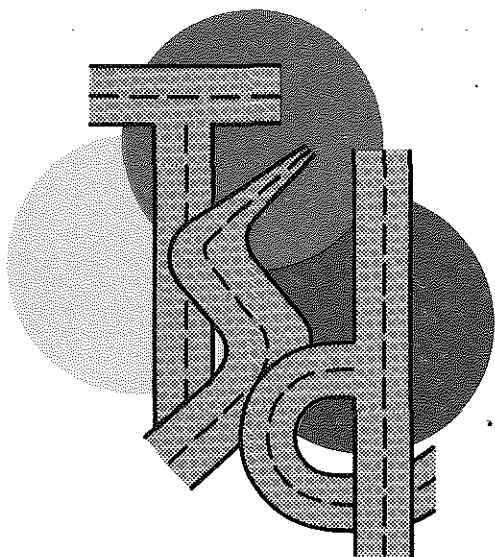


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A TRAFFIC ACCIDENT ANALYSIS
OF HIGH ACCIDENT LOCATIONS
IN BENZIE COUNTY

Report TSD-SS-153-71



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OSCAR E. VARGAS

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April, 1971

PREPARED BY THE
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in cooperation with
The Michigan Office of Highway Safety Planning
and the U. S. Department of Transportation
National Highway Traffic Safety Administration

"The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration."

ACKNOWLEDGMENTS

Michigan Department of State Police

Captain Amthor
Sgt. Hathaway
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Benzie County Road Commission

James R. Thompson - County Engineer

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NHTSA PROJECT #IS-69-3-002

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	ii
LIST OF FIGURES	v
LIST OF MAPS	vii
INTRODUCTION	1
Scope	2
Study Procedures	3
Study Area	4
GLOSSARY	10
TRAFFIC ENGINEERING ANALYSIS	11
SUMMARY AND CONCLUSIONS	62
APPENDIX - I List of Tables and Charts	64
CHART 1 Benzie County Population and State of Michigan Population, 1940 - 2000	65
TABLE 1 Reported Traffic Accidents in Benzie County	66
2 Annual Accident Summary	67
3 Monthly and Daily Accident Occurrence	68
4 Daily and Hourly Accident Occurrence	69
5 Age of Drivers Involved in Accidents	70
6 Residence of Drivers Involved in Accidents	70
7 Weather Conditions at Scene of Accidents	71
8 Pavement Conditions at Scene of Accidents	71

Table of Contents Continued

Page

APPENDIX - II Excerpts from Sections B and C,
Michigan Manual of Uniform
Traffic Control Devices

72

LIST OF FIGURES

FIGURE		Page
1	Collision Diagram - Case Road and Homestead Road	16
1A	Photo - Northbound Case Road	17
1B	Photo - Southbound Case Road	18
1C	Photo - Eastbound and Westbound Homestead Road	19
2	Collision Diagram - Indian Hill Road, 0.5 Miles North of Ryan Road	21
2A	Photo - Northbound Indian Hill Road, Location 2	22
2B	Photo - Southbound Indian Hill Road, Location 2	23
3	Collision Diagram - Indian Hill Road, 0.5 Miles South of Hooker Road	26
3A	Photo - Southbound Indian Hill Road, Location 3	27
3B	Photo - Northbound Indian Hill Road, Location 3	28
4	Collision Diagram - Crystal Drive and Eden Hill Road	31
4A	Photo - Northbound Crystal Road and Eden Hill Road	32
4B	Photo - Southbound Crystal Road and Eden Hill Road	33
5	Collision Diagram - River Road and Adams Road	36
5A	Photo - Eastbound River Road	37
5B	Photo - Westbound River Road and Adams Road	38
6	Collision Diagram - Narrow Gauge Road and Moss Road	41
6A	Photo - Eastbound Narrow Gauge Road	42
6B	Photo - Westbound Narrow Gauge Road and Moss Road	43
6C	Photo - Narrow Gauge Road Near Marshall Road	44

List of Figures Continued

FIGURE		Page
7	Collision Diagram - Lake Michigan Road	46
7A	Photo - Lake Michigan Road	47
8	Collision Diagram - River Road	50
8A	Photo - Westbound River Road	51
8B	Photo - Eastbound River Road	52
9	Collision Diagram - County Road #669 (Thompsonville Road)	54
9A	Photo - Thompsonville Road (County Road #669)	55
10	Collision Diagram - Almira Road and Reynolds Road	58
10A	Photo - Southbound Reynolds Road	59
10B	Photo - Southbound Reynolds Road and Westbound Almira Road	60
10C	Photo - Eastbound Almira Road	61

LIST OF MAPS

		Page
MAP		
1	Benzie County in Relation to the State of Michigan	5
2	Benzie County Road System	8
3	Spot Map of High Accident Locations	13

INTRODUCTION

The Highway Safety Act of 1966 was enacted by the Congress of the United States in order to promote highway safety programs. Subsequently, various highway safety standards were developed to assure the orderly implementation of the Act.

Highway Safety Standard 4.4.9, Identification and Surveillance of Accident Locations, is one of those standards. The purpose of Standard 4.4.9 is to identify specific locations or sections of streets and highways which have high or potentially high accident experience as a basis for establishing priorities for improvement, selective enforcement or other operational practices that will eliminate or reduce accidents and potential hazards at the location so identified.

The State of Michigan carries out a program of this type on the State trunkline system; however, many of the State's city and county agencies lack the financial and technical prerequisites necessary to pursue similar programs with similarly defined objectives. To insure that this highway safety standard is met and to improve the overall evaluation of the accident picture in Michigan, the Michigan Department of State Highways requested and received through the Office of Highway Safety Planning in the Department of State Police a federally funded project

entitled "Traffic Accident Analysis for Cities and Counties". The intent of this new project is to provide a special traffic engineering field service for cities and counties. In cooperation with participating cities and counties, the proposed service under the direction of Department personnel will make a traffic engineering evaluation of the factors causing traffic accidents and will recommend engineering corrections to those conditions which may be contributing to accidents.

SCOPE

As highway engineers, we have very little influence on changing or correcting the motorist's ability to drive (driver education, experience and enforcement) or for the condition of the vehicle (manufacturer's design and owner responsibility). We do have, however, the responsibility to construct, operate and maintain the roadway environment within feasible economic and design limits so that the driver and vehicle can function safely within the environment.

The intent of the "Traffic Accident Analysis for Cities and Counties" program is to improve traffic safety on all Michigan streets and roads by expanding the traffic engineering evaluation of factors causing accidents. This is accomplished by conducting a traffic accident analysis of locations which

experience high accident frequencies and then summarizing recommendations for corrective action.

STUDY PROCEDURES

The study procedures for the subject project involve several distinct phases. They may be described as follows: basic data collection, identifying and locating high accident locations, a traffic engineering analysis of accidents, technical evaluation of previously compiled facts and consequent recommendations for improvements.

Since a portion of the data collection phase involves accident records and reports and since the Michigan Department of State Police is responsible for keeping all accident records in Michigan, the task of identifying and locating high accident locations in Benzie County (and providing an inventory of those locations) was designated as State Police responsibility. Because a modern and automatic system of locating accidents on the county road system has not yet been established, the high accident locations for Benzie County were determined by manually extracting and compiling those locations with the highest number of accidents from the county accident reports for the study period 1966 through 1969. From this list, the ten highest accident locations were selected. Upon completion of this portion of the data

collection, the Department of State Police documented and transmitted to the Traffic and Safety Division of the Department of State Highways a list, along with the accident reports, of the high accident locations for Benzie County.

The second portion of the data collection phase which is the responsibility of the Department of State Highways involves preparation of collision diagrams and, if necessary, physical condition diagrams and traffic counts for selected locations.

The accident analysis and traffic engineering evaluation phases involve the detailed analysis of the summarized facts and field data and prescribing the proper corrective treatment.

STUDY AREA

Benzie County is located in the northwestern portion of the Lower Peninsula (see map following page). Benzie County is divided into 12 townships with an inland lake area of 26 square miles and a total area of 316 square miles. It is bordered on the north by Leelanau County, on the east by Grand Traverse County, on the south by Manistee County and on the west by Lake Michigan.

Population of the county in 1960 was 7,834. This figure

is lower than the 1950 population of 8,306. During the 1950-1960 period, there was a negative net migration of 5.7 percent, and the net migration is expected to remain at a level very close to the natural population increase.

Population projections indicate a very stable population level for the next 20 years (see Chart 1, Appendix I, p. 65 for a comparison with Michigan Population Projections).

