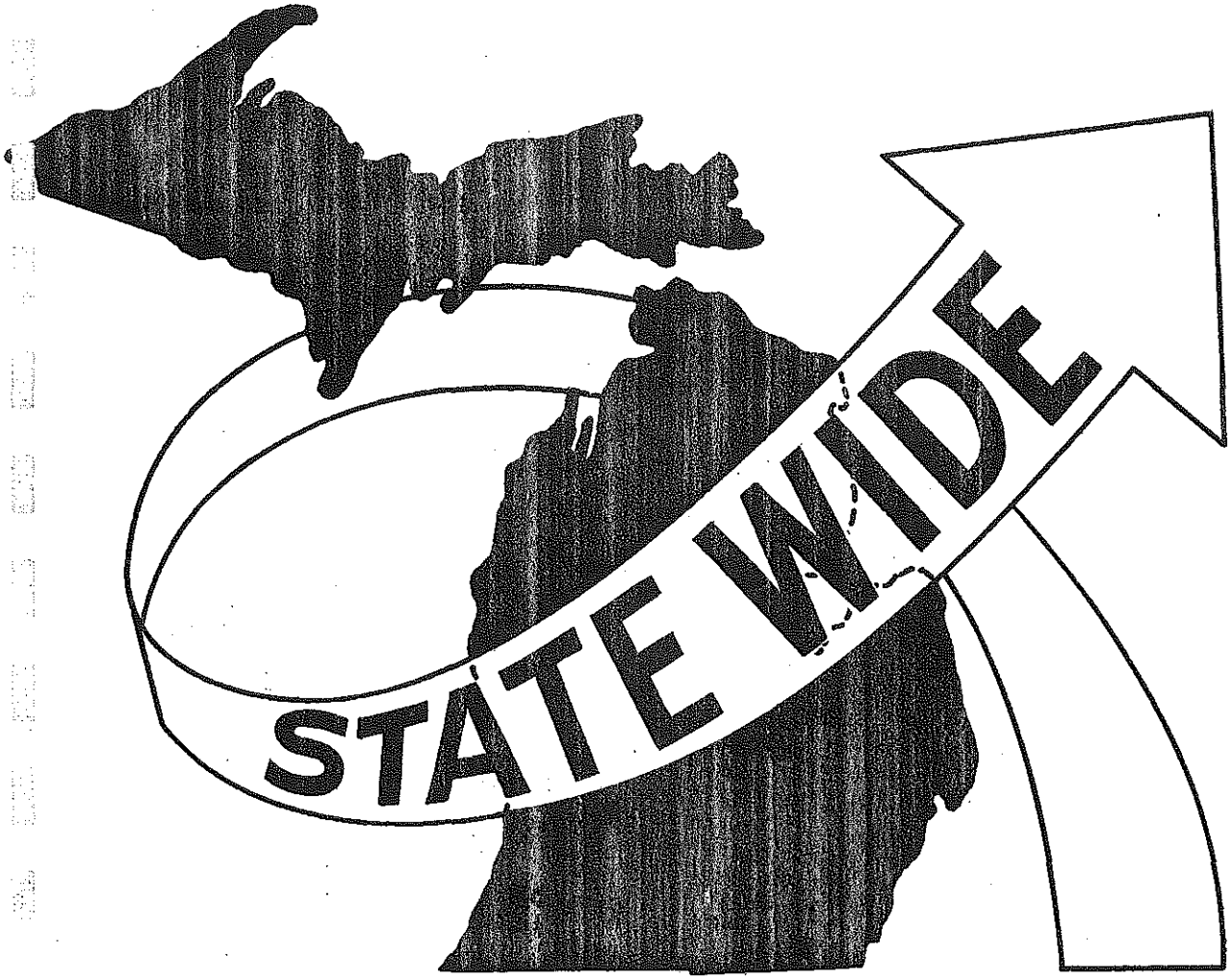


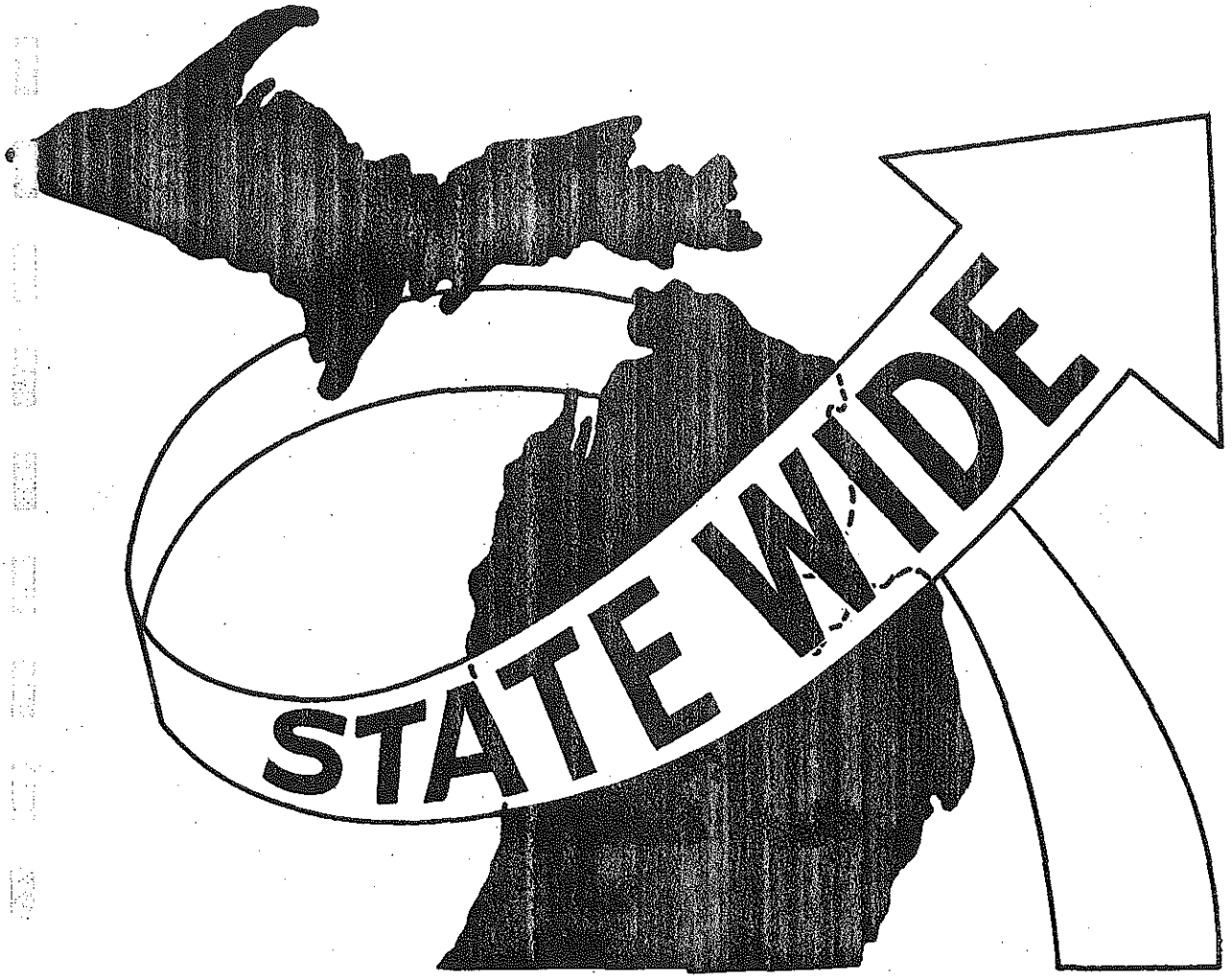
PREFACE

Progress within the Statewide Transportation Model to this point has dealt with total system functions and model development. Attention has now turned to the actual application of these analysis models within the total system as applied to the real world transportation planning process. This report deals with the application of a Statewide Transportation Modeling System and the measurement and evaluations of selected economic impacts brought about as a result of proposed construction programs.

This report is the third in a series of four reports which deal with the development and testing of procedures directed at supplying information related to travel, social, economic and environmental impact analysis.

For purposes of illustration, the US-31, US-131 project was chosen to illustrate the economic analysis potential of the model as applied to the regional transportation planning processes. It will be shown that the output of the analysis tools can be viewed from the standpoints of both public and private interests as required by the Federal Highway Administration.

INTRODUCTION

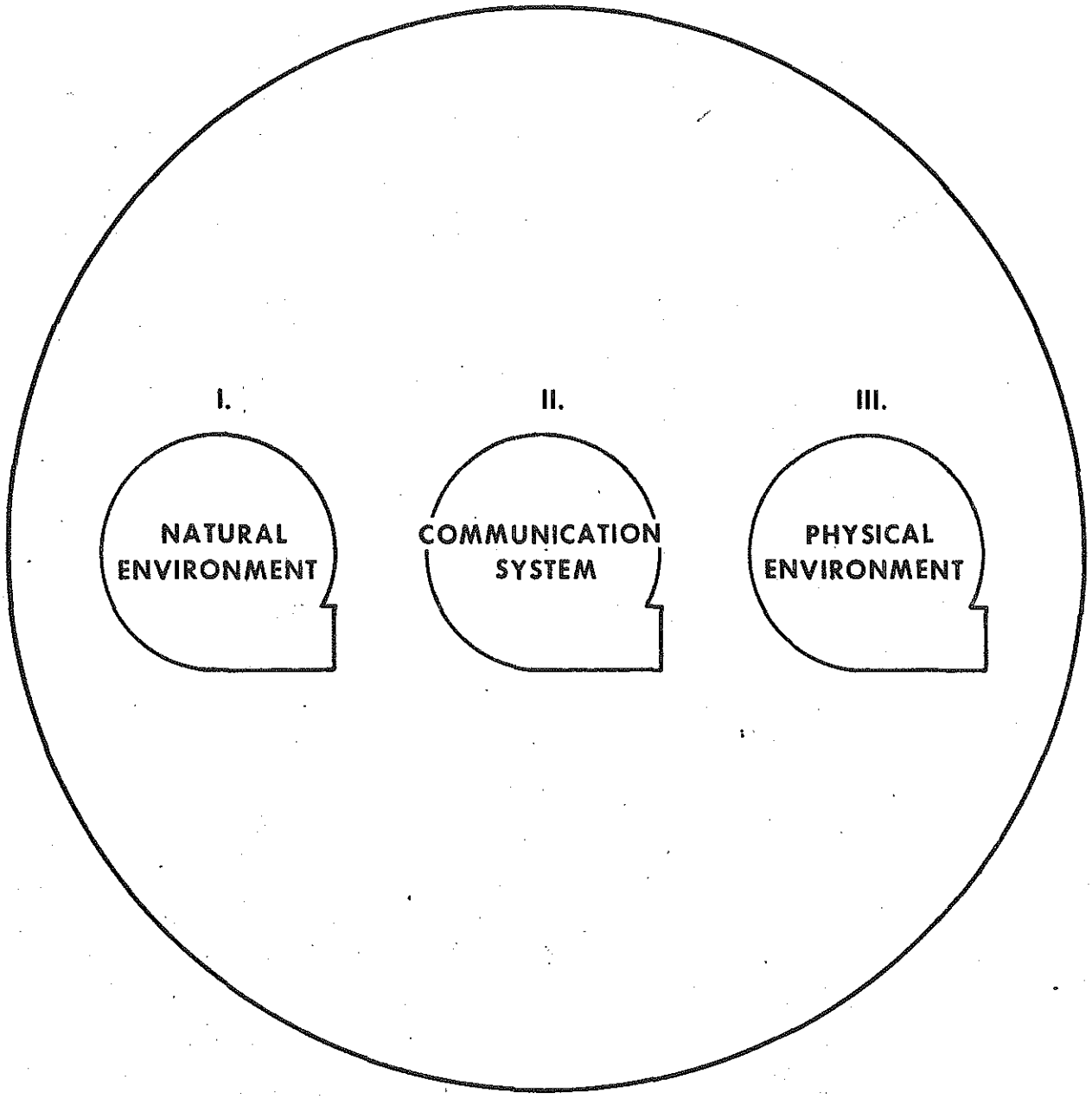


INTRODUCTION

The Statewide Transportation Modeling System

The Statewide Transportation Modeling System has been described in detail in a separate report entitled "A Statewide Transportation Modeling System Effectively meets the Transportation Challenge of the 70's". Therefore, the description of it here is only a coarse outline. Stated concisely, the Statewide Transportation Modeling System is a dynamic integrated tool for specialized information compilation and analysis. It is dynamic in two ways. First, it is capable of rapid information retrieval. New data can be fed into the information files as it is received and old data can be eliminated or stored in secondary files. Second, it is capable of indicating the secondary effects of transportation changes as well as the primary effects. Few Transportation Systems have such dynamic characteristics at this time.

It is the basic simplicity of the system that allows it to be such a dynamic tool. For data compilation the real world is divided into two environments (See Figure 1) - the Natural Environment and the Physical Environment. The Natural Environment is conceived to be all parts of the real world not physically created by men, including man himself; (the socio-economic data file) and the Physical Environment is considered to be the man-made physical environment (the statewide facility file). Connecting these two environments is a communication system (the highway network file). This communication system connects not only the two environments but also parts within each of them.



I. STATEWIDE SOCIO-ECONOMIC DATA FILE

II. STATEWIDE TRANSPORTATION NETWORK

III. STATEWIDE PUBLIC & PRIVATE FACILITY FILE

FIGURE 1

The functional base of the system reflects this conception of reality. A Statewide Socio-Economic Data file contains information about the natural environment. The information contained within that file is listed in Figure 2. A Statewide Public and Private Facilities File contains information about the physical man-built environment. The information contained within that file is listed in Figure 3. Both of these files are capable of rapid updating and enlargement as new data becomes available. Finally, and most importantly, a Statewide Transportation Network File contains information about the existing highway network and possible alternative networks (communication system). See Figure 4 for an example. This file too is capable of rapid updating and enlargement.

For data analysis a number of component models have been created. See Figure 5. These models interrelate to create a unified analysis system. Each model utilizes at least one of the two basic information files as well as the statewide network file, some models utilize all three files.

All information is related to geographical areas in the State thru a zone system. The State and contiguous areas outside the state are broken into 547 zones of which 508 are instate zones. See Figure 6. Zone sizes and boundaries have been determined on the basis of population, land area, political boundaries and other relevant factors. In each file, data are related to zones by zone numbers and located within zones by a grid system that is similar to latitude and longitude lines.