The county is primarily agriculturally oriented with 23 percent of its land area dedicated to agriculture. It is well known for its orchards of cherries, peaches and apples which have an annual yield of nearly ten million pounds. Other important farm products include celery, onions and countless vegetables.

Benzie County is very famous as a vacation area. Tourism is one of the major businesses of the county. The county has various ski resorts and many miles of rivers and lake shoreline (including 24.8 miles of Lake Michigan shoreline). Fishing is one of the major attractions with coho salmon being one of the sought species. Rainbow trout, smelt, perch and whitefish are among the species that make Benzie County a fisherman's paradise.

It is worthwhile to mention the City of Frankfort which is one of the State's major harbors handling over 1.5 million tons of freight a year. It is also the base for the Ann Arbor

Railroad car ferries between Michigan's Lower Peninsula and ports in the Upper Peninsula and Wisconsin.

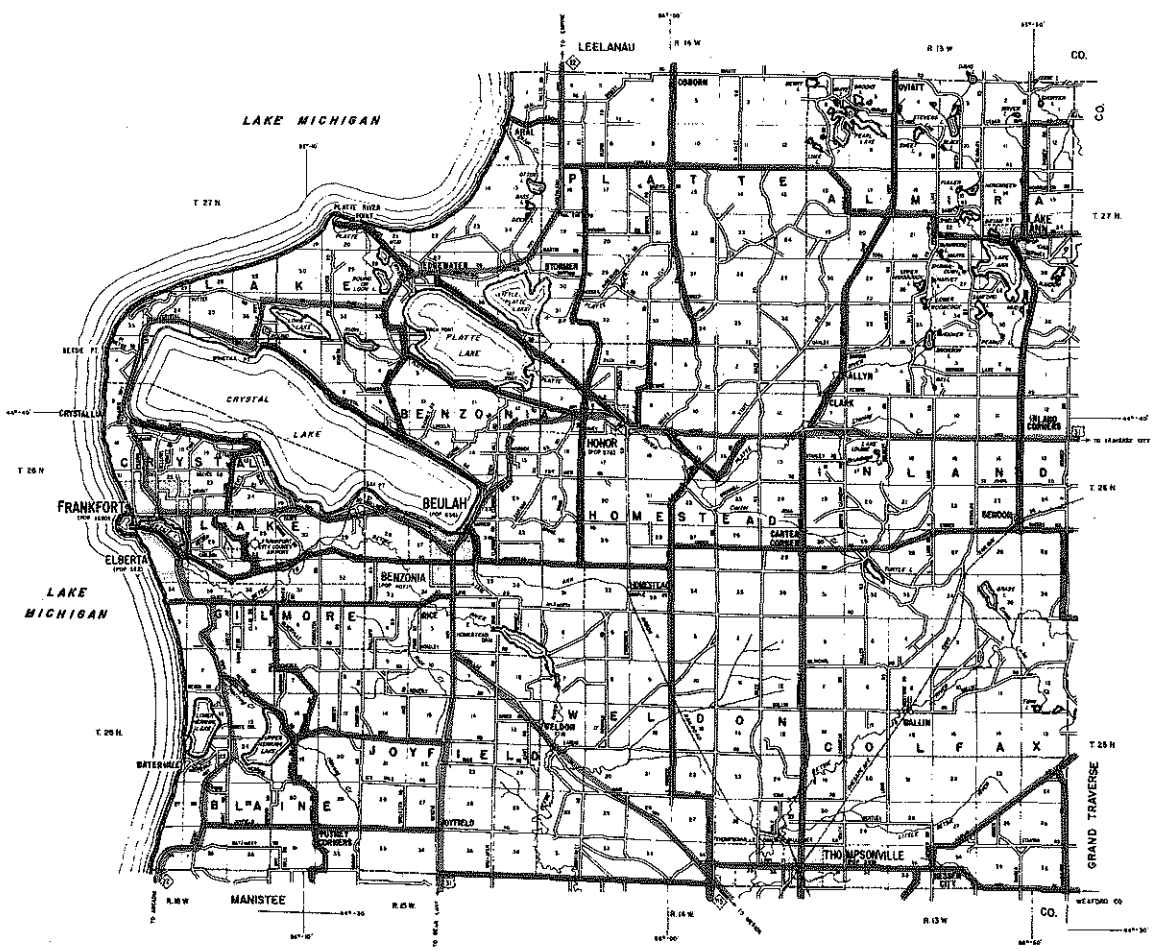
The employed labor force of Benzie County was 2,547 in 1960 with small manufacturing, trade, agriculture, forestry and fisheries accounting for 48 percent of the total employment. The labor force (as well as the population) is expected to remain at a stable level for the next decade.

According to the Nineteenth Annual Progress Report, as compiled by the Local Government Division of the Michigan Department of State Highways, Benzie County has 661.03 miles of highways excluding city and incorporated village streets and roads. This includes 61.21 miles of state trunklines, 170.17 miles of county primary roads and 429.65 miles of local roads.

Of the 599.82 miles of county roads, 197.05 miles are hard surfaced and the remaining mileage is either gravel, graded and drained earth or unimproved earth (see county map following page).

Traffic congestion is not a significant problem in Benzie County. An implied indication of this fact is that the population density is 25 persons per square mile in Benzie County versus 137.2 persons per square mile in the State of Michigan (1960 census).

The yearly totals of traffic accidents have remained fairly constant during the study period 1966 through 1969.



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- STATE TRUNKLINE**
- COUNTY PRIMARY**
- COUNTY LOCAL**

MAP 2

BENZIE COUNTY
 MICHIGAN
 STATE HIGHWAY COMMISSION
 DEPARTMENT OF STATE HIGHWAYS
 DATA OBTAINED FROM
HIGHWAY PLANNING SURVEY
 CONDUCTED IN COOPERATION WITH
 U.S. DEPARTMENT OF TRANSPORTATION
 FEDERAL HIGHWAY ADMINISTRATION
 BUREAU OF PUBLIC ROADS
 SCALE 1:50,000
 FEET TO INCHES
 1" = 4.1667 MILES

This is also the case with fatal and injury accidents for the same years (see Table 2, Appendix I, p. 67).

GLOSSARY

The term "Manual" when used in this report will refer to the "Michigan Manual of Uniform Traffic Control Devices"; publication prepared by the Michigan Department of State Highways in conjunction with the Michigan State Police.

Excerpts of the Manual are included in Appendix II.

TRAFFIC ENGINEERING ANALYSIS

Compared to the millions of vehicle miles traveled, accidents are very rare events. However, they are the only present means available to indicate a failure in the driver-road-vehicle environment. Any of these three may be a major contributor to an accident.

In our analysis, we examined the contributing factors from the viewpoint of a highway traffic engineer with special attention to the effect which the highway environment may have had on the accident. At each high accident location, individual accident reports were reviewed in detail and the accident facts were tabulated and grouped in various tables. It was apparent that no unusually high concentration of accidents existed at any one location. In fact, the highest total at any one location for the four-year study period was seven accidents.

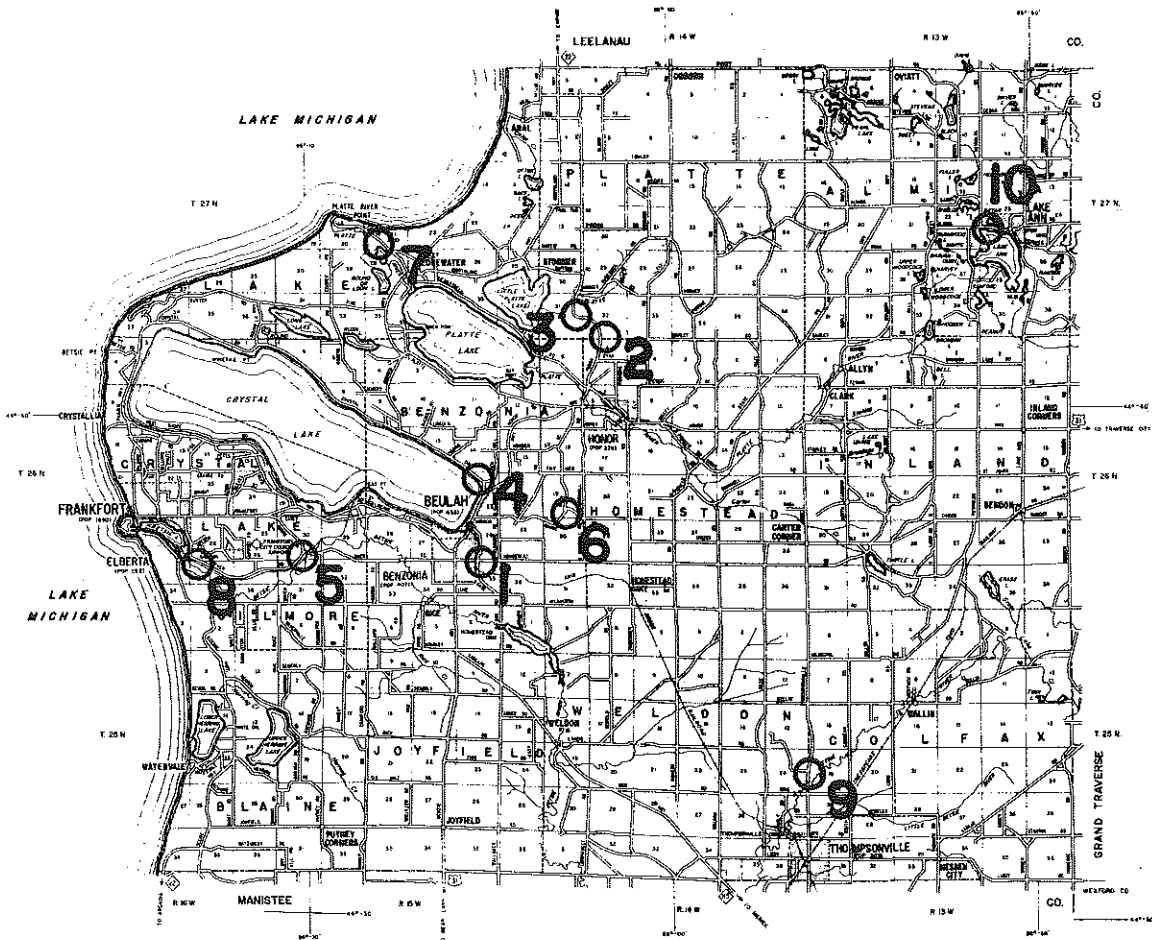
The first step in the traffic engineering analysis phase of Benzie County's high accident locations was the preparation of collision diagrams. At each location, accidents were grouped in order to locate the accident in relation to the intersection, approaches to the intersection or section of roadway. The various methods of accident analysis are intended to probe into the detailed aspects of the accidents to determine the reasons for their occurrence.

To further document the various facts present at the

ten high accident locations in Benzie County, the following tables were prepared to analyze the specific data.

2. Annual Accident Summary
3. Monthly and Daily Accident Occurrence
4. Daily and Hourly Accident Occurrence
5. Age of Drivers Involved in Accidents
6. Residence of Drivers Involved in Accidents
7. Weather Conditions at Scene of Accidents
8. Pavement Conditions at Scene of Accidents

This report will discuss in detail the high accident locations in Benzie County. Collision diagrams and photographs for each location will be found on the pages following the discussion. A map showing the ten locations within the county is included on the following page.

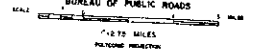


HIGH ACCIDENT LOCATIONS

SPOT MAP

BENZIE COUNTY

MICHIGAN
 STATE HIGHWAY COMMISSION
 DEPARTMENT OF STATE HIGHWAYS
 DATA OBTAINED FROM
HIGHWAY PLANNING SURVEY
 CONDUCTED IN COOPERATION WITH
 U.S. DEPARTMENT OF TRANSPORTATION
 FEDERAL HIGHWAY ADMINISTRATION
 BUREAU OF PUBLIC ROADS



1. Homestead Road @ Case Road, Benzonia Township

This location is a right angle intersection with Homestead Road having the right of way. Homestead Road in this area has a plus gradient in both directions away from the intersection. West of the intersection Homestead Road has a 20 ft wide bituminous surface with five foot shoulders. East of the intersection it has a 29 ft bituminous surface. Case Road is a 21 ft bituminous surface with five to seven foot grass or gravel shoulders and centerline markings.

Traffic controls for Homestead Road consist of a 36 in. railroad advance warning sign for westbound traffic (east of the junction), a 24 in. railroad advance crossing sign for eastbound traffic and a railroad crossing sign (crossbuck) for each direction of traffic (no flashing beacons at the crossing).

Traffic control for Case Road is a 36 in. stop sign for each direction of traffic. There are also railroad crossing signs on Case Road south of the intersection. The intersection has guardrail in the northeast and southeast quadrants where deep ditches exist.

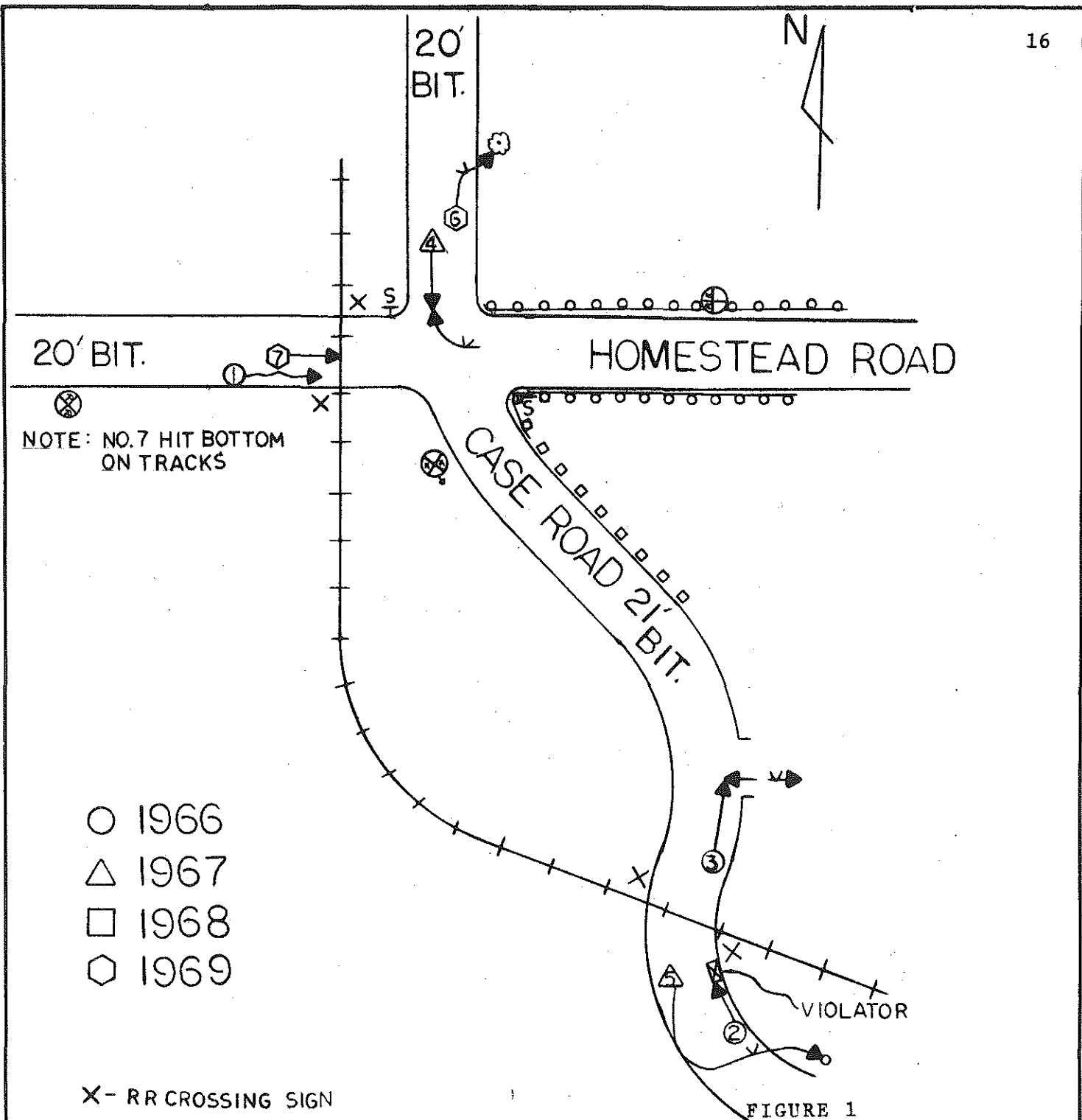
There was a total of seven accidents at this location during the study period. They were scattered and did not reveal a concentrated pattern.

Recommendation:

We recommend that the existing 24 in. railroad advance

warning sign for eastbound Homestead Road traffic be replaced by a new W10-1-36 advance warning sign (Appendix II, p. 85).