STATEWIDE SOCIO-ECONOMIC DATA FILE*

General characteristics of population

- AGE BY SEX
- TYPE OF FAMILY
- MARITAL STATUS

Social characteristics of population

- SCHOOL ENROLLMENT BY TYPE OF SCHOOL
- YEARS OF SCHOOL COMPLETED
- CITIZENSHIP BY AGE

Labor force characteristics of population

- EMPLOYMENT BY AGE
- EMPLOYMENT BY OCCUPATION AND SEX
- EMPLOYMENT BY INDUSTRY AND SEX

Income characteristics of population

- FAMILY INCOME
- INCOME BY OCCUPATION AND SEX
- RATIO OF FAMILY INCOME TO POVERTY LEVEL

Area characteristics

- LAKE FRONTAGE
- ASSESSED VALUATION
- WATER AREA

*THOSE ITEMS LISTED HERE ARE SAMPLES TAKEN FROM THE COMPLETE FILE WHICH CONTAINS OVER 700 ITEMS.

FIGURE 2

STATEWIDE FACILITY FILE

AIRPORTS
AMBULANCE SERVICE
BUS TERMINALS
CAMP GROUNDS, PUBLIC AND PRIVATE
CERTIFIED INDUSTRIAL PARKS
CITIES OVER 30,000 POPULATION
CITIES OVER 5,000 POPULATION
CIVIL DEFENSE TERMINALS
COLLEGES, NON-PUBLIC
COLLEGES, PUBLIC COMMUNITY
COLLEGES AND UNIVERSITIES, PUBLIC 4 YEAR
CONVENTION CENTERS
GAME AREAS
GOLF COURSES
HIGH SCHOOLS
HISTORIC SITES
HOMES FOR THE AGED
HOSPITALS
MAJOR COMMERCIAL CENTERS
MANUFACTURERS
MENTAL HEALTH CENTERS
NEWSPAPERS, DAILY
NEWSPAPERS, WEEKLY AND BIWEEKLY
NURSING HOMES
PORTS
RAIL TERMINALS
SECRETARY OF THE STATE OFFICES
SEWAGE TREATMENT FACILITIES
SKI RESORTS
SNOWMOBILE TRAILS
STATE PARKS
STATE POLICE POSTS
TOURIST ATTRACTIONS
TREASURY OFFICES
TRUCK TERMINALS
UNEMPLOYMENT OFFICES
WEATHER SERVICE STATIONS-NATIONAL
WHOLESALE TRADE CENTERS

FIGURE 3

STATEWIDE HIGHWAY NETWORK

LINK FILE

CONTENTS OF EACH HIGHWAY SEGMENT OR LINK

AVERAGE SPEED
DISTANCE
URBAN-RURAL DESIGNATION
TYPE OF ROUTE
TRAFFIC VOLUME CAPACITY
AVERAGE ANNUAL DAILY TRAFFIC VOLUME
COMMERCIAL TRAFFIC VOLUME
DESIGN HOUR VOLUME
ACCIDENT FATAL RATE
ACCIDENT INJURY RATE
ACCIDENT RATE
NUMBER OF LANES
LANE WIDTH
SURFACE CONDITION
RIGHT OF WAY
SIGHT RESTRICTION

FIGURE 4

STATEWIDE MODELING SYSTEM COMPONENTS

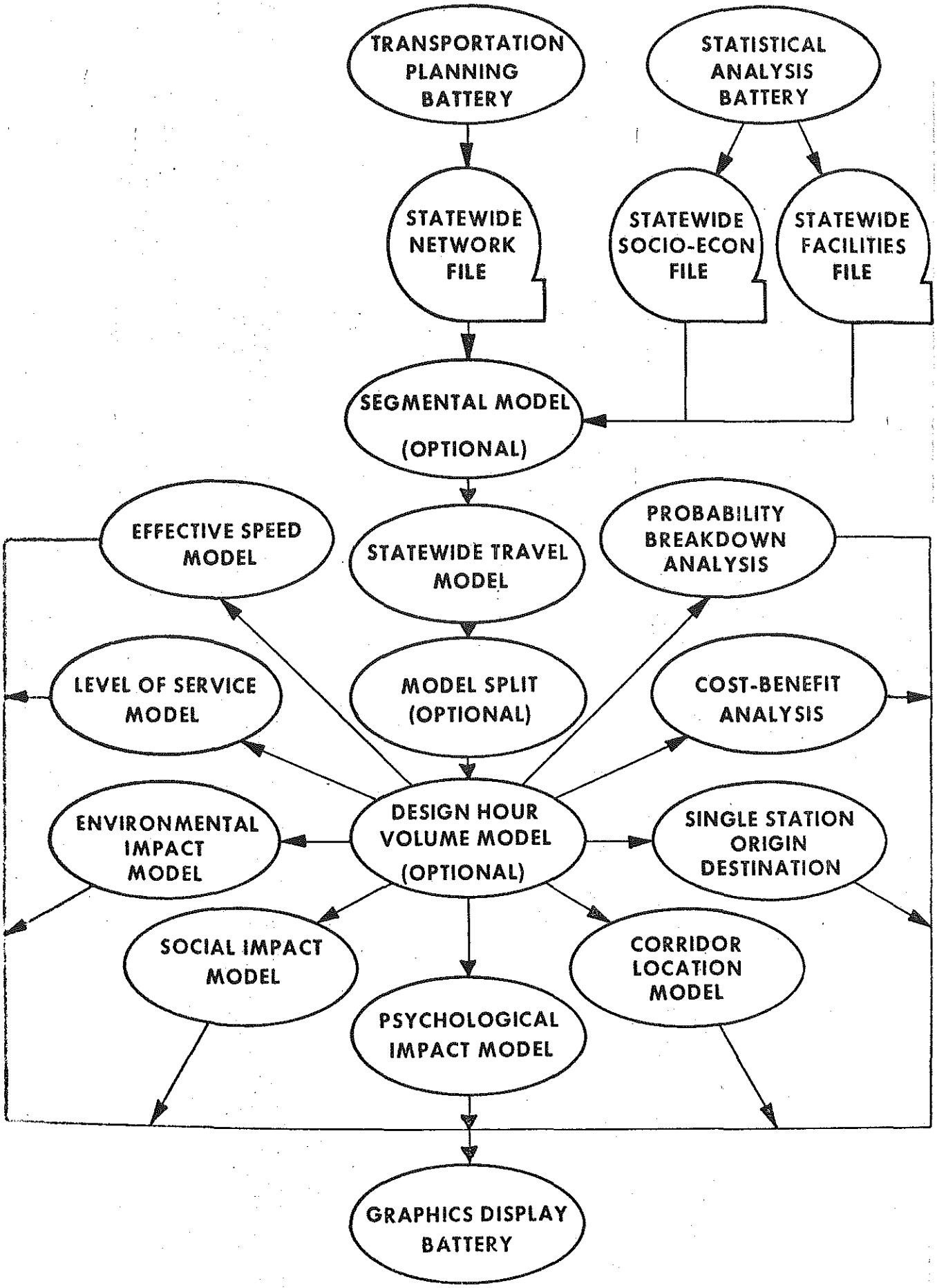


FIGURE 5

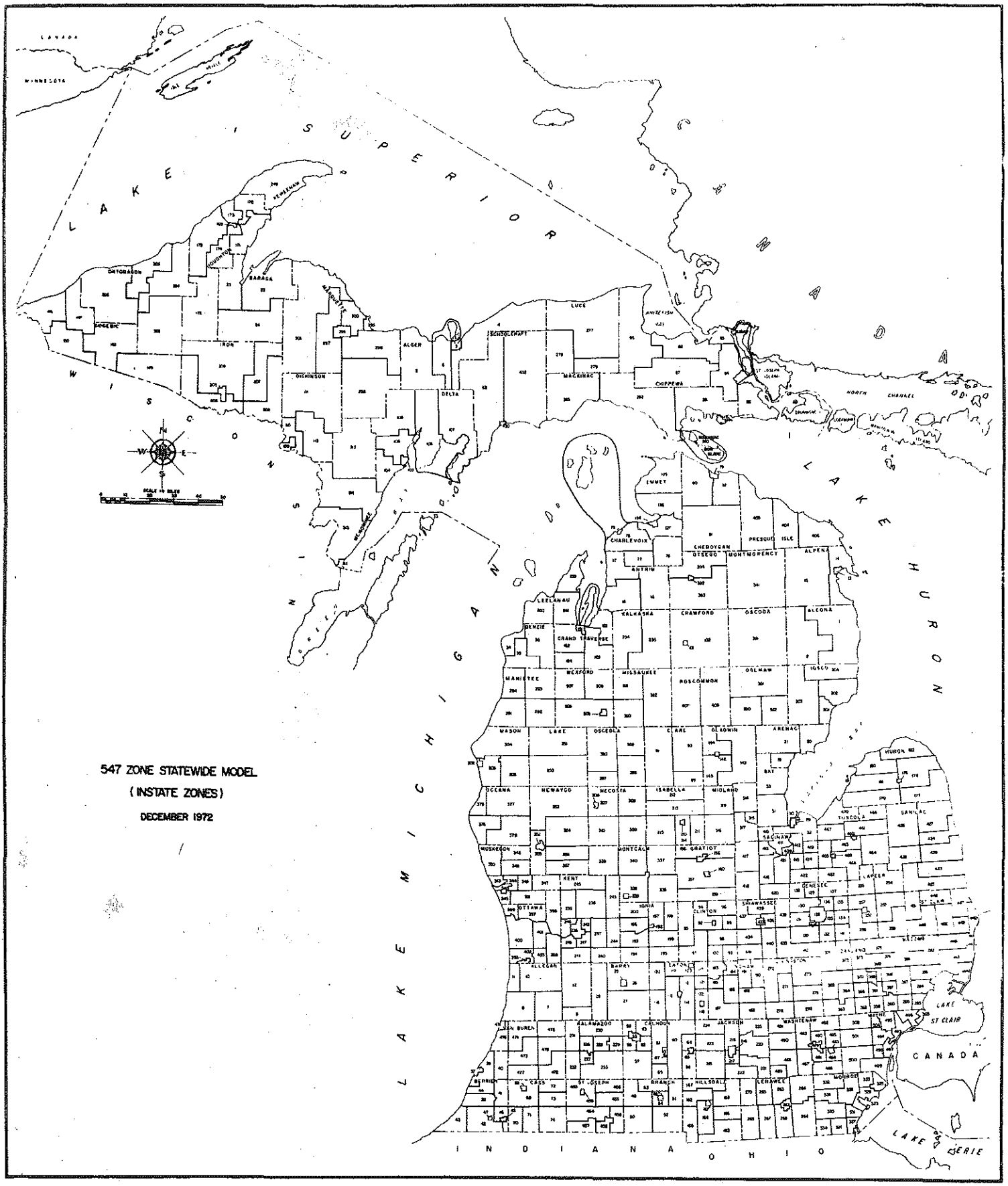

547 ZONE STATEWIDE MODEL
(INSTATE ZONES)
DECEMBER 1972
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ST CLAIR
LAKE ERIE
CANADA
WISCONSIN
INDIANA
OHIO

FIGURE 6

The Discussion in this report will center around those components of the Transportation Modeling System that can be utilized in making economic impact studies.

As an aid to a better understanding of the economic analysis impact procedures developed in this report and to demonstrate some of the analytical procedures, an illustrative economic analysis is presented. This analysis applies to a set of three real world, mutually exclusive, alternatives of an regional corridor location project. (US-31, US-131). The purpose of the report is multifold:

(1) To illustrate the application of the statewide transportation modeling system within the transportation planning process (Figure 7).

(2) To identify possible economic measurement indices output by the analysis models. (Figure 8).

(3) To test actual application within a regional planning situation. (See Analysis Results).

(4) To test the real powers of the economic analysis battery as related to nine areas of investigation (Figure 8).

(5) To provide sample evaluations of the output as related to specific interests of concerned groups. (Figure 9).

This analysis situation was formulated, not to analyze all alternates involved or to draw conclusions on the final construction choice but as a demonstration of how this system could be used by any highway department to supply information and answer questions of groups who are involved in the final decision process.

TYPICAL PLANNING ACTIVITY RELATIONSHIPS

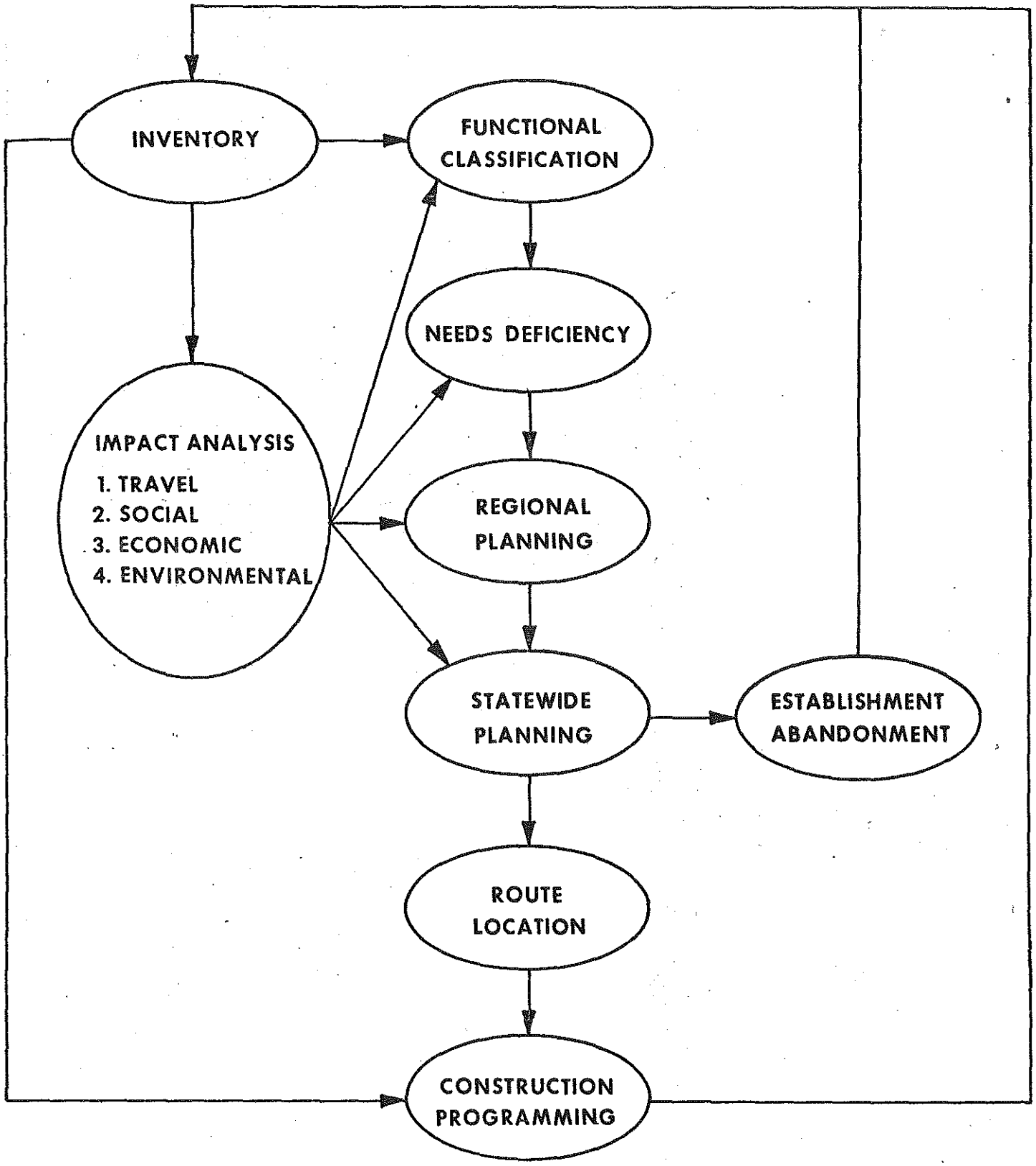


FIGURE 7

ECONOMIC IMPACT MEASUREMENTS

COST-EFFECTIVENESS (PROXIMITY) ANALYSIS

(1) Accessibility of wholesalers to cities

(2) Accessibility of farmers to markets

(3) Accessibility of labor to manufacturing

(4) Accessibility of population to shopping centers

COST-BENEFIT ANALYSIS

(5) User operating costs

(6) Trucking costs

(7) Accident costs

(8) Maintenance costs

(9) Capital expenditure costs

FIGURE (8)