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LEGEND		MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION	
Stop & Go Signal	Stop Sign	Location # 1 HOMESTEAD ROAD AT CASE ROAD BENZONIA TWP. SECS. 26 35 BENZIE CO.	
Flashing Beacon	Yield Sign		
Fatal	Pedestrian	Period: 1966 THRU 1969	
Injury	Tree	Accidents - Total <u>7</u> P.D. <u>6</u>	
Skidding	Out of Control	Injury <u>1</u> (1) Fatal <u>0</u> ()	
Jackknife	Driver Intent	C.S. _____ Miles _____ Drawn <u>DJM</u>	
Overturned	Door	Plan No. _____ Date <u>2-12-71</u>	
Backing	Violator		



NORTHBOUND CASE ROAD
APPROACHING THE INTERSECTION



NORTHBOUND CASE ROAD
APPROACHING THE INTERSECTION



NORTHBOUND CASE ROAD
AT THE INTERSECTION

FIGURE 1A



SOUTHBOUND CASE ROAD
APPROACHING THE INTERSECTION

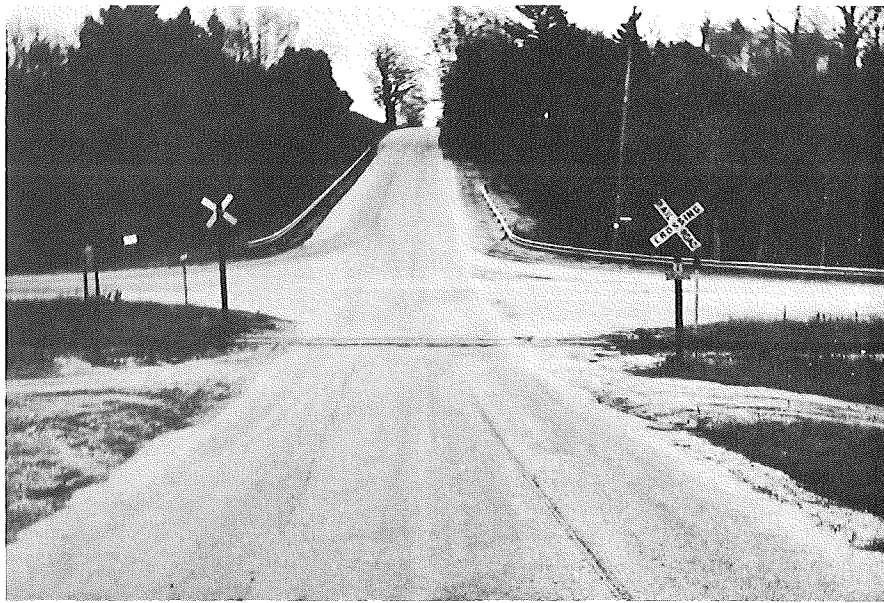


SOUTHBOUND CASE ROAD
AT THE INTERSECTION



EASTBOUND HOLMESTEAD ROAD
APPROACHING THE INTERSECTION

FIGURE 1B



EASTBOUND HOMESTEAD ROAD
AT THE INTERSECTION



WESTBOUND HOMESTEAD ROAD
APPROACHING THE INTERSECTION



WESTBOUND HOMESTEAD ROAD
AT THE INTERSECTION

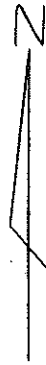
2. Indian Hill Road, 0.5 Miles North of Ryan Road, Platte and Homestead Townships

Indian Hill Road has a 21 ft wide bituminous surface throughout this location with seven foot shoulders and center-line markings. It is characterized by gentle changes in horizontal alignment. There were six accidents at this location during the study period. Five of the accidents were car-deer accidents and the remaining accident was caused by excessive speed (see Figures 2 and 2A, pps. 21-22). No accident was attributed to the existing horizontal alignment.

Recommendation:

We suggest that consideration be given to the erection of warning signs for deer crossing area (W12-8-36, Appendix II, p. 88) at this location for northbound and southbound traffic. As required by the Manual, a joint investigation must be made by representatives of the Michigan Department of Natural Resources and the agency having jurisdiction over the highway before this sign is installed.

INDIAN HILL ROAD
21' BIT.



- 1966
- △ 1967
- 1968
- ◇ 1969

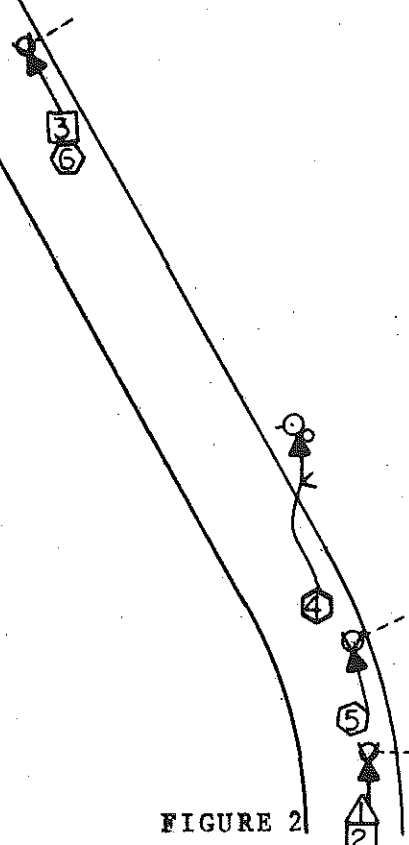
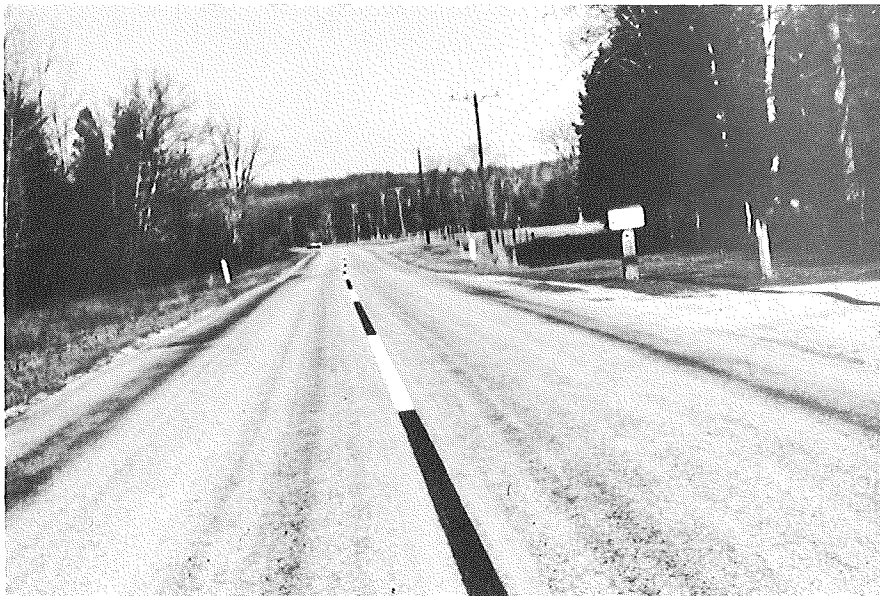


FIGURE 2

LEGEND		MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION	
Stop & Go Signal Flashing Beacon	Stop Sign Yield Sign	Location #2 INDIAN HILL ROAD 0.5 MI. NORTH OF RYAN ROAD PLATTE AND HOMESTEAD TWPS. BENZIE CO.	
Fatal Injury Skidding Jackknife Overturned Backing	Pedestrian Tree Out of Control Driver Intent Deer Violator	Period: <u>1966 THRU 1969</u> Accidents - Total <u>6</u> P.D. <u>5</u> Injury <u>1</u> (1) Fatal <u>0</u> () C.S. _____ Miles _____ Drawn <u>DJM</u> Plan No. _____ Date <u>2-12-71</u>	



NORTHBOUND INDIAN HILL ROAD
AT THE FIRST CURVE



NORTHBOUND INDIAN HILL ROAD
APPROACHING SECOND CURVE



SOUTHBOUND INDIAN HILL ROAD
APPROACHING THE CURVE



SOUTHBOUND INDIAN HILL ROAD
AT THE CURVE

3. Indian Hill Road, 0.5 Miles South of Hooker Road, Platte Township

This section of Indian Hill Road is gently rolling and on a curve. The roadway is a 21 ft bituminous surface with five to seven foot grass shoulders and centerline markings.

Traffic control for this section of Indian Hill Road is a 30 in. turn sign for each direction of traffic. There were four accidents reported at this location during the study period. All of these accidents were of the ran-off roadway type.

Recommendations:

We recommend that the existing turn signs (W1-1-30, Appendix II, p. 79) be supplemented with a 30 mph advisory speed panel for both northbound and southbound traffic. The appropriate advisory speed panel legend was determined by using a devil level indicator and the theory outlined in Appendix II, pps. 86-87.

The following averages were obtained during field investigation.

	MPH	Devil Level Reading
	30	8°
Northbound Traffic	35	12°
	40	15°

	MPH	Devil Level Reading
	30	5°
Southbound Traffic	35	8°
	40	11°

We also recommend the erection of a target arrow sign (W1-6-48, Appendix II, p. 84) for each direction of traffic. They shall be erected in target position.

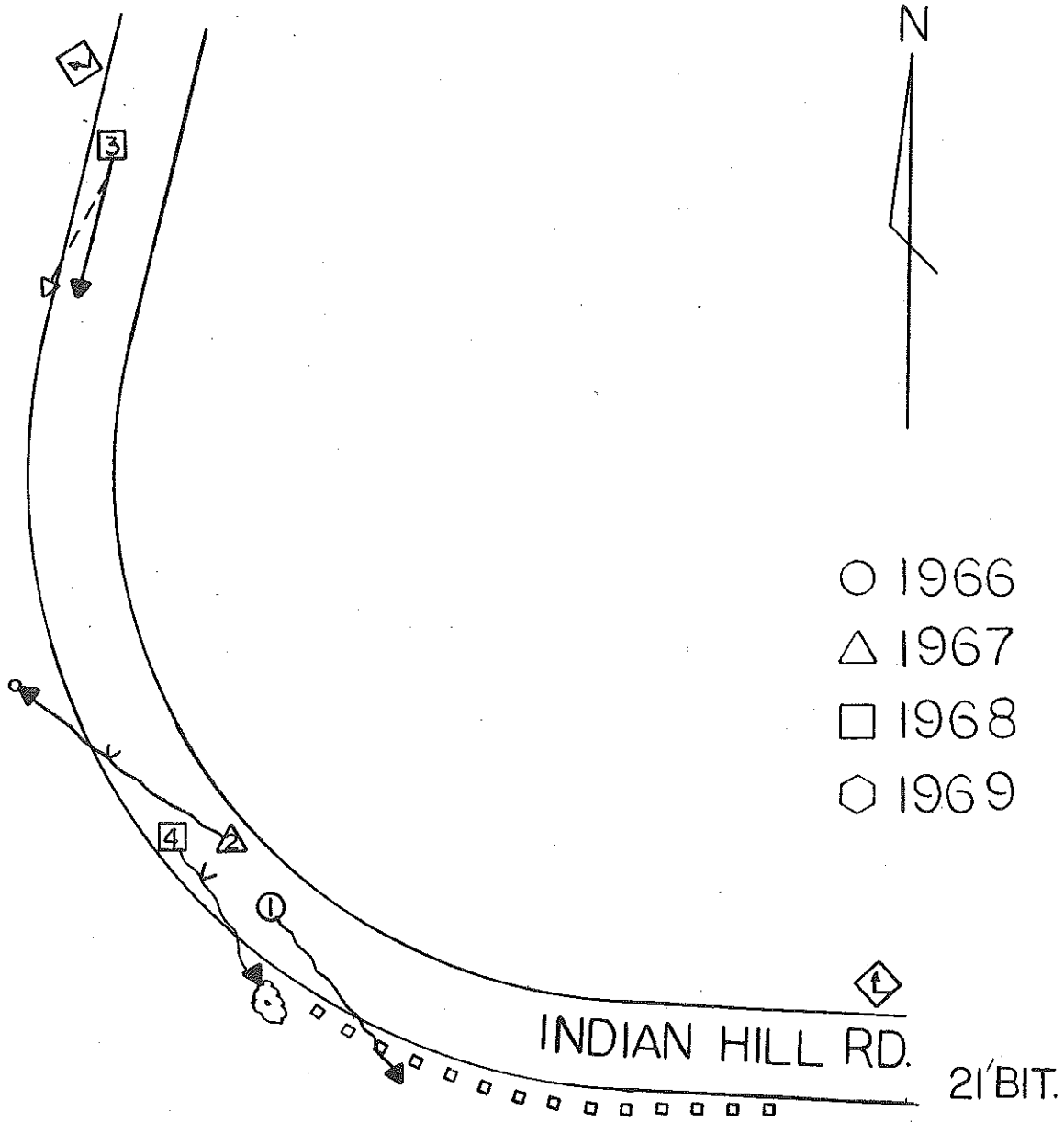


















FIGURE 3

LEGEND		MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION	
Stop & Go Signal  Flashing Beacon 	Stop Sign  Yield Sign 	Location #3 INDIAN HILL ROAD 0.5 MI. SOUTH OF HOOKER ROAD PLATTE TWP. SEC. 31 BENZIE CO.	
Fatal  Injury  Skidding  Jackknife  Overturned  Backing 	Pedestrian  Tree  Out of Control  Driver Intent  Door Violator  Violator 	Period: <u>1966</u> THRU <u>1969</u> Accidents - Total <u>4</u> P.D. <u>2</u> Injury <u>2 (3)</u> Fatal <u>0 ()</u> C.S. _____ Miles _____ Drawn <u>D.J.M.</u> Plan No. _____ Date <u>2-11-71</u>	



SOUTHBOUND INDIAN HILL ROAD
APPROACHING THE CURVE



SOUTHBOUND INDIAN HILL ROAD
AT THE CURVE

FIGURE 3A



NORTHBOUND INDIAN HILL ROAD
APPROACHING THE CURVE



NORTHBOUND INDIAN HILL ROAD
AT THE CURVE

FIGURE 3B

4. Crystal Drive @ Eden Hill Road, Benzonia Township

These two roads form a "T" intersection. Eden Hill intersects Crystal Drive on a curve with Eden Hill forming the stem of the "T". Crystal Drive curves west for north-bound traffic in the vicinity of the intersection and a short distance ahead curves to the north and proceeds in a northwesterly direction. Eden Hill is a 20 ft bituminous roadway with centerline markings but no shoulders. Crystal Drive is a 21 ft wide bituminous road with three to twelve foot gravel shoulders and centerline markings.

The traffic controls present are a 24 in. stop sign for Eden Hill Road and a 30 in. reverse turn sign for each direction of traffic on Crystal Drive. There is a 35 mph speed control zone on Crystal Drive throughout the location and the Traffic Control Order is on record at the Michigan Department of State Police.

There were four accidents at this location during the study period. Three of the accidents were reportedly caused by excessive speed. These three accidents were ran-off roadway type accidents.

Recommendations:

We recommend that target arrows (W1-6-48, Appendix II, p. 84) be erected for each direction of traffic on Crystal Drive. The recommended target arrows should be erected in

target position at each curve (two for northwestbound traffic and two for southwestbound traffic).

We also recommend that the existing reverse turn signs (W1-3-30, Appendix II, p. 81) be supplemented with 25 mph advisory speed panels. The appropriate speed panel legend was determined by using a devil level indicator and the theory outlined in Appendix II, pps. 86 - 87.

The following averages were obtained during field investigation.

	MPH	Devil Level Readings	
		1st Curve	2nd Curve
Northwestbound Traffic	30	18°	13°
	25	8°	7°
Southeastbound Traffic	30	13°	20°
	25	5°	10°

The first curve encountered by northwestbound traffic is the same curve as the second encountered by southeastbound traffic but in both cases the appropriate panel legend should be 25 mph.