OUTPUT EVALUATION ITEMS

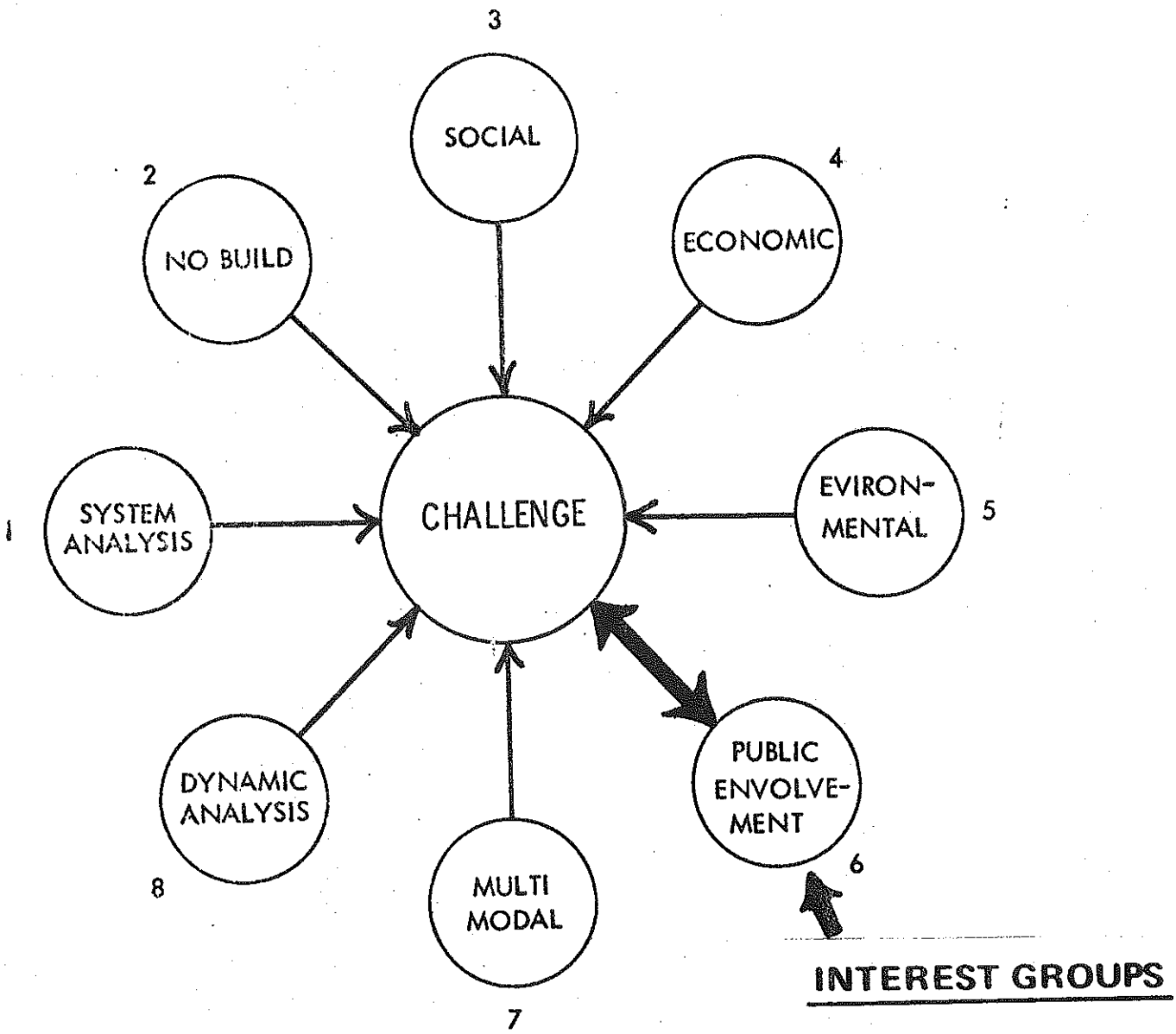
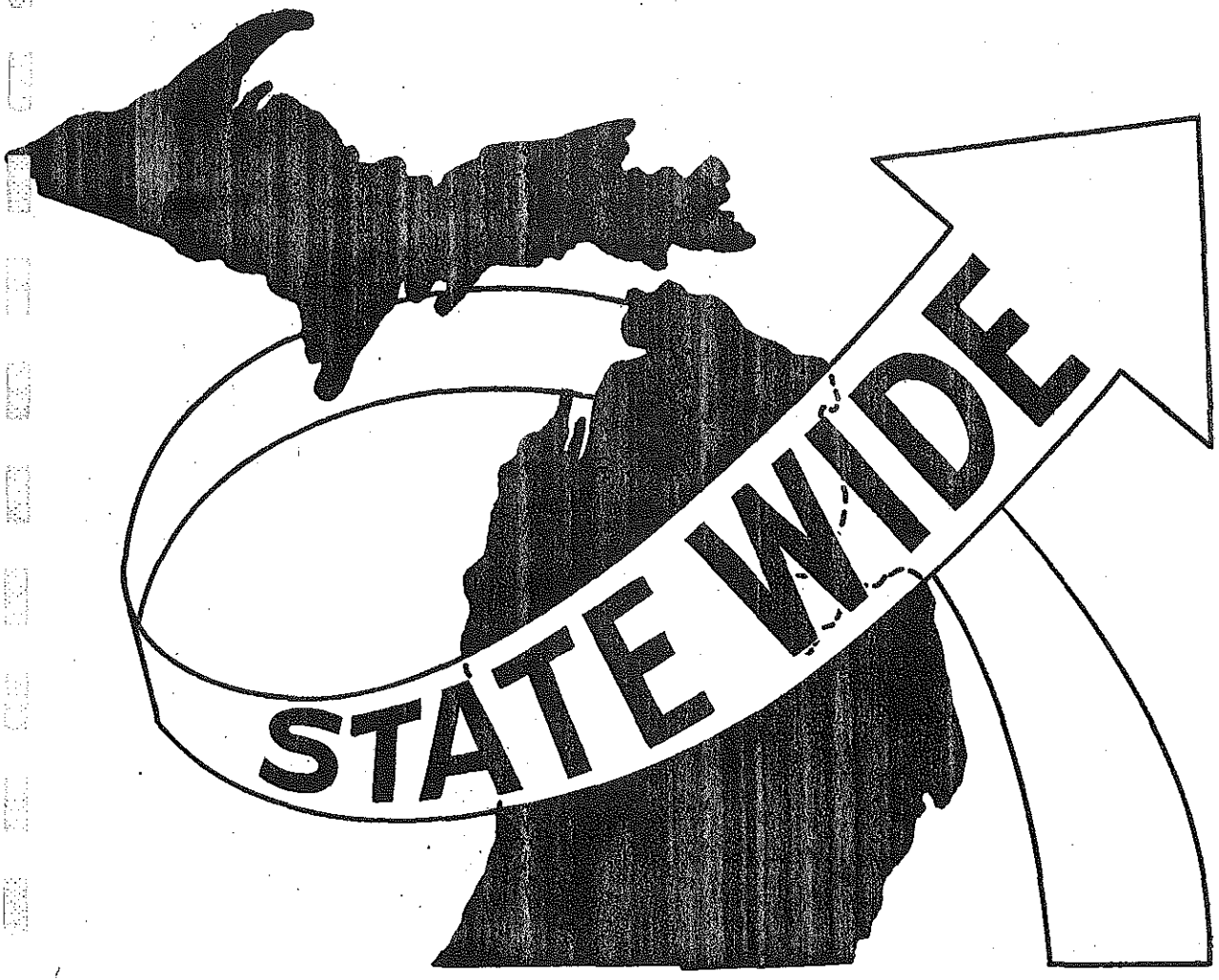


FIGURE 9

Not only does application of these techniques relay specific item analysis but the scope of impact considerations is narrowed or wided through the review of all item information. For example, the effect of farm to market accessibility may or may not show significant variations from one alternate to the other. The opposite may be true for user operating costs and thus the field width of considerations would be selected for more thorough review. This can only be accomplished through a learning process of trial and error. To provide just such a process the previous items of economic impact are reviewed through the output of the two analysis tools. Charts are provided to aid the analyst in future efforts and are found in the analysis results section.

ECONOMIC METHODS OF ANALYSIS



ECONOMIC METHODS OF ANALYSIS

The Statewide Transportation Modeling System was used as the common element for the application of two economic investigatory tools . . . proximity analysis and cost-benefit analysis. These two system components were custom applied to provide impact indices of nine economic dependent variables at the local, regional, and state levels. The independent variables of course being the highway alternatives under consideration. These alternates were chosen to depict a "do-nothing" option and two new construction alternates of varying alignment. The nine areas of economic variables were chosen to provide an example of the different viewpoints alternate research can take to provide reference points for given interested parties.

Cost-benefit analysis, by its very nature, aims at identifying "high payoff" projects whose benefits per unit cost are greatest. In highway terms, such projects are those that minimize total transportation cost, that is, both road and user costs. Therefore, it deals in general with consequences of road development to which it is possible to assign dollar values. Additional social and economic consequences of such developments where the dollar values cannot be assertained are the province of cost-effectiveness analysis.

In order to use effectiveness analysis (Proximity Analysis), the planner should have in mind an objective or goal which he wished his new development to achieve. The cost-effectiveness

process then compares a series of alternative plans by contrasting, for each plan, the costs of gaining the objective with the extent to which the plan approaches the goal. A distinguishing feature of effectiveness analysis is that it does not lead to economic evaluation in the same sense as does engineering economy analysis. Neither is there a precise way to apply it to the project formulation of an engineering design. Because the items subject to a cost-effectiveness approach often cannot be priced either on the cost or the benefit side and sometimes even defy any quantification, they must often be evaluated largely on their own merits and in terms of the overall goals of the community and the public's preferences with respect to social and economic values.

Thus, cost-benefit analysis and cost-effectiveness analysis are not, in the final analysis, anthithetic. Rather, they should be used to complement one another in the decision-maker's economic analysis. To aid in the understanding of the two procedures used: (1) PROXIMITY ANALYSIS AND (2) COST BENEFIT ANALYSIS, a brief summation of the two techniques will be presented at this time. They are presented only to give the reader a feeling for the type of analysis applied and a thorough summation can be obtained through review of the actual analysis reports: VOL. I-D and VOL. I-E. Excerpts of these volumes are re-printed here to expedite the presentations of the analysis tools.

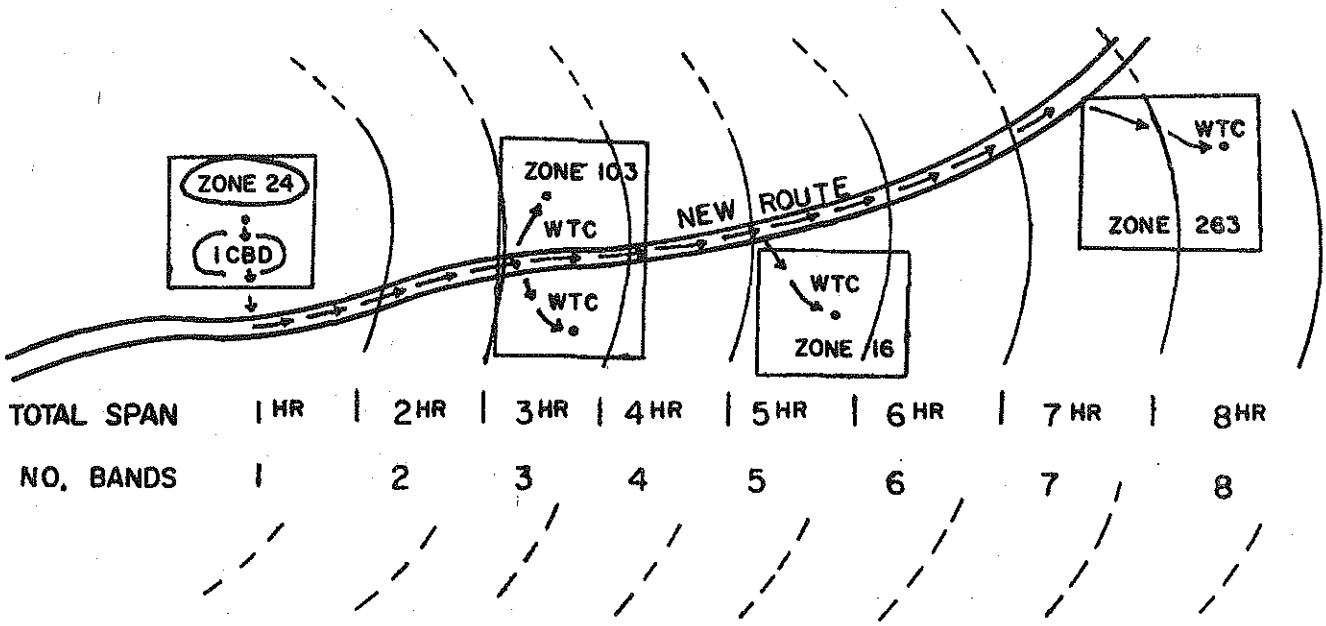
(1) PROXIMITY ANALYSIS

This technique deals with an automated method of measuring the economic impacts of a proposed highway network at the county,

regional and state level by calculating to what extent in time the altered or unaltered network makes public services accessible to selected segments of the population.

This specific analysis tool was created to fulfill additional responsibilities imposed by Federal Legislation. According to Federal-Aid Highway Act of 1970, the evaluation of each proposed Federal-aid highway project must include an analysis of the economic effects of the project. In addition, Section 109(h) stipulates that final decisions on highway projects must be made in the best overall public interest; impacts on the public services are among the effects which must be monitored.