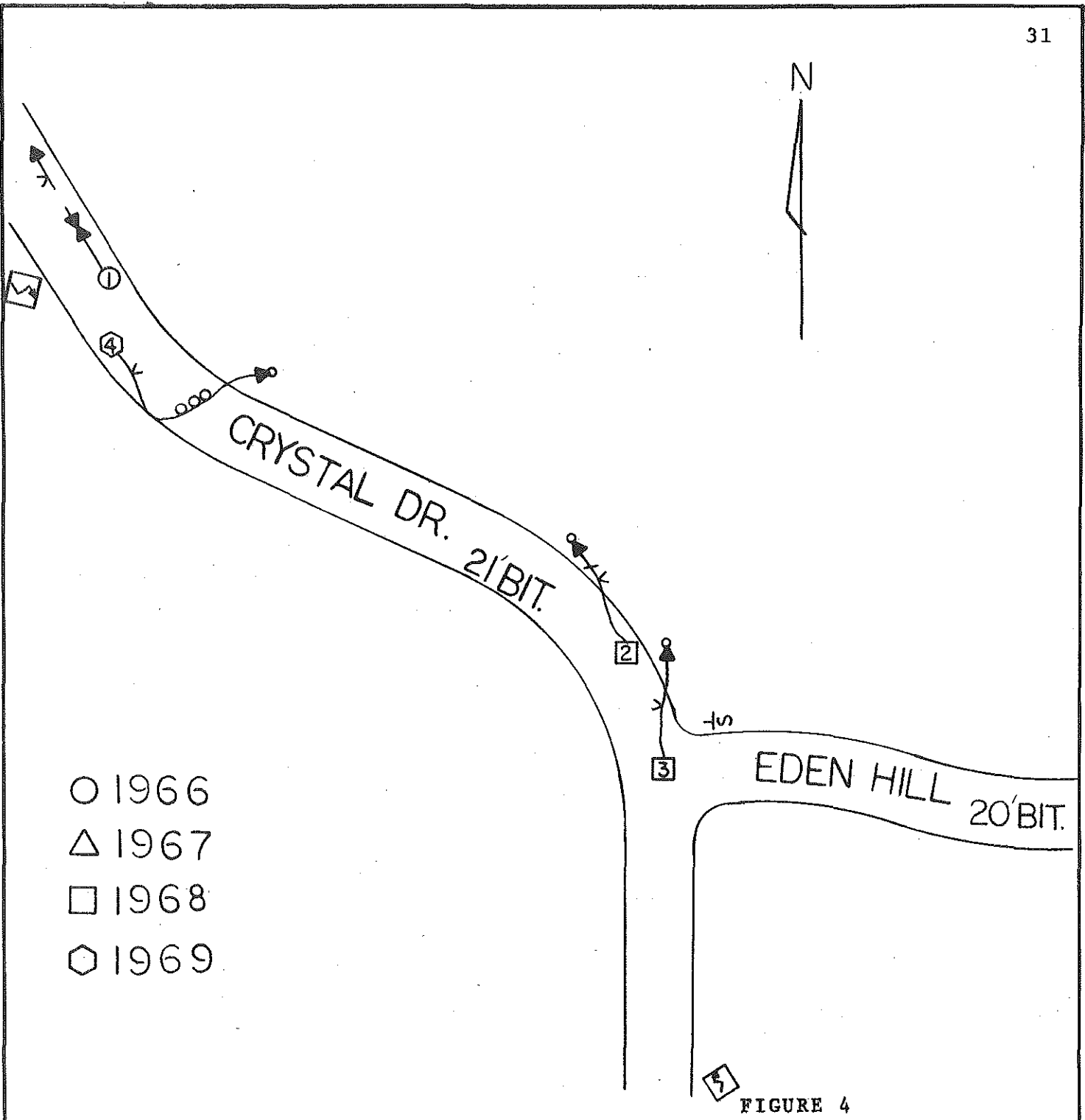


FIGURE 4

LEGEND		MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION	
Stop & Go Signal	Flashing Beacon	Stop Sign	Yield Sign
Fatal	Injury	Skidding	Jackknife
Overturned	Backing	Pedestrian	Tree
Out of Control	Driver Intent	Deer	Violator
Location #4 CRYSTAL DRIVE AT EDEN HILL ROAD BENZONIA TWP. SEC. 23 BENZIE CO.		Period: 1966 THRU 1969 Accidents - Total 4 P.D. 1 Injury 3 (7) Fatal 0 () C.S. _____ Miles _____ Drawn DJM Plan No. _____ Date 2-11-71	



NORTHBOUND CRYSTAL ROAD
APPROACHING THE INTERSECTION



NORTHBOUND CRYSTAL ROAD
AT THE INTERSECTION

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WESTBOUND EDEN HILL ROAD
AT THE INTERSECTION

FIGURE 4A



SOUTHBOUND CRYSTAL ROAD
APPROACHING THE INTERSECTION



SOUTHBOUND CRYSTAL ROAD
APPROACHING THE INTERSECTION



SOUTHBOUND CRYSTAL ROAD
AT THE INTERSECTION

5. River Road @ Adams Road, Crystal Lake Township

At this location River Road runs in an east to west direction and is crossed at grade by the Ann Arbor Railroad immediately east of the subject intersection. River Road in this area is characterized by a sharp reverse turn. This reverse turn is typical of many locations throughout the State where the geometrics of a highway has been designed to cross a railroad at a 90° angle in order to improve sight distance.

The approach to the turns from the west is named River Road and from this approach Adams Road seems as a continuation of River Road. However, the majority of the traffic from the west continues on River Road and has to negotiate the sharp turns.

Adams Road is a 22 ft gravel roadway. The approach to the turns from the west is a 24 ft bituminous roadway with seven to nine foot shoulders and centerline markings. The approach to the turns from the east is a 20 ft wide bituminous roadway with three to five foot grass and gravel shoulders and centerline markings.

Traffic control for Adams Road is a 24 in. stop sign. For River Road there are 30 in. reverse turn signs with 20 mph advisory speed panels, 36 in. railroad advance warning signs and railroad crossing signs for each direction of traffic.

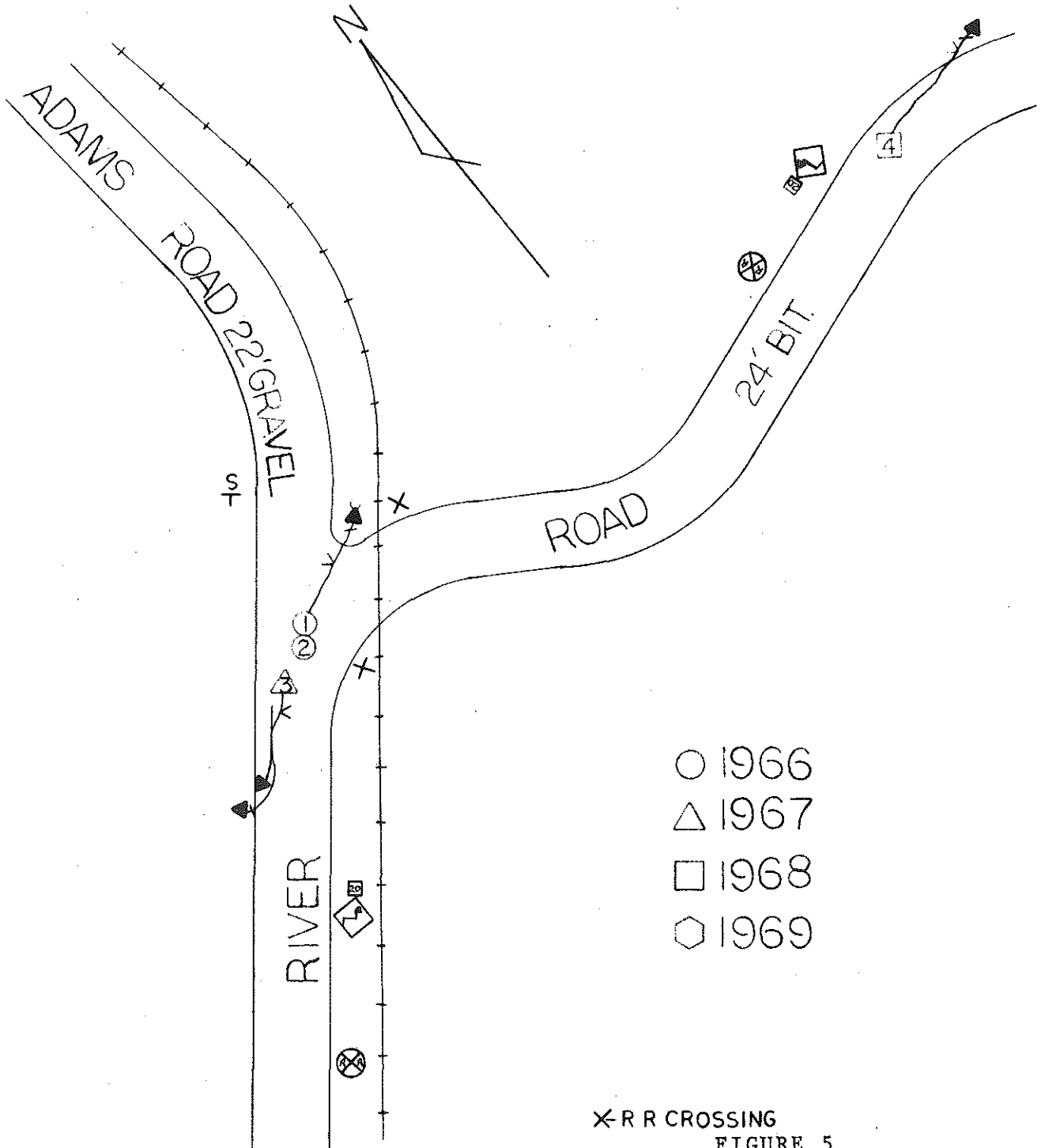
There were four accidents at this location during the years 1966 through 1969. Two of the accidents involved drivers who were unable to negotiate one of the sharp turns (first one encountered by eastbound traffic) and the vehicles rolled over. There is no safe landing area provided at the end of this turn and the two guard posts at this location have been hit several times.