The input data comes from the socio-economic data bank (VOL. V) and a file containing information on the 1970 census. Computing the accessibility of the socio-economic data (such as wholesale trade centers) to elements within the population or other data is the basic function of proximity analysis. One of the options of Proximity Analysis allows the user to define the number of minutes to be included within each driving time band and the number of bands to be used for comparison purposes (up to ten). For example, when investigating the proximity of wholesale trade centers to central business districts, eight ranges were used with a 60 minute span separating each range.



PROXIMITY ILLUSTRATION

In the above example, Proximity Analysis would calculate the increase or decrease in the number of wholesale trade centers made accessible to the central business district in zone 24 as brought about by the construction of the proposed route as defined through driving time increases or decreases. This is accomplished for each zone which is contained in the region of investigation - notably the northwest region of the state which is affected by the construction of US-31 - US-131. These regions can be optionally analyzed by county, region or for the effect of the construction on the entire state, relative to WTC's and CBD (over 5000) or any other combination of population and socio-economic variables. A point which has to be made at this time is the consideration that the number of ranges to be used

and the number of minutes within each range must be proportional or related to the type of socio-economic elements under consideration. In the previous example eight one hour bands or ranges were used. This was assumed subjectively to represent a logical breakdown since many goods shipped from WTC to cities are sent by truck and it is not unusual for a trucker to travel eight hours (one day) or even more to in effect "deliver the goods".

Other data element comparisons such as proximity of labor force to manufacturing centers would of necessity and logic contain fewer ranges with smaller time increments to reflect the span of home to work travel-time workers are willing to travel to arrive at their jobs. An eight hour range as used for WTC's to CBD's would be unreasonable. The distance or cost (combination of time and distance) differences or proximities between zones and the socio-economic elements within those zones are measured by a skimmed tree input which lists the minimum differences in travel costs between the zones. In regional analysis, the program simply measures the increases or decreases in minimum cost travel time between the socio-economic characteristics of specified zones and the facility file items of all other zones as brought about through differing alternate highway plans. Each plan can then be analyzed as to its impact on the desired goal of the proposed transportation system.

(2) COST BENEFIT ANALYSIS

This analysis process 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 alternates. Federal law also requires the consideration of economic effects as ". . . direct and indirect benefits or losses to the community and to highway users". The cost benefit process contrasts value gained or lost by users and taxpayers through the implementations of a number of alternative highway plans. Moreover, 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.

Future traffic forecasts are combined with estimates of road-user costs to produce these economic comparisons between alternative highway plans.

The process described is fully automated and efficient enough to permit rapid feedback during the actual formations of alternative transportation plans, as required by Federal Policy.

The analysis process defined here will surely be of use to the department as the new Federal guidelines go into effect, since it seems to be especially adapted to the new requirements.

For many years, cost-benefit analysis has been used in transportation planning as well as in business. Transportation management has soundly reasoned that a specific improvement in a highway network should not be made unless it could reasonably be expected to pay for itself in long-term benefits to the taxpayer.

Cost-benefit analysis, by its very nature, aims at identifying "high payoff" projects whose benefits per unit cost are greatest.

In highway terms, such projects are those that minimize total transportation cost, that is, both road and user costs. Therefore, it deals in general with consequences of road development to which it is possible to assign dollar values. Social and economic consequences of such developments are the province of cost-effectiveness analysis. (As was provided through the use of Proximity Analysis).

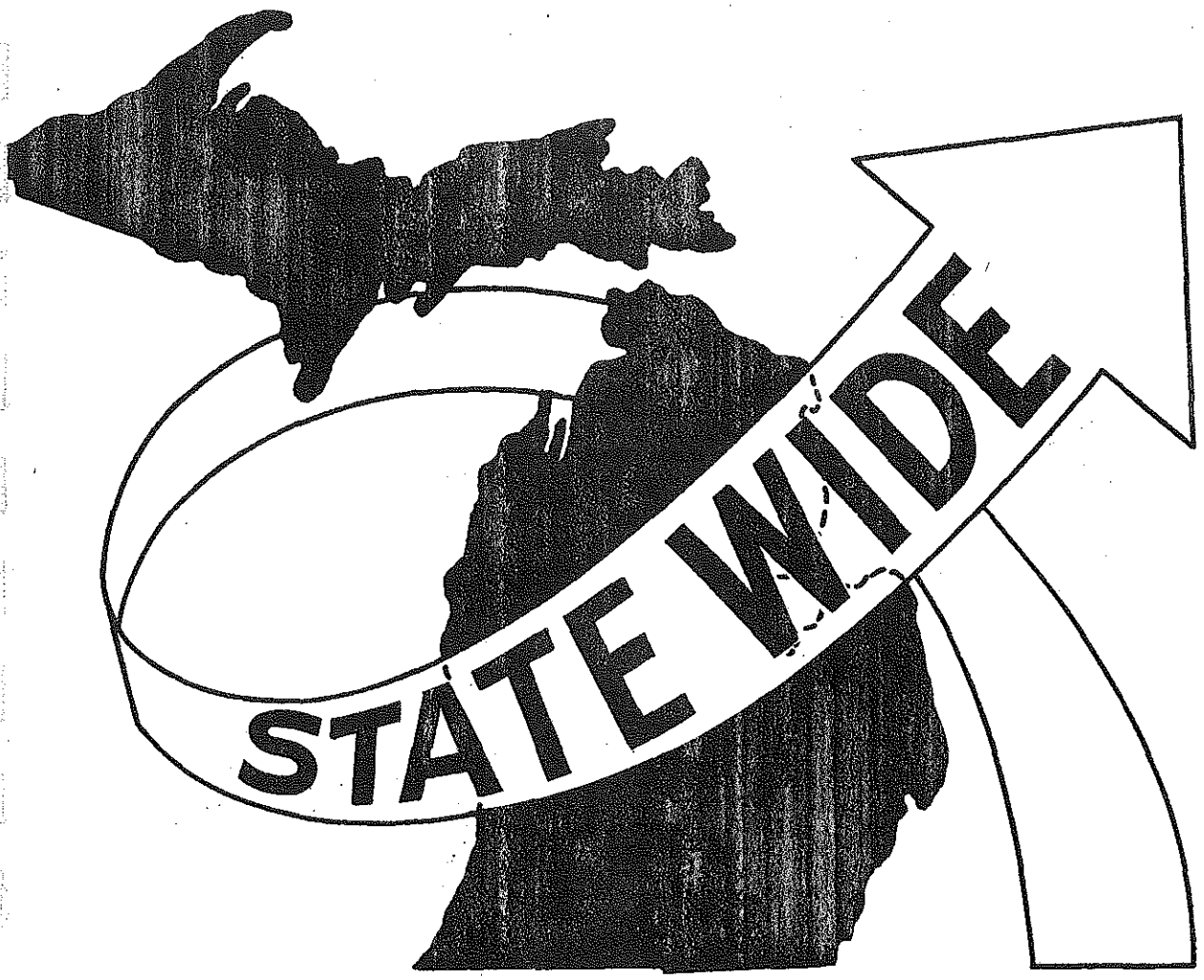
One additional word on the decision-making process is also in order here. Cost-benefit analysis and cost-effectiveness, too, have at various times and by various people either been denounced as useless or hailed as the ultimate solution to the decision problem. It is neither. Both views arise from a less-than-thorough understanding of this management tool. When the procedures of cost-benefit analysis are correctly applied, the answer to the question of priorities is reliable. However, it must be understood by all concerned that one cannot substitute the results of the analysis for the decision itself; in order to arrive at an objective, rational decision, a manager is obligated to use all pertinent information at his disposal, including cost-benefit analysis.

Referring again to the guidelines for an Action Plan (Section 109 (h)), one notes that any analysis of feasible alternatives must include a "do-nothing" or "no-build" alternative. The first step in the analysis process developed by the Statewide Studies Unit is to contrast each proposed highway construction plan with the "do-nothing" alternative.

Finally, an Action Plan should identify procedures to be followed "to ensure that potential...economic...effects are identified insofar as practicable in system planning studies". Because this process is completely interfaced with the Statewide Traffic Forecasting Model, it will compare costs and benefits at the system level. Cost-benefit summaries can be formulated for virtually any combination of geographical regions in Michigan.

The analysis process defined here will surely be of use to many departments as the new Federal guidelines go into effect. The output and functions of these analysis tools will also become clearer as the reader reviews the results of actual applications in the next section.

ANALYSIS RESULTS



ANALYSIS RESULTS

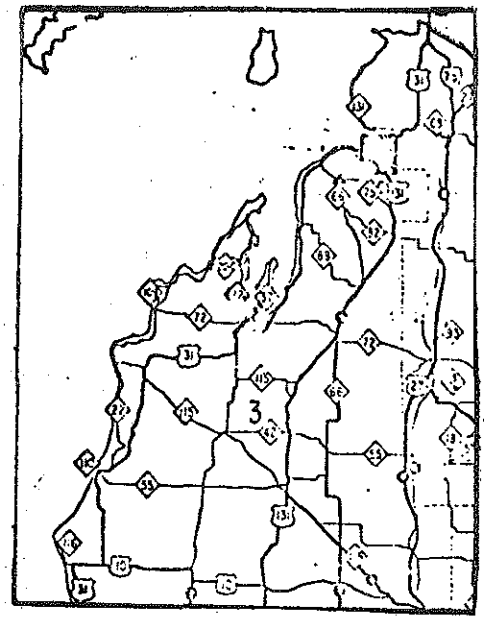
Certain points must be made at this time to aid in the understanding of the data presentation.

The first impact analysis item (Wholesale Trade Centers to Central Business Districts) is viewed from a county as well as a regional (ten county) level of investigation. The next seven impact items are reviewed only at the Regional level. The last item (Capital Exp. Costs) is viewed, first from the regional level and secondly from the Statewide (83 county) level. The nine summary tables only contain results of the regional analysis to maintain consistency throughout the presentation. This was done to show that the impact indicators can be examined at three levels: County, Regional and Statewide. As an added insight to the reader, the results of this three level approach can take on different meanings to different people as evidenced by the results of the following analysis. The results can be interpreted as negative or positive depending on the position the reviewing agents may wish to take. The presentations only show that the tools can output data which are of interest to all concerned parties. As a true test of application, three of the US-31, US-131 projects were examined using both proximity and cost-benefit analysis. They are listed as follows and the accompanying illustration shows the approximate alignments. (Figure 10).

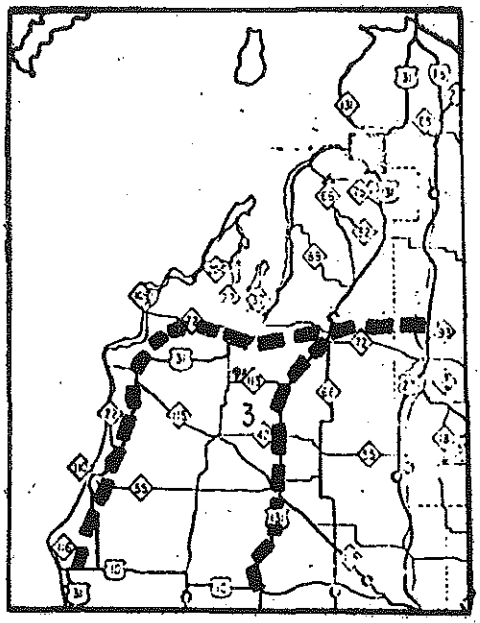
ALTERNATE A: "Do-nothing" network year 2000 assignment with no improvements

ALTERNATE B: New freeway alignment year 2000 assignment

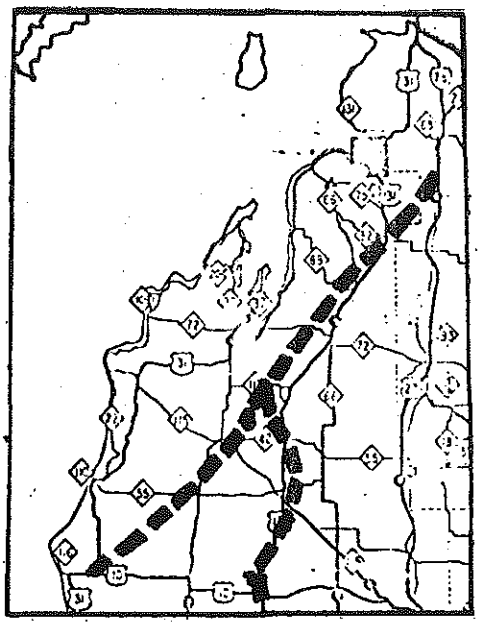
ALTERNATE C: New freeway alignment year 2000 assignment



ALTERNATE "A"



ALTERNATE "B"



ALTERNATE "C"

FIGURE 10

The presentation format is shown as follows:

	WTC TO CBC	FARM TO MARKET	LABOR TO MANUF	POP TO SHOP	USER OPER COSTS	TRUCK COSTS	ACC COSTS	MAINT COSTS	CAP COSTS
COUNTY ANALYSIS	✓								
REGIONAL ANALYSIS	✓	✓	✓	✓	✓	✓	✓	✓	✓
STATEWIDE ANALYSIS									✓

TABLE 1

COUNTY PROXIMITY ANALYSIS: Wholesale trade centers to central business districts.

In Tables 2A, 2B and 2C summaries are presented which convey the impact of the three alternates on the proximity of wholesale trade centers to central business districts within Grand Traverse County. In this analysis, avenues of possible further investigation will be pointed out to pave the way for anyone who may wish to delve further into specifics. Searching analysis will not be presented in this report since the purpose of the publication was only to provide a basic guideline of examples of possible economic impact as mentioned earlier.

To review the summarized zonal impact tables:

Column A = Travel range in minutes as defined by skim trees.

Column B = Travel range in hours as defined by skim trees.

Column C = Central Business District Population located within these time bands

Column D = The percent of the total Business population located within the band.

Column E = The cumulative business population.

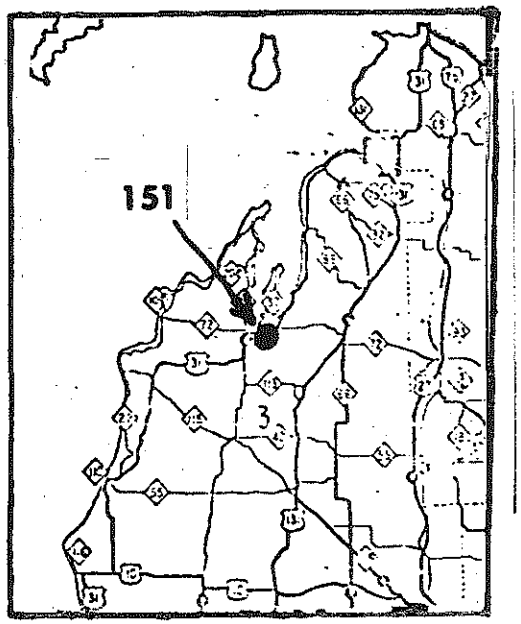
Column F = The cumulative business population percentages.

Column G = Number of Wholesale Trade Centers within the band.

Column H = Cumulative number of Wholesale trade centers.

Column I = Central Business Population divided by the number of Wholesale Trade Centers within each band.

ALTERNATE A

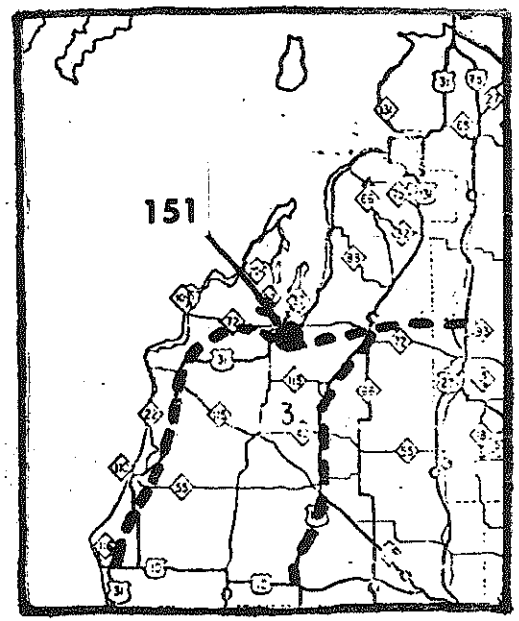


ZONAL ANALYSIS (151) TRAVERSE CITY
ALTERNATE PROXIMITY EFFECT - W. T. C. = → CBDs

TRAVEL RANGE IN MINUTES	HOURS	CENTRAL BUSINESS POPULATION	% TOT BUS. POP.	CUMULATIVE BUSINESS POPULATION	CUMULATIVE CBD POP. PERCENTAGE	NO. WHOLE TRADE CTRS	CUMULATIVE NO. WHOLE TRADE CTRS	CENT BUS. WTC
0 - 60	1	18,048	.335	18,048	.033	1	1	18,048.0
60 - 120	2	36,050	.670	54,098	.100	0	1	0.0
120 - 180	3	93,690	1.741	147,788	2.753	3	4	31,230.0
180 - 240	4	1,066,252	19.812	1,214,040	22.62	10	14	106,625.0
240 - 300	5	1,781,018	33.093	2,995,058	55.80	13	27	137,001.0
300 - 360	6	2,296,454	42.670	5,291,512	98.59	6	33	382,742.0
360 - 420	7	50,828	.944	5,342,340	99.53	2	35	25,414.0
420 - 480	8	24,726	.459	5,367,066	100.00	2	37	12,363.0
A	B	C	D	E	F	G	H	I

TABLE 2-A

ALTERNATE B

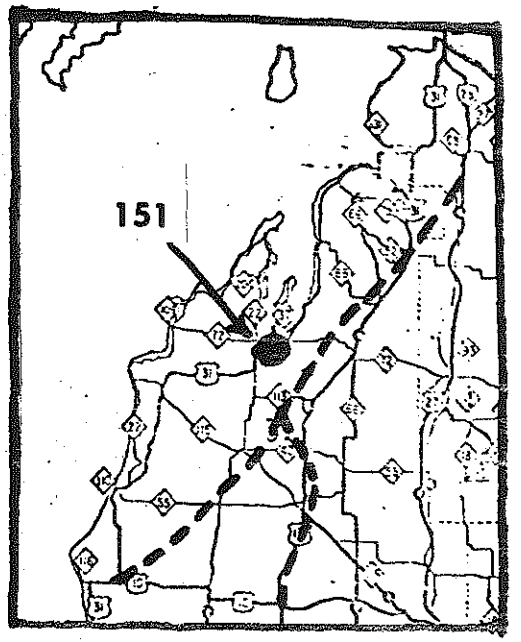


ZONAL ANALYSIS (151) TRAVERSE CITY
ALTERNATE PROXIMITY EFFECT - W. T. C. = → CBDs

TRAVEL RANGE MINUTES	HOURS	CENTRAL BUSINESS POPULATION	% TOT. BUS. POP.	CUMULATIVE BUSINESS POPULATION	CUMULATIVE CBD POP. PERCENTAGE	NO. WHOLE TRADE CTRS	CUMULATIVE NO. WHOLE TRADE CTRS	CENT BU WTC
0 - 60	1	18048	.335	18,048	.033	1	1	18048.0
60 - 120	2	45071	.837	63,119	.117	0	1	0.0
120 - 180	3	665,329	12.362	728,448	13.572	8	9	83166.0
180 - 240	4	674,187	12.527	1,402,635	26.13	11	20	61289.0
240 - 300	5	3,883,640	72.162	5,286,275	98.49	13	33	298,741.0
300 - 360	6	20605	.383	5,306,880	98.87	1	34	20,605.0
360 - 420	7	60186	1.118	5,367,066	100.00	3	37	20062.0
420 - 480	8	0	0.0	5,367,066		0	37	0.0
A	B	C	D	E	F	G	H	I

TABLE 2-B

ALTERNATE C



ZONAL ANALYSIS (151) TRAVERSE CITY
ALTERNATE PROXIMITY EFFECT - W. T. C. = → CBDs

TRAVEL RANGE IN MINUTES	HOURS	CENTRAL BUSINESS POPULATION	% TOT BUS POP.	CUMULATIVE BUSINESS POPULATION	CUMULATIVE CBD POP. PERCENTAGE	NO. WHOLE TRADE CTRS	CUMULATIVE NO. WHOLE TRADE CTRS	CENT BUS. WTC
0 - 60	1	28038	.521	28,038	.522	1	1	28,038.0
60 - 120	2	40634	.755	68,672	.127	0	1	0.0
120 - 180	3	645090	11.986	713,762	13.298	8	9	80,636.0
180 - 240	4	727804	13.523	1,441,566	26.85	12	21	60,650.0
240 - 300	5	3844709	71.439	5,286,275	98.49	12	33	320,392.0
300 - 360	6	20605	.388	5,306,880	98.87	1	34	20,605.0
360 - 420	7	60186	1.118	5,367,066	100.00	3	37	20,062.0
420 - 480	8	0	0.0	5,367,066		0	37	29,062.0
A	B	C	D	E	F	G	H	I

TABLE 2-C

These figures as well as the following proximity figures were taken from actual computer proximity runs and summarized as shown. Figure (10-A) gives an example of this output. The entire output of each category cannot be included here because of the sheer volume of data involved but it can be reviewed at the Statewide Studies Unit if anyone may wish to do so.

Through examination of the table the indications which become immediately apparent are that the construction of either new alternate:

(1) Provides a greater degree of competition to the one wholesaler* within the Traverse City Area. In Column H the cumulative number of wholesalers within 2 hours driving time of Traverse City remains the same for all three alternates. When one compares the number of wholesalers within three hours, however, the do-nothing (A) provides only four wholesalers while the other two (B) and (C) provide nine respectively, or over double the number of the do-nothing. This trend continues within the remaining time bands.

(2) Provides a larger market outlet for the wholesaler or other industries. - Where one element of the definition of measured market can be understood to mean a larger number of consumers within a given distance or time of the supplier, Alternates (B) and (C) also provide an advantage to both wholesale and retail outlets. In Column E (cumulative business population) the number of people (in CBD's) within given time bands increases

STATEWIDE PROXIMITY ANALYSIS

PROXIMITY OF CENTRAL BUS

DATA FOR ZONE 151
CENTRAL BUS = 18048
NUMBER OF WHOLE TRADE = 1
TOTAL CAPACITY = 100000

	0- 60	0- 60
CENTRAL BUS	18048	18048
PERCENT OF TOTAL CENTRAL BUS	0.335	0.335
WHOLE TRADE	1	1
CENTRAL BUS /WHOLE TRADE	18048.00	18048.00

	60-120	0-120
CENTRAL BUS	36050	54098
PERCENT OF TOTAL CENTRAL BUS	0.670	1.005
WHOLE TRADE	0	1
CENTRAL BUS /WHOLE TRADE	0.00	54098.00

	120-180	0-180
CENTRAL BUS	93690	147788
PERCENT OF TOTAL CENTRAL BUS	1.741	2.746
WHOLE TRADE	3	4
CENTRAL BUS /WHOLE TRADE	31230.00	36947.00

	180-240	0-240
CENTRAL BUS	1066252	1214040
PERCENT OF TOTAL CENTRAL BUS	19.812	22.558
WHOLE TRADE	10	14
CENTRAL BUS /WHOLE TRADE	106625.00	86717.14

	240-300	0-300
CENTRAL BUS	1781018	2995058
PERCENT OF TOTAL CENTRAL BUS	33.093	55.651
WHOLE TRADE	13	27
CENTRAL BUS /WHOLE TRADE	137001.00	110928.07

	300-360	0-360
CENTRAL BUS	2296454	5291512
PERCENT OF TOTAL CENTRAL BUS	42.670	98.322
WHOLE TRADE	6	33
CENTRAL BUS /WHOLE TRADE	382742.00	160348.85

FIGURE 10-A

beyond those control limits imposed by the do-nothing alternate (A) The five million figure is reached at least an hour earlier for both alternates (B) and (C), along with a marked advantage in the 3 hour range.

(3) Opens the Traverse City Area to larger avenues of supply as marked by a greater number of wholesalers. - This is the other side of the coin as presented in effect (1). Effect (1) demonstrated the impact of the alternates on the one wholesaler within the area. Effect (3) views the situation from the consumer standpoint. Same results - different impact.

(4) Would probably place a positive downward force on prices due to greater competition and lower transportation costs realized through alternate travel advantages to wholesalers, retailers, and trucking firms, since the cost of transporting an item to market is included in the price of that product. Reductions in relative transportation costs brought about through construction of alternates (B) and (C) should allow wholesalers and retailers to lower prices. This of course assumes normal economic forces will be brought to bear on the elasticity of the supply and demand curves within the region.

(5) Either alternate appears to present the same degree of advantages to the wholesale trade situation of the area. Differences appear very minor and would not appear to be statistically significant.

* Knowledge of only one wholesaler within the Traverse City Area comes from Proximity output which, in the first half of analysis, only prints data for those zones which have a wholesale facility within them. (In this case wholesale trade centers) Zone 151 (Traverse City) appeared in this output and thus it is known that a wholesaler is located within that zone and the corresponding output was presented for review (Figure 10-A). This method within proximity allows a view from the perspective of wholesalers and the second half of output allows a review of the relationship from all zones.

REGIONAL ANALYSIS: PROXIMITY OF WHOLESALE TRADE CENTERS (WTC) TO CENTRAL BUSINESS DISTRICTS (CBD).

The second half of the proximity output lists the number of wholesale trade centers within the given hourly time bands for all zones regardless of the inclusion of a wholesale trade center within that zone. Ten counties were selected for regional analysis (Fig. 11). The wholesale data for each zone within this region was compiled and is presented in Tables (3), (4), and (5). This analysis includes a total of 35 zones.

It must be pointed out that the "number of wholesalers within band" (B) will include duplications of the same WTC's since more than one zone is being analyzed.

For example, the 18 WTC's in the 1 hour band of column B may in fact be one single WTC but accessible from 18 separate zones within the region and not 18 separate WTC's. In other words a given number of WTC's are accessible to the region, but this includes duplications since the common denominator of accessibility is at the zonal level. Consequently, the "overlapping" effect is reflected in the regional figures. The only logical statistic for alternate comparison purposes is actually the average number of WTC's accessible per zone within the region and not the regional total. The regional totals were only presented to show where the zonal "average" figures originated.

Column C represents the mean number of WTC's per zone ($B \div 35$) and provides this common ground for comparison with the zonal analysis.

ANALYSIS AREA

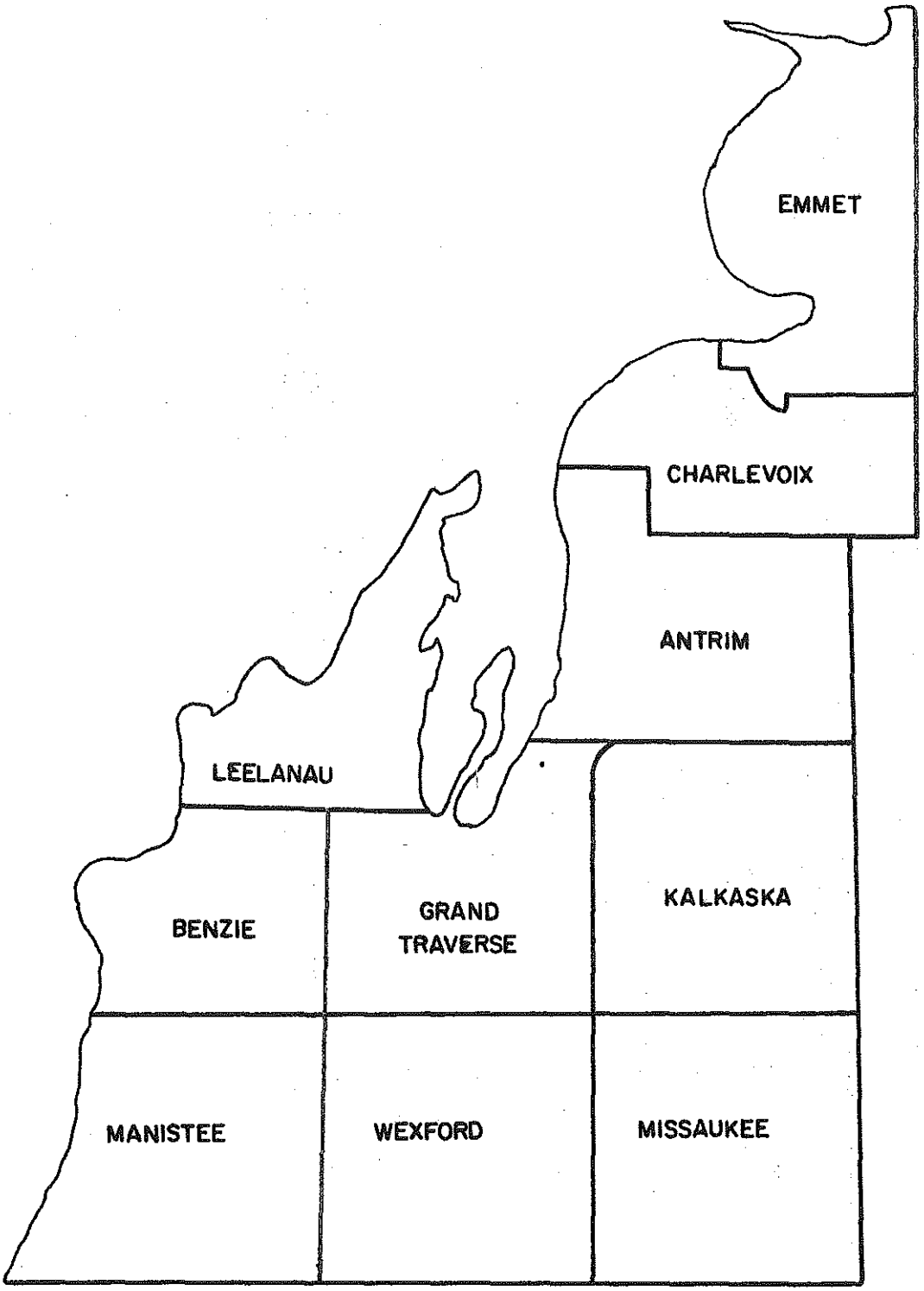


FIGURE 11

"DO-NOTHING" ALTERNATE "A"