Recommendations:

We recommend that a target arrow (W1-6-48) be erected in target position in the northeast quadrant (if the configuration of the intersection allows) of the subject intersection for northeastbound River Road traffic.

We further recommend that target arrows be placed in target position for both directions of traffic at the first curve east of the intersection.

We also recommend that an additional target arrow be erected in target position at the end of River Road immediately west of the intersection for southwestbound River Road traffic. Additionally, we recommend, if the topography of the area permits and when funds are available, that the reverse turn be straightened.



○ 1966
 △ 1967
 □ 1968
 ⬡ 1969

✕ R R CROSSING
 FIGURE 5

<p>LEGEND</p>	<p>MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION</p>
<p>Stop & Go Signal Stop Sign S Y</p> <p>Flashing Beacon Yield Sign Y Y</p>	<p>Location #5 ADAMS ROAD AT RIVER ROAD CRYSTAL LAKE TWP. SEC. 30+31 BENZIE CO.</p>
<p>Fatal Injury Skidding Jackknife Overturned Backing Pedestrian Tree Out of Control Driver Intent Deer Violator Y</p>	<p>Period: <u>1966 THRU 1969</u></p> <p>Accidents - Total <u>4</u> P.D. <u>2</u></p> <p>Injury <u>2</u> (4) Fatal <u>0</u> ()</p> <p>C.S. _____ Miles _____ Drawn <u>DJM</u></p> <p>Plan No. _____ Date <u>2-15-71</u></p>



EASTBOUND RIVER ROAD
APPROACHING THE INTERSECTION



EASTBOUND RIVER ROAD
AT THE INTERSECTION



EASTBOUND RIVER ROAD
AT THE RAILROAD CROSSING

FIGURE 5A



WESTBOUND RIVER ROAD
APPROACHING THE INTERSECTION



WESTBOUND RIVER ROAD
AT THE RAILROAD CROSSING



SOUTHBOUND ADAMS ROAD
AT THE INTERSECTION

6. Narrow Gauge Road @ Moss Road, Homestead Township

Narrow Gauge Road was recently paved. It has a 20 ft wide bituminous surface with eight foot gravel shoulders and clear centerline markings. Moss Road is a 20 ft wide gravel road. It forms a "Y" type intersection with Narrow Gauge Road. Narrow Gauge Road is characterized by a series of curves in the vicinity of its intersection with Moss Road. There is a 30 in. winding road sign just west of the intersection of Narrow Gauge Road and Marshall Road. No other traffic control exists in the vicinity of the study location.

There were four accidents reported for this location for the four-year period studied (1966-1969). Two accidents were car-deer accidents and the remaining accidents were ran-off roadway type accidents.

Recommendations:

We recommend that a yield sign (R1-2-36, Appendix II, p. 75) be erected on Moss Road at the approach to its intersection with Narrow Gauge Road and that a stop ahead sign (W3-1-30, Appendix II, p. 89) be erected on Narrow Gauge Road (for eastbound traffic) in advance of its intersection with Marshall Road.

We further recommend that the existing winding road sign (W1-5-30) be replaced with a curve sign (W1-2-30, Appendix II, p. 80) and another curve sign be erected in advance of the second curve encountered by westbound Narrow Gauge Road

traffic. This curve sign should be supplemented with a 35 mph advisory speed panel. Curve signs should also be erected in advance of the second and third curves encountered by eastbound Narrow Gauge Road traffic. The curve sign for the second curve should be supplemented with a 40 mph advisory speed panel. The appropriate panel legend was determined by using a devil level indicator and the criteria outlined in Appendix II, pps. 86-87. The following averages were obtained during field investigation.

	MPH	Devil Level Reading
Eastbound Traffic	35	8°
	40	11°
Westbound Traffic	35	10°
	40	14°

We suggest that target arrows be erected in target position at the following curves:

- (1) First curve west of Marshall Road (both directions of traffic)
- (2) Second curve west of Marshall Road (both directions of traffic)
- (3) Third curve west of Marshall Road (eastbound traffic only)