TIME SPAN IN HOURS	TOTAL NO. OF WTC WITHIN TIME BAND FOR ALL ZONES	% OF WTC WITHIN BAND	AVG. NO. WTC WITHIN BAND	CUMULATIVE WTC AVG. WITHIN BAND	CUM. AVG. WTC WITHIN BAND
0-1	18	1.399	.51	.51	1.38
1-2	36	2.799	1.03	1.54	4.19
2-3	160	12.441	4.57	6.11	16.63
3-4	359	27.918	10.26	16.37	44.55
4-5	401	31.183	11.45	27.82	75.72
5-6	207	16.096	5.92	33.74	91.83
6-7	57	4.432	1.63	35.37	96.27
7-8	48	3.732	1.37	36.74	100.00
A	B	C	D	E	F

(TABLE 3)

ALTERNATE "B"

TIME SPAN IN HOURS	TOTAL NO. OF WTC WITHIN TIME BAND FOR ALL ZONES	% OF WTC WITHIN BAND	AVG. NO. WTC WITHIN BAND	CUMULATIVE WTC AVG. WITHIN BAND	CUM. AVG. % WTC WITHIN BAND
0-1	19	1.47%	.54	.54	1.47%
1-2	45	3.47%	1.29	1.83	4.94%
2-3	229	17.68%	6.54	8.37	22.62%
3-4	405	31.28%	11.57	19.94	53.90%
4-5	381	29.42%	10.90	30.82	83.32%
5-6	134	10.35%	3.82	34.65	93.67%
6-7	58	4.48%	1.65	36.31	98.15%
7-8	24	1.85%	.69	37.00	100.00%
A	B	C	D	E	F

(TABLE 4)

ALTERNATE "C"

TIME SPAN IN HOURS	TOTAL NO. OF WTC WITHIN BAND FOR ALL ZONES	% OF WTC WITHIN BAND	AVG. NO. WTC WITHIN BAND	CUMULATIVE WTC AVG. WITHIN BAND	CUMULATIVE WTC AVG. WITHIN BAND
0-1	19	1.47%	.54	.54	1.47%
1-2	44	3.40%	1.26	1.80	4.87%
2-3	226	17.45%	6.46	8.25	22.32%
3-4	397	30.67%	11.34	19.60	52.99%
4-5	377	29.11%	10.77	30.37	82.10%
5-6	156	12.04%	4.46	34.82	94.14%
6-7	63	4.86%	1.80	36.62	99.00%
7-8	13	1.00%	.37	37.00	100.00%
A	B	C	D	E	F

(TABLE 5)

The regional effect of proximity analysis as compared to zonal analysis takes on more significance because a larger area and more people are thusly affected. For purposes of brevity the same conclusions can be drawn relative to the impact of the new alternates over the old on truck savings, pricing pressures etc. The new alternates offer advantages over the do-nothing but the question must now be asked: which alternate does the best positive job of aiding the proximity of WTC's relative to regional impact? By review of the three tables alternate B offers minor advantages to wholesale trade. The percentages of WTC within given shorter time bands is slightly higher for alternate B than alternate C. The importances of these differences can take on their own meaning when reviewed in conjunction with other element analysis. For purposes of illustration we will give the nod to alternate B as the best choice relative to this specific definition of impact WTC to CBC. Our Analysis to this point can be summarized on the following table which will be carried through each impact area.

	WTC TO CBD	FARM TO MKT.	LABOR TO MANUF.	POP. TO SHOP CTRS	USER ORDER COSTS	TRUCK COSTS	ACCIDENT COSTS	MAINT. COSTS	CAP. EXP. COSTS
ALT A	3								
ALT B	1								
ALT C	2								

TABLE 6

1 = 1st Choice

2 = 2nd Choice

3 = 3rd Choice

(2) FARMERS TO MARKETS

REGIONAL ANALYSIS: PROXIMITY OF FARM LABOR TO CENTRAL BUSINESS DISTRICTS (WITHIN FOUR HOUR RANGE)

When central business districts are mentioned it means the number of people or potential market within that central business district. We are trying to determine here, through the use of three proximity runs, the increase in the number of people in CBD's brought within the range of existing farm population for each alternate. A determination then should be able to be made which alternate provides the largest market for the existing farm population and consequently the greatest benefit for both groups.

A zonal analysis was presented in the last section to show how it could be accomplished but this section as with following sections will only include a regional analysis for purposes of expediency and convenience to the reader.

The data in table 5 were derived from accumulating the totals of items for each of 35 zones within the analysis region.

	AVG. ACCESSIBLE CBD POP. PER ZONE	AVG. CBD POP. PER FARMER
NO. OF FARMERS	(53.08)	(1)
ALT A	1,549,530	29,192
ALT B	1,899,980	35,794
ALT C	1,845,950	34,776

TABLE 7

One can see through examination of the table that alternate (B) opens a wider market area to the farmers in the study region than the other alternates. To explain further, the average farmer in an average zone within the region will be accessible to 35,794 persons for Alt. B, 34.776 for alternate C and 29,192 for alternate A (Within four hours driving time).

To view the results from several perspectives as dictated by conditions, the farmers in the study region should feel a somewhat greater demand for their products and correspondingly farmers in other areas may feel a slackening of demand. The assumed increase in demand would put an upward force on prices depending on the ability of the farmers to produce more etc. This gets into the realm of economics and elasticity of supply curves whose inter-relationships will be left to economic experts.

The data analysis to this point changes the summary table in the following manner.

	WTC TO CBD	FARM TO MKT.	LABOR TO MANUF.	POP. TO SHOP	USER OPER COSTS	TRUCK COSTS	ACCIDENT COSTS	MAINT COSTS	CAP. EXP. COSTS
ALT A	3	3							
ALT B	1	1							
ALT C	2	2							

TABLE 8

1 = 1st Choice

2 = 2nd Choice

3 = 3rd Choice

(3) LABOR TO MANUFACTURING

REGIONAL ANALYSIS: PROXIMITY OF LABOR FORCE TO MANUFACTURERS

A sample output as displayed in Figure (12) shows the number of jobs available etc. within a one hour range as broken down in 5 minute increments. Only the data at the 60 minute band were totaled to show the overall effect of the alternates within a one hour time frame. The data defined on the printout is cumulative and the one hour driving time limit appeared reasonable for this particular study region. A few, in fact, may even drive further to get to work.

The results are displayed in table (9).

		35 Zone Total	Number of jobs accessible per zone	
ALT A	Workers/Jobs	12.80		A
	No. Jobs	180,276	5,151	B
ALT B	Workers/Jobs	11.70		C
	No. Jobs	202,798	5,794	D
ALT C	Workers/Jobs	10.91		E
	No. Jobs	206,731	5,907	F

TABLE (9)

STATEWIDE PROXIMITY ANALYSIS

PROXIMITY OF LABOR FORCE

DATA FOR ZONE 151
LABOR FORCE = 7631
NUMBER OF MANUFACTING = 30
TOTAL CAPACITY = 2202

	0- 15	0- 15
LABOR FORCE	7631	7631
PERCENT OF TOTAL LABOR FORCE	0.110	0.110
MANUFACTING	30	30
LABOR FORCE /MANUFACTING	254.00	254.37

	15- 20	0- 20
LABOR FORCE	6446	14077
PERCENT OF TOTAL LABOR FORCE	0.093	0.203
MANUFACTING	0	30
LABOR FORCE /MANUFACTING	0.00	469.23

	20- 25	0- 25
LABOR FORCE	2023	16100
PERCENT OF TOTAL LABOR FORCE	0.029	0.233
MANUFACTING	0	30
LABOR FORCE /MANUFACTING	0.00	536.67

	25- 30	0- 30
LABOR FORCE	378	16478
PERCENT OF TOTAL LABOR FORCE	0.005	0.238
MANUFACTING	0	30
LABOR FORCE /MANUFACTING	0.00	549.27

	30- 35	0- 35
LABOR FORCE	714	17192
PERCENT OF TOTAL LABOR FORCE	0.010	0.249
MANUFACTING	1	31
LABOR FORCE /MANUFACTING	714.00	554.58

	35- 40	0- 40
LABOR FORCE	3956	21148
PERCENT OF TOTAL LABOR FORCE	0.057	0.306
MANUFACTING	11	42
LABOR FORCE /MANUFACTING	359.00	503.52

FIGURE 12

The ratio of workers per job is highest for Alternate A (ZONE TOTAL, ROW A) and lowest for Alternate C (ZONE TOTAL ROW E) with Alternate B falling in the middle (ZONE TOTAL, ROW C). This means that there are fewer jobs available to the workers in the region (within a one hour range) for Alternate A as for Alternate C. Alternate C also shows that it brings a higher average number of jobs within a one hour range than any of the other alternates (check NUMBER OF JOBS Rows B, D and F). Alternate C would offer an average of 5,907 jobs per zone: An average of 113 more jobs per zone that Alternate B and an average of 756 more jobs than the no-build Alternate A.

This does not mean that the construction of the new routes create jobs. It only means that more jobs are available within a given one-hour span of driving time. This should be a positive effect for the job seekers within that region. There are, however, two edges on this sword. The proximity data as presented is only looking <u>out</u> from each zone in the region, it does not present the view of the laborers outside of the region looking in. In other words, Alternate C will make more jobs accessible to the workers in the region but it will also make jobs already in that region more accessible to outsiders.

Therefore, we can see that Alternate C, of the three alternates is going to increase the competition for jobs in the northwest region by having the lowest average home to work driving times. More jobs are available but also more applicants are available.

From industries' point of view, the construction of Alternate C would aid these labor acquisitors efforts. For workers, their emotions might be a bit mixed. The nod in this proximity example, therefore, has to go to alternate C.

THE SUMMARY TABLE NOW READS AS FOLLOWS:

	WTC TO CBD	FARM TO MKT.	LABOR TO MANUF.	POP. TO SHOP	USER OPER COSTS	TRUCK COSTS	ACCIDENT COSTS	MAINT. COSTS	CAP. EXP. COSTS
ALT A	3	3	3						
ALT B	1	1	2						
ALT C	2	2	1						

TABLE (10)

(4) POPULATION TO SHOPPING CENTERS

REGIONAL ANALYSIS: PROXIMITY OF POPULATION TO SHOPPING CENTERS

Analysis of the regional data from proximity shows that either new alternate (B or C) would provide an increased choice of shopping opportunities within a 2 hour driving time range. (See Table 11).

(TABLE 11)

	WITHIN 2-HOURS	ZONAL AVERAGE
ALT A	NO. SHOP. CTRS	18.8
	POP/S.C.	256.1
ALT B	NO. SHOP. CTRS	25.7
	POP/S.C.	215.1
ALT C	NO. SHOP CTRS	25.4
	POP/S.C.	222.1

Table 11 shows that Alt. A (DO-NOTHING) provides an average of 18.8 shopping centers per zone within a 2-hour range and Alts. B and C show an average of 25.7 and 25.4 respectively, an average increase of approximately 7 shopping centers per zone for the new alternates. Alternate A shows a higher number of people served per shopping center but this is a little misleading since the population for each zone in each alternate remains the same and only the number of shopping centers fluctuates.

So for analysis purposes the greatest opportunity for shopping is reflected by a lower mean number (POP/S.C.) which is the case for Alternate B. To illustrate the viewpoints that could be taken regarding the construction of alternate B or C, the shopping population within that region should be positively affected because they would have a greater choice of places to shop within the same given driving distance (2 hours). The shopping center merchants in the region however, may have mixed emotions. The increased accessibility of the region to other areas and vice-versa may take some of their customers away from them. On the other hand, the greater accessibility would also open new customers to them.

The cause and effect offshoots of, in effect, shrinking the marketable service areas would definitely include the effect of increasing competition between the shopping centers. This may cause more merchants to lower prices and possibly remodel or expand services to keep their old customers and draw in new ones. The effect on the shoppers in either case would be positive.

Retailers then may take a stand in favor of the do-nothing to retain a relatively "captive" market and the shopping public would likewise favor either of the new highway possibilities for purposes of expanding the shopping dollars, both in terms of choice and savings.

Areas of Government or many local agencies may stay out of the decision-making process in compliance with the age-old doctrine of Laissez - Faire. This would remain to be seen at the public hearings. The choice of alternates then would of course be left

to the interested parties but in terms of increased shopping opportunities, which is what we were trying to measure, alternate B would best meet the intended requirements with C and A following suite.

Our table concerning alternate choice then would look like this.

	WTC TO CBD	FARM TO MKT.	LABOR TO MANUF.	POP. TO SHOP	USER OPER COSTS	TRUCK COSTS	ACCIDENT COSTS	MAINT COSTS	CAP. EXP. COSTS
ALT A	3	3	3	3					
ALT B	1	1	2	1					
ALT C	2	2	1	2					

TABLE 12

This last analysis concludes the economic effects of the three alternates through the application of proximity analysis. Alternate B came through with 3 of the 4 first place choices but the areas of investigation would have to be weighted as to importance in order to make a final decision.

COST-BENEFIT ANALYSIS APPLICATION

Sections of the total Cost-Benefit printout are presented here as an aid in the interpretations of results. The individual cost categories are relatively self explanatory except for a few points which will be discussed at this time.

In all cases the 0, 1, and 2 refer respectively to alternates A, B and C. In the numbered columns the E designation means the initial numbers are followed by the specified number of zeros. In the case of Fig. (13), the .742E 06 after Present Worth of Auto Running cost under column 0 (A) should be interpreted as $ 742,000,000 etc. The actual methods or base figures used to calculate these results are explained in detail in Volume I-E "Model Applications: Cost-Benefit Analysis". For purposes of brevity, only final results of the alternate comparisons will be discussed here.

(The figures are calculated and represent a base 30 year period of time. The above figure for Auto Running Cost then would reflect the total cost of operating all autos on these sections of highways for 30 years: fuel, tires, repairs, etc.).

The costs are computed at monetary lending rates of 6%, 8% and 10%. This is to offer the analyst a needed option of allowing for varying economic conditions and perspectives.

LENGTH .12E 03 INTEREST RATE 6 PERCENT VALUE OF PASSENGER CAR TRAVEL TIME $ 2.0

ALT. 0 VEH.-MILES YEAR 1 .2E 04 YEAR 30 .4E 04 ALTERNATIVE CHOSEN 9

REGIONAL ANALYSIS

FIGURE 13

	ALTERNATIVE COST, THOUSANDS		
	0	1	2	3
PRESENT WORTH OF AUTO RUNNING COST	$ .742E 06	.593E 06	.624E 06
PRESENT WORTH OF TRUCK RUNNING COST	$ .147E 06	.110E 06	.112E 06
PRESENT WORTH OF ACCIDENT COSTS	$.696E 05	.541E 05	.579E 05
PRESENT WORTH OF TRUCK TIME COSTS	$ .960E 05	.719E 05	.735E 05
TOTAL PRESENT WORTH OF USER COSTS	$ .105E 07	.829E 06	.868E 06
ANNUAL MAINTAINENCE COST	$ .154E 04	.184E 04	.191E 04
PRESENT WORTH OF ANNUAL MAINTAINENCE COST	$ .212E 05	.253E 05	.262E 05
PRESENT WORTH OF AUTO TIME COSTS	$ .451E 06	.360E 06	.382E 06
PRESENT WORTH OF USER, MAINTAINENCE, AND AUTO TIME COSTS	$ .153E 07	.121E 07	.128E 07
CAPITAL COSTS	$ .0	.115E 06	.907E 05

LENGTH .12E 03 INTEREST RATE .8 PERCENT VALUE OF PASSENGER CAR TRAVEL TIME $ 2.0

ALT. 0 VEH.-MILES YEAR 1 .2E 04 YEAR 30 .4E 04 ALTERNATIVE CHOSEN 9

REGIONAL ANALYSIS

FIGURE 14

	ALTERNATIVE COST, THOUSANDS			
	0	1	2	3
PRESENT WORTH OF AUTO RUNNING COST	$ .586E 06	.471E 06	.500E 06	
PRESENT WORTH OF TRUCK RUNNING COST	$ .116E 06	.875E 05	.894E 05	
PRESENT WORTH OF ACCIDENT COSTS	$.550E 05	.428E 05	.462E 05	
PRESENT WORTH OF TRUCK TIME COSTS	$ .758E 05	.572E 05	.587E 05	
TOTAL PRESENT WORTH OF USER COSTS	$ .833E 06	.659E 06	.694E 06	
ANNUAL MAINTAINENCE COST	$ .154E 04	.184E 04	.191E 04	
PRESENT WORTH OF ANNUAL MAINTAINENCE COST	$ .174E 05	.207E 05	.215E 05	
PRESENT WORTH OF AUTO TIME COSTS	$ .356E 06	.287E 06	.306E 06	
PRESENT WORTH OF USER, MAINTAINENCE, AND AUTO TIME COSTS	$ .121E 07	.966E 06	.102E 07	
CAPITAL COSTS	$ .0	.115E 06	.907E 05	

LENGTH .12E 03 INTEREST RATE 10 PERCENT VALUE OF PASSENGER CAR TRAVEL TIME $ 2.0

ALT. 0 VEH.-MILES YEAR 1 .2E 04 YEAR 30 .4E 04 ALTERNATIVE CHOSEN 9

REGIONAL ANALYSIS

FIGURE 15

	ALTERNATIVE COST, THOUSANDS		
	0	1	2	3
PRESENT WORTH OF AUTO RUNNING COST	$ .475E 06	.384E 06	.411E 06
PRESENT WORTH OF TRUCK RUNNING COST	$ .942E 05	.714E 05	.733E 05
PRESENT WORTH OF ACCIDENT COSTS	$.446E 05	.348E 05	.379E 05
PRESENT WORTH OF TRUCK TIME COSTS	$ .615E 05	.467E 05	.481E 05
TOTAL PRESENT WORTH OF USER COSTS	$ .675E 06	.537E 06	.570E 06
ANNUAL MAINTAINENCE COST	$ .154E 04	.184E 04	.191E 04
PRESENT WORTH OF ANNUAL MAINTAINENCE COST	$ .145E 05	.173E 05	.180E 05
PRESENT WORTH OF AUTO TIME COSTS	$ .289E 06	.234E 06	.251E 06
PRESENT WORTH OF USER, MAINTAINENCE, AND AUTO TIME COSTS	$ .979E 06	.788E 06	.839E 06
CAPITAL COSTS	$ .0	.115E 06	.907E 05

STATEWIDE PROJECT OUTPUT

COMPARISON OF ALTERNATIVES

NET PRESENT WORTHS (THOUSANDS)

REGIONAL ANALYSIS

	USER, MAINT., AUTO TIME COST	CAPITAL COST	NET BENEFIT
1 VS 0	.2E 06	.1E 06	.8E 05
2 VS 0	.1E 06	.9E 05	.5E 05

BENEFIT COST RATIOS

1 VS 0	1.67
2 VS 0	1.54

10% INTEREST RATE

FIGURE 16

PROJECT NO. 212211000
SEGMENT GROUP ALL

ANNUAL VEHICLE ACCIDENTS - YEAR 30

ALT.	FATAL	INJURY	PROP.DAM.
0	36.	975.	2045.
1	32.	833.	1783.
2	35.	901.	1961.

REGIONAL ANALYSIS

FIGURE 17

LENGTH .12E 03 INTEREST RATE 6 PERCENT VALUE OF PASSENGER CAR TRAVEL TIME $ 2.0

ALT. 0 VEH.-MILES YEAR 1 .4E 05 YEAR 30 .1E 06 ALTERNATIVE CHOSEN 9

STATEWIDE ANALYSIS

FIGURE 18

	ALTERNATIVE COST, THOUSANDS		
	0	1	2	3
PRESENT WORTH OF AUTO RUNNING COST	$ .211E 08	.193E 08	.195E 08
PRESENT WORTH OF TRUCK RUNNING COST	$ .754E 07	.647E 07	.650E 07
PRESENT WORTH OF ACCIDENT COSTS	$.150E 07	.133E 07	.135E 07
PRESENT WORTH OF TRUCK TIME COSTS	$ .446E 07	.381E 07	.383E 07
TOTAL PRESENT WORTH OF USER COSTS	$ .346E 08	.310E 08	.312E 08
ANNUAL MAINTAINENCE COST	$ .189E 05	.214E 05	.214E 05
PRESENT WORTH OF ANNUAL MAINTAINENCE COST	$ .261E 06	.295E 06	.294E 06
PRESENT WORTH OF AUTO TIME COSTS	$ .119E 08	.108E 08	.109E 08
PRESENT WORTH OF USER, MAINTAINENCE, AND AUTO TIME COSTS	$ .467E 08	.421E 08	.424E 08
CAPITAL COSTS	$ .0	.103E 07	.986E 06

LENGTH .12E 03 INTEREST RATE 8 PERCENT VALUE OF PASSENGER CAR TRAVEL TIME $ 2.0

ALT. 0 VEH.-MILES YEAR 1 .4E 05 YEAR 30 .1E 06 ALTERNATIVE CHOSEN 9

STATEWIDE ANALYSIS

FIGURE 19

	ALTERNATIVE COST, THOUSANDS			
	0	1	2	3
PRESENT WORTH OF AUTO RUNNING COST	$ .166E 08	.153E 08	.154E 08	
PRESENT WORTH OF TRUCK RUNNING COST	$ .591E 07	.509E 07	.511E 07	
PRESENT WORTH OF ACCIDENT COSTS	$.118E 07	.105E 07	.107E 07	
PRESENT WORTH OF TRUCK TIME COSTS	$ .350E 07	.301E 07	.302E 07	
TOTAL PRESENT WORTH OF USER COSTS	$ .272E 08	.244E 08	.246E 08	
ANNUAL MAINTAINENCE COST	$ .189E 05	.214E 05	.214E 05	
PRESENT WORTH OF ANNUAL MAINTAINENCE COST	$ .213E 06	.241E 06	.241E 06	
PRESENT WORTH OF AUTO TIME COSTS	$ .932E 07	.854E 07	.863E 07	
PRESENT WORTH OF USER, MAINTAINENCE, AND AUTO TIME COSTS	$ .367E 08	.332E 08	.335E 08	
CAPITAL COSTS	$ .0	.103E 07	.986E 06	

LENGTH .12E 03 INTEREST RATE 10 PERCENT VALUE OF PASSENGER CAR TRAVEL TIME $ 2.0

ALT. 0 VEH.-MILES YEAR 1 .4E 05 YEAR 30 .1E 06 ALTERNATIVE CHOSEN 9

STATEWIDE ANALYSIS

FIGURE 20

	ALTERNATIVE COST, THOUSANDS		
	0	1	2	3
PRESENT WORTH OF AUTO RUNNING COST	$ .134E 08	.124E 08	.125E 08
PRESENT WORTH OF TRUCK RUNNING COST	$ .476E 07	.412E 07	.413E 07
PRESENT WORTH OF ACCIDENT COSTS	$.956E 06	.856E 06	.868E 06
PRESENT WORTH OF TRUCK TIME COSTS	$ .282E 07	.243E 07	.244E 07
TOTAL PRESENT WORTH OF USER COSTS	$ .219E 08	.198E 08	.199E 08
ANNUAL MAINTAINENCE COST	$ .189E 05	.214E 05	.214E 05
PRESENT WORTH OF ANNUAL MAINTAINENCE COST	$ .179E 06	.202E 06	.202E 06
PRESENT WORTH OF AUTO TIME COSTS	$ .753E 07	.693E 07	.700E 07
PRESENT WORTH OF USER, MAINTAINENCE, AND AUTO TIME COSTS	$ .296E 08	.269E 08	.271E 08
CAPITAL COSTS	$ .0	.103E 07	.986E 06

STATEWIDE PROJECT OUTPUT

COMPARISON OF ALTERNATIVES

NET PRESENT WORTHS (THOUSANDS)

	USER, MAINT., AUTO TIME COST	CAPITAL COST	NET BENEFIT
1 VS 0	.3E 07	.1E 07	.2E 07
2 VS 0	.2E 07	.1E 07	.2E 07

BENEFIT COST RATIOS

1 VS 0	2.65
2 VS 0	2.53

STATEWIDE ANALYSIS

10% INTEREST RATE

FIGURE 21

PROJECT NO. 212211000₁
SEGMENT GROUP ALL

ANNUAL VEHICLE ACCIDENTS - YEAR 30

ALT.	FATAL	INJURY	PROP.DAM.
0	820.	20452.	42174.
1	784.	19321.	41710.
2	799.	19459.	42067.

STATEWIDE ANALYSIS

FIGURE 22

(5)

REGIONAL SUMMARY

USER OPERATING COSTS

The first of these sections will show all three interest rate base year costs to give the reader a feeling for the impact of their differences. The remaining sections will only carry the 10% rate of interest outline and a 6% 8%, and 10% averaged summary for purposes of obtaining a comparison figure. The actual dollars and cents impact of these different rates can be seen by referring to the given output figures and the totals used to obtain the average.

(The cost-benefit ratio in the following 10% example is simply the number of current value dollars to be returned per current value dollar invested in the given alternate at the specified rate of interest).

A. 6% (Figure 13)

TOTAL PRESENT WORTH OF USER COSTS (ROW 5)

ALTERNATE . . .	(A)	(B)	(C)
COST RATING			
HIGHEST	$ 1,050,000,000		
MEDIUM			$ 868,000,000
LOWEST		$ 829,000,000	

B. 8% (Figure 14)

ALTERNATE	(A)	(B)	(C)
COST RATING			
HIGHEST . . .	$ 833,000,000		
MEDIUM . . .			$ 694,000,000
LOWEST . . .		$ 659,000,000	

C. 10% (Figure 15)

ALTERNATE	(A)	(B)	(C)
COST RATING			
HIGHEST . . .	$ 675,000,000		
MEDIUM . . .			$ 570,000,000
LOWEST . . .		$ 537,000,000	
COST-BENEFIT RATIO		1.67	1.54

As revealed by the summaries and figures alternate B provides the greatest cost-savings to users. The cost-benefit ratio curves cross when the interest rate increases and alternate B becomes more economical at the higher levels. In actual comparison situations the higher interest rates of 8% and 10% should probably be used as a base of decision since the annual rate of 6% has long since passed under current economic conditions. The 6, 8 and 10 percent totals are only added here for illustration. As the followed summary shows, alternate B is chosen as the more economical to users and will be entered in the summary chart as the best choice.

MEAN TOTALS

ALTERNATES	(A)	(B)	(C)
6%	$ 1,050,000,000	$ 829,000,000	$ 868,000,000
8%	$ 833,000,000	$ 659,000,000	$ 694,000,000
10%	$ 675,000,000	$ 537,000,000	$ 570,000,000
	$ 2,558,000,000	2,025,000,000	2,132,000,000
$\overline{X}$ =	$ 852,666,666	$ 675,000,000	$ 710,666,666

A =	$ 852,666,666	
- B =	$ 675,000,000	
	$ 177,666,666	SAVINGS DIFFERENCE
C =	710,666,666	
- B =	675,000,000	
	$ 35,666,666	SAVINGS DIFFERENCE

The savings difference illustrated is only a single impact indicator and it must be mentioned that other items are to be considered when computing actual savings. The cost-benefit ratio is a good indicator of this since it also considers the initial cost of construction versus realized savings. These summaries are only presented for comparison purposes and the real "digging" is left to the analyst.

THE SUMMARY TABLE APPEARS AS FOLLOWS:

	WTC TO CBD	FARM TO MKT.	LABOR TO MANUF.	POP. TO SHOP	USER OPER. COSTS	TRUCK COSTS	ACC. COSTS	MAINT. COSTS	CAP. EXP. COSTS
ALT A	3	3	3	3	3				
ALT B	1	1	2	1	1				
ALT C	2	2	1	2	2				

TABLE 13

(6)

REGIONAL SUMMARY

TRUCKING COSTS

10% FIGURE (15)

ALTERNATE . . .	(A)	(B)	(C)
COST RATING			
HIGHEST . . .	$ 94,200,000		
MEDIUM . . .			$ 73,300,000
LOWEST . . .		$ 71,400,000	

ALTERNATE	(A)	(B)	(C)
6%	$ 147,000,000	$ 110,000,000	$ 112,000,000
8%	$ 116,000,000	$ 87,500,000	$ 89,400,000
10%	$ 94,200,000	$ 71,400,000	$ 73,300,000
TOTAL	$ 357,200,000	$ 268,900,000	$ 274,700,000
MEAN	$ 119,066,666	$ 89,633,333	$ 91,566,666

A	$ 119,066,666	
- B	$ 89,633,333	
	$ 29,433,333	AVERAGE SAVINGS DIFFERENCE

C	$ 91,566,666	
- B	$ 89,633,333	
	$ 1,933,333	AVERAGE SAVINGS DIFFERENCE

Alternate B should save approximately 29 million dollars in trucking costs over a thirty year period within the study region over and above the "do-nothing" alternate. Alternate B should save an average of approximately 2 million dollars in trucking costs as opposed to alternate C.

The choice then again is alternate B. The summary continues as follows.

	WTC TO CBD	FARM TO MKT.	LABOR TO MANUF.	POP. TO SHOP.	USER OPER COSTS	TRUCK COSTS	ACCIDENT COSTS	MAINT. COSTS	CAP. EXP. COSTS
ALT A	3	3	3	3	3	3			
ALT B	1	1	2	1	1	1			
ALT C	2	2	1	2	2	2			

TABLE 14

(7)

1 - REGIONAL SUMMARY

ACCIDENT COSTS

PRESENT WORTH OF ACCIDENT COSTS

10% (FIGURE 15)

ALTERNATE	(A)	(B)	(C)
COST RATING			
HIGHEST	$ 44,600,000		
MEDIUM			$ 37,900,000
LOWEST		$ 34,800,000	

Figure (17) provides a summary of the number of accidents to be expected in the design year (2000) per 100 million vehicle miles for the designated study region (ten counties). Alternate 1 (B) shows a distinct advantage over the other alternates.

MEAN SUMMARY

ALTERNATE	(A)	(B)	(C)
6%	$ 69,600,000	$ 54,100,000	$ 57,900,000
8%	$ 55,000,000	$ 42,800,000	$ 46,200,000
10%	$ 44,600,000	$ 34,800,000	$ 37,900,000
	$169,200,000	$131,700,000	$142,000,000
$\bar{X}$ =	$ 56,400,000	$ 43,900,000	$ 47,333,333

(A) $ 56,400,000
(B) $ 43,900,000
$ 12,500,000 AVERAGE SAVINGS DIFFERENCE

(C) $ 47,333,333
(B) $ 43,900,000
$ 3,433,333 AVERAGE SAVINGS DIFFERENCE

Accident costs are lower for alternate B than for the other considerations. A 12.5 million dollar advantage is offered over alternate A and a 3.4 million dollar advantage over alternate C. Remember again that these figures are spread over a 30 year period.

Our summary tables now looks like this.

	WTC TO CBD	FARM TO MKT.	LABOR TO MANUF.	POP. TO SHOP	USER OPER. COSTS	TRUCK COSTS	ACCIDENT COSTS	MAINT. COSTS	CAP. EXP. COSTS
ALT A	3	3	3	3	3	3	3		
ALT B	1	1	2	1	1	1	1		
ALT C	2	2	1	2	2	2	2		

TABLE 15

(8)

REGIONAL SUMMARY

MAINTENANCE COSTS

C. 10% (FIGURE 15)

ALTERNATE	(A)	(B)	(C)
COST RATING			
HIGHEST			$ 18,000,000
MEDIUM		$ 17,300,000	
LOWEST	$ 14,500,000		

ALTERNATE	(A)	(B)	(C)
6%	$ 21,200,000	$ 25,300,000	$ 26,200,000
8%	$ 17,400,000	$ 20,700,000	$ 21,500,000
10%	$ 14,500,000	$ 17,300,000	$ 18,000,000
	$ 53,100,000	$ 63,300,000	$ 65,700,000
$\bar{X}$ =	$ 17,700,000	$ 21,100,000	$ 21,900,000

	(C)	$ 21,900,000
-	(B)	$ 21,100,000
		$ 800,000

Alternate A wins the race for maintenance costs. This is understandable since either new alternate provides additional miles of highway to maintain along with the existing facilities of the do-nothing (Alt. A) The real question then is which construction alternate requires the least amount of maintenance expenditure. The answer is alternate B.

A difference of $ 800,000 separates the two and would not be considered a minimal difference.

Mixed emotions would accompany reasoning on the maintenance question. The construction of the highway would cost the taxpayers additional money in terms of maintenance but it would save them

millions of additional dollars in terms of the other costs. This situation demonstrates where decisions must be given to the people affected, in this case both the Highway Department and the tax-paying public. It appears from analysis to this point, however, that the people involved could not afford not building the highway.

Our summary chart now looks like this.

	WTC TO CBD	FARM TO MKT.	LABOR TO MANUF.	POP. TO SHOP	USER OPER. COSTS	TRUCK COSTS	ACC. COSTS	MAINT. COSTS	CAP. EXP. COSTS
ALT A	3	3	3	3	3	3	3	1	
ALT B	1	1	2	1	1	1	1	2	
ALT C	2	2	1	2	2	2	2	3	

TABLE 16

As can be seen from the comparisons the construction cost remains the same for each percentage because the initial cost would be the same regardless of the going financial rate - this would not be true if the money were borrowed to finance construction but normally it is not. Understandably alternate A has no capital expenditure costs since it has already been built and paid for. Only the other two (B & C) would require initial capital expenditure.

(To avoid the now apparent mathematical process of computing dollars returned for dollars invested one need simply to review the cost-benefit ratios for each alternate which appear in Figures (16) and (21).)

As exemplified in Figure (16) the incremental approach as previously explained shows that alternate B has a cost-benefit ratio of $ 1.67 to $1 at the 10% rate of capital growth. This says that for every dollar invested at the base year in the construction of alternate 1 (B) $ 1.67 is returned in savings. This would be realized over the given 30 year period for the entire state.

(9)

REGIONAL SUMMARY

CAPITAL EXPENDITURE COSTS

The following figures were computed at the 10% rate of interest to reflect the minimal amount of return received relative to the value of money 30 years from now. (Actual return could be higher depending on the rate).

ALTERNATE	(A)	(B)	(C)
COST RATING			
HIGHEST		$ 115,000,000	
MEDIUM			$ 90,700,000
LOWEST	$ 0.00		
COST-BENEFIT RATIOS @ 10%		$ 1.67	$ 1.54
		$ 115,000,000	$ 90,700,000
GROSS BENEFITS RETURNED		X 1.67	X 1.54
AFTER 30 YEARS		$192,05,000.00	$139,678,000.00

(B) $192,050,000.00
(C) 139,678,000.00
$ 52,372,000.00 DIFFERENCE IN RETURN

(B)	$115,000,000,00	
(C)	90,700,000,00	
	$ 24,300,000,00	DIFFERENCE IN COST
	$ 52,372,000,00	
	24,300,000,00	
	$ 18,072,000,00	GROSS DIFFERENCE IN RETURN FROM INVESTING IN ALT B VS ALT C

Alternate B then offers a $18 million dollar advantage over alternate C when all costs and returns are computed.

$192,050,000,00	GROSS BENEFIT
115,000,000,00	GROSS COST
$ 77,050,000,00	RETURN ON INVESTMENT

The people in the ten county region then would realize savings to them of over 77 million dollars within the prescribed 30 year period. Alternate A wins, so to speak, the race for the lowest capital costs, but alternate B returns its original cost plus 77 million or approximately 18 million more that the return realized from the construction of alternate C.

The people of the region would conclusively reap greater benefits from the construction of a new route than from a no-build plan.

	WTC TO CBD	FARM TO MKT.	LABOR TO MANUF.	POP. TO SHOP	USER OPER. COSTS	TRUCK COSTS	ACCIDENT COSTS	MAINT COSTS	CAP. EXP. COSTS
ALT A	3	3	3	3	3	3	3	1	1
ALT B	1	1	2	1	1	1	1	2	3
ALT C	2	2	1	2	2	2	2	3	2

TABLE 17

STATEWIDE SUMMARY

CAPITAL EXPENDITURE COSTS

Note: The following capital cost figures differ markedly from those of the regional analysis since other common highway improvements are included in the figures. The regional analysis provides a better summary for the US-31, US-131 improvement but it must be realized that the figures described here include the effects of those improvements along with other highway modifications and additions. These additional improvements are referred to as a committed network or one that will probably exist in conjunction with the specified US-31, US-131 project. The results of that impact in terms of capital costs and returns are as follows. (As mentioned previously, the 10% rate was used as a basis of comparison. This shows really the lowest amount of return to be expected from the improvements and is used to prevent a criticism associated with the presentation of a "too optimistic" viewpoint.)

The illustrated differences in returns etc. would still reflect the impact of the differences in the regional alternates since all other considerations were held constant. The monetary effect in this section merely reflects the impact on the entire state. The total US-31-US-131 project extended beyond the ten county region and this is reflected in the cost differential.

A. 6%, 8%, 10% (FIGURES 18, 19, 20) (THIS EXAMPLE: 10%)

ALTERNATE	(A)	(B)	(C)
COST RATING			
HIGHEST		$ 1,030,000,000	
MEDIUM			$ 986,000,000
LOWEST	$ 0.00		
COST-BENEFIT RATIOS		2.65	2.53
GROSS BENEFITS RETURNED AFTER 30 YEARS		$ 1,030,000,000 X 2.65 $ 2,729,500,000	$ 986,000,000 X 2,53 $2,494,580,000

$ 2,729,500,000
- 2,494,580,000
$ 234,920,000 DIFFERENCE IN RETURN

$ 1,030,000,000
- 986,000,000
44,000,000 DIFFERENCE IN COST

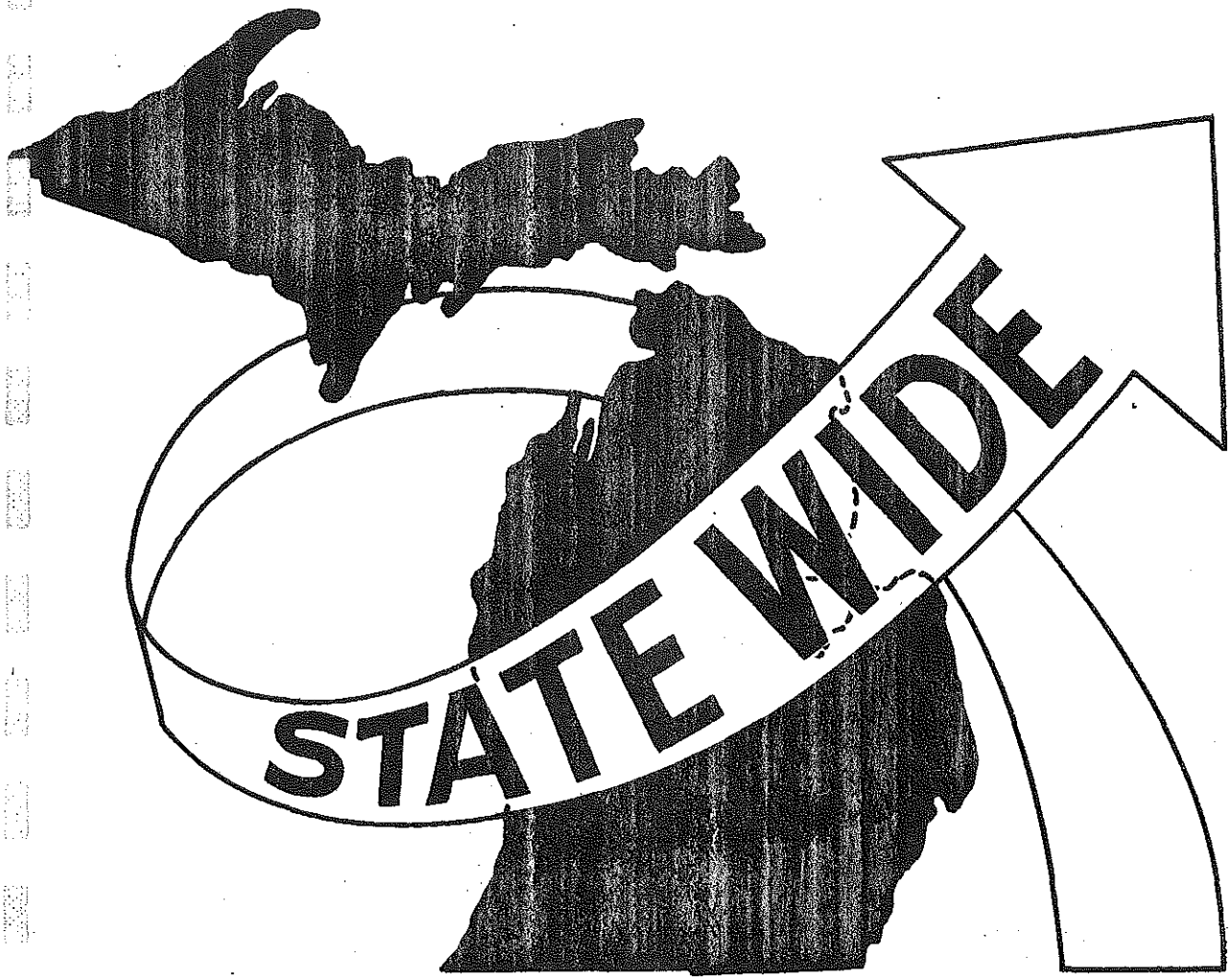
$ 234,920,000
- 44,000,000
$ 190,920,000 GROSS DIFFERENCE IN RETURN FROM INVESTING IN ALT B VS ALT C.

Alternate B then offers a 190 million dollar advantage over Alternate C when all costs and returns are computed.

$ 2,729,500,000 GROSS BENEFIT
- 1,030,000,000 GROSS COST
$ 1,699,500,000 RETURN ON INVESTMENT (SAVINGS)

The amount of savings realized through the construction of these routes are certainly astronomical over a thirty year period. The initial investment is almost doubled and definitely points out the advisably of undertaking such a project. A savings of over 1.6 billion dollars would be spread over all citizens of Michigan plus those people who wish to visit Michigan. Alternate B as opposed to C provides 190 million dollars worth of additional benefits. The conclusions are self evident.

CONCLUSION



CONCLUSION

The preceeding analysis section presents a majority of the conclusions that are to be reached regarding the impact of proximity and cost-benefit application. The clarity of the differences between alternates becomes more evident as the figures speak for themselves.

In brief review, the application of these two techniques add immensely to the points of perspective needed in the highway decision-making process. Specific figures add more to the reasoning process than vocally aired opinions. This adds body to the contention that the statewide model and its integral analysis tools offer distinct advantages over the subjective techniques of the past. When the user asks now what costs or savings are involved with different alternates, it is possible to tell him. As in the case of the regional summary, people can be told that construction of the new highway will not only pay for itself but return a healthy dividend in the next 30 years. This type of output should aid all parties in coming to justified conclusions not only in terms of should we build but in specific dollars and cents figures of which one should be built.

In closing, this report only concerned itself with 3 alternates. The computer program runs and subsequent analysis took time to prepare but when returns on investments from alternates differ by millions of dollars the effort involved and the cost incurred seem well worth the expense. We feel others will agree, and we hope this report can pave the way for future efforts in this area. That, simply stated, was its primary purpose. The Statewide Studies team opens its doors to interested persons through the presentation of this document.

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