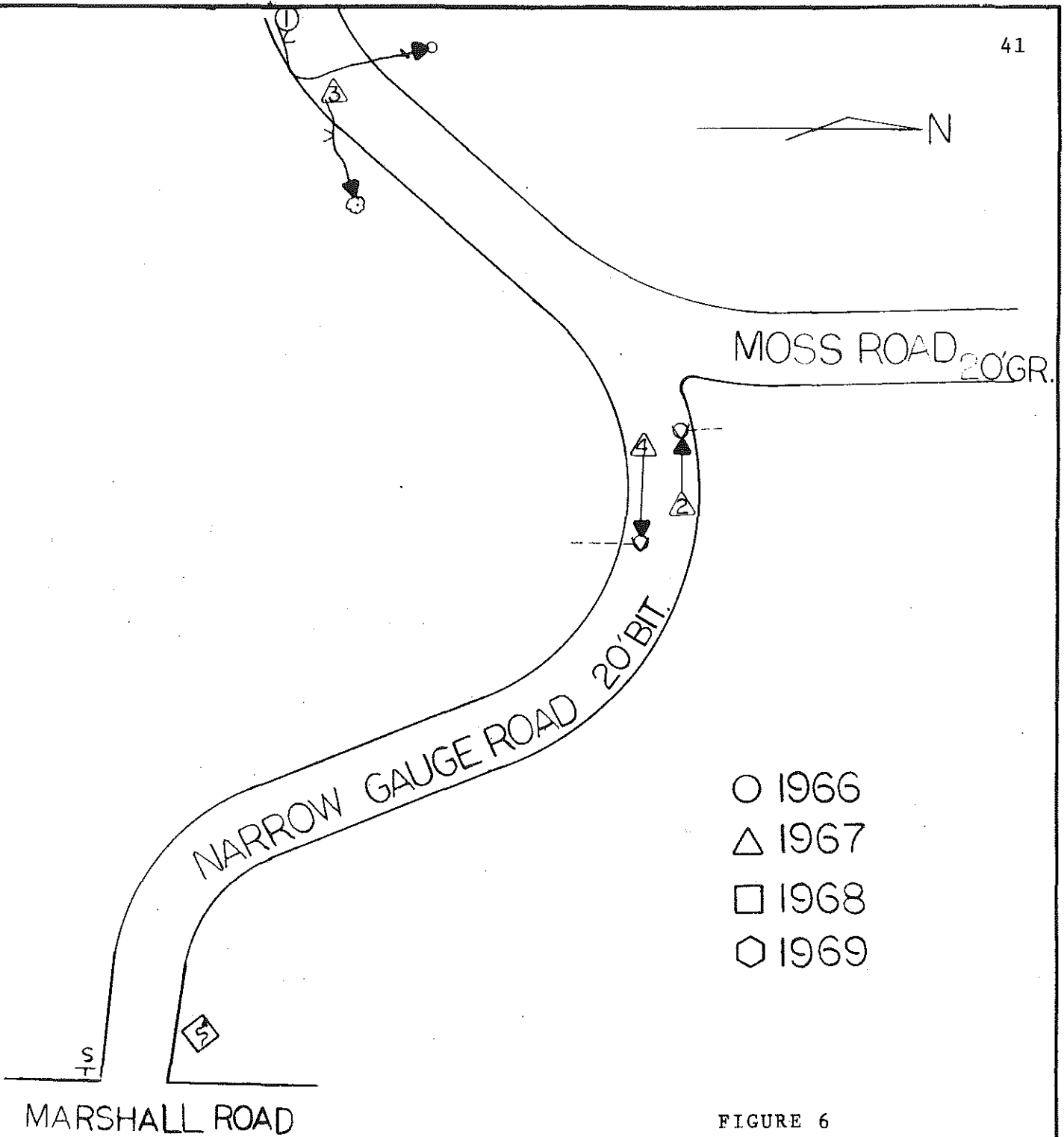
















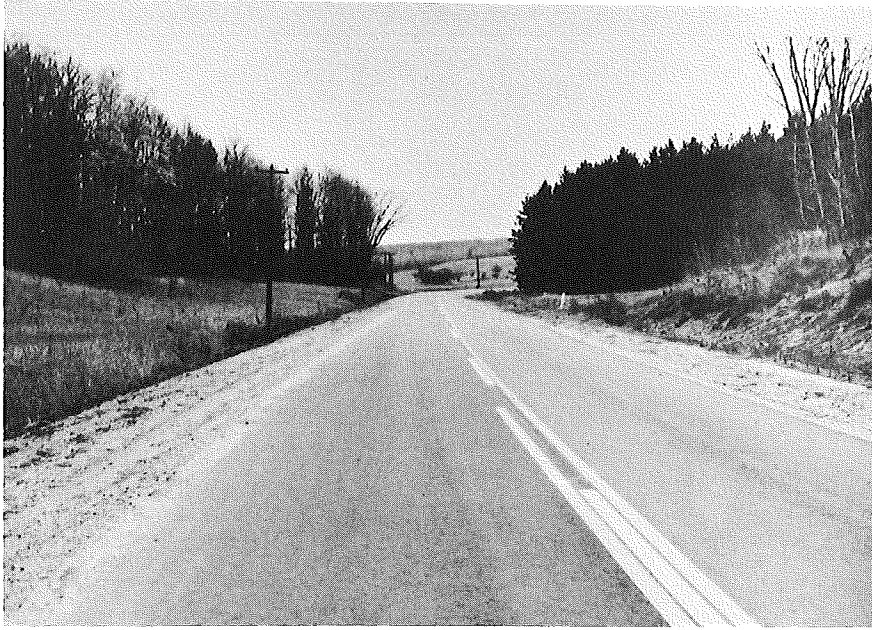


FIGURE 6

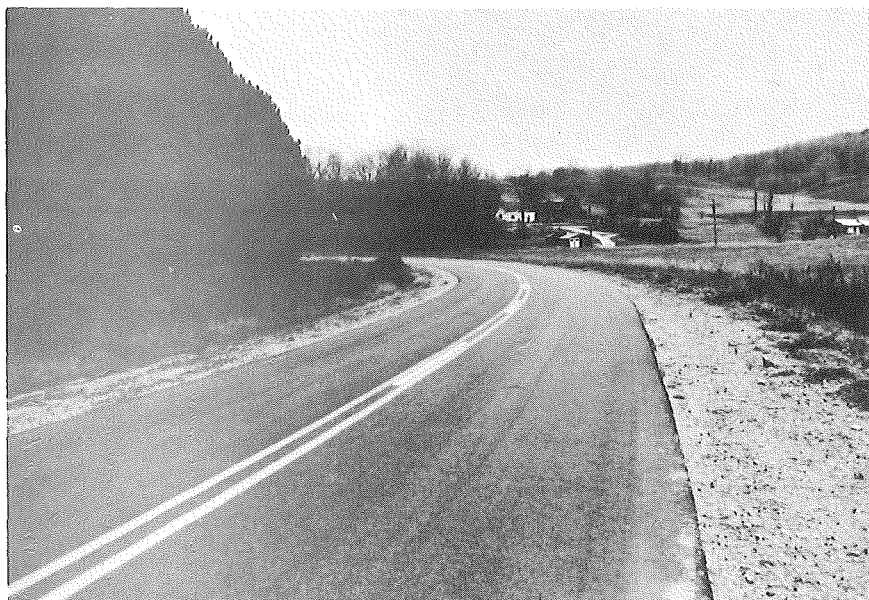
<p align="center">LEGEND</p>	<p align="center">MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION</p>
<p>Stop & Go Signal  Stop Sign </p> <p>Flashing Beacon  Yield Sign </p>	<p>Location #6 NARROW GAUGE ROAD AT MOSS ROAD HOMESTEAD TWP. SECS. 19+30 BENZIE CO.</p>
<p>Fatal  Pedestrian </p> <p>Injury  Tree </p> <p>Skidding  Out of Control </p> <p>Jackknife  Driver Intent </p> <p>Overtaken  Deer </p> <p>Backing  Violator </p>	<p>Period: 1966 THRU 1969</p> <p>Accidents - Total <u>4</u> P.D. <u>3</u></p> <p>Injury <u>1</u> (2) Fatal <u>0</u> ()</p> <p>C.S. _____ Miles _____ Drawn <u>DJM</u></p> <p>Plan No. _____ Date <u>2-15-71</u></p>



EASTBOUND NARROW GAUGE ROAD
APPROACHING THE INTERSECTION



EASTBOUND NARROW GAUGE ROAD
AT THE INTERSECTION



WESTBOUND NARROW GAUGE ROAD
APPROACHING THE INTERSECTION



WESTBOUND NARROW GAUGE ROAD
AT THE INTERSECTION



SOUTHBOUND MOSS ROAD
AT THE INTERSECTION

FIGURE 6B



WESTBOUND NARROW GAUGE ROAD
WEST OF THE MARSHALL
ROAD INTERSECTION



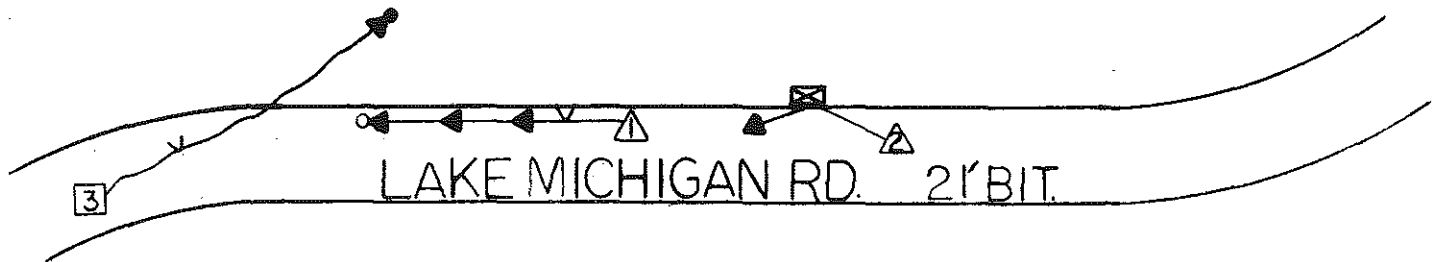
EASTBOUND NARROW GAUGE ROAD
APPROACHING MARSHALL
ROAD INTERSECTION

7. Lake Michigan Road, 1.5 Miles West of M-22, Lake Township

This section of Lake Michigan Road is a 21 ft wide bituminous roadway with seven foot gravel shoulders and centerline markings. This road is traveled by local traffic and countless tourists since it leads to the Platte River Point in Lake Michigan. It is characterized by gentle curves throughout its length (2.5 miles). The road is very well signed with curve signs for the majority of the curves.

The accident location is a straight section of Lake Michigan Road for which three accidents were reported during the study period. One of the accidents was due to excessive speed and resulted in a fatality. The other two were minor accidents.

After field investigation, the study team concluded that no serious condition exists at this location and no recommendations are being made.



- 1966
- △ 1967
- 1968
- ◇ 1969

FIGURE 7

LEGEND		MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION	
Stop & Go Signal		Stop Sign	S T
Flashing Beacon		Yield Sign	Y T
Fatal		Pedestrian	
Injury		Tree	
Skidding		Out of Control	
Jackknife		Driver Intent	
Overtaken		Deer	
Backing		Violator	
Location #7 LAKE MICHIGAN ROAD 1.0 TO 1.5 MI. WEST OF M-22 LAKE TWP. SEC. 21 BENZIE CO.		Period: 1966 THRU 1969	
Accidents - Total 3 P.D. 1		Injury 1 (1) Fatal 1 (1)	
C.S. Miles _____		Drawn DJM	
Plan No. _____		Date 2-12-71	



WESTBOUND LAKE MICHIGAN ROAD



WESTBOUND LAKE MICHIGAN ROAD

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EASTBOUND LAKE MICHIGAN ROAD

8. River Road, 0.1 Miles Southeast of M-22, Crystal Lake Township

This section of River Road is a 20 ft wide bituminous roadway with seven foot shoulders and centerline markings. The accident location is 0.1 miles southeast of M-22. At this location River Road runs in an east to west direction and is crossed at grade by the Ann Arbor Railroad. River Road in this area is characterized by a reverse turn. This reverse turn is typical of many locations throughout the State where the geometrics of a highway has been designed to cross a railroad at a 90° angle or near 90° in order to improve sight distance.

Traffic controls for each direction of traffic are a 36 in. railroad advance warning sign, a 30 in. curve sign and a railroad crossing sign. Northwestbound River Road has to stop for M-22 traffic a short distance from the railroad crossing (0.1 miles).

There were three accidents at this location during the years 1966 through 1969.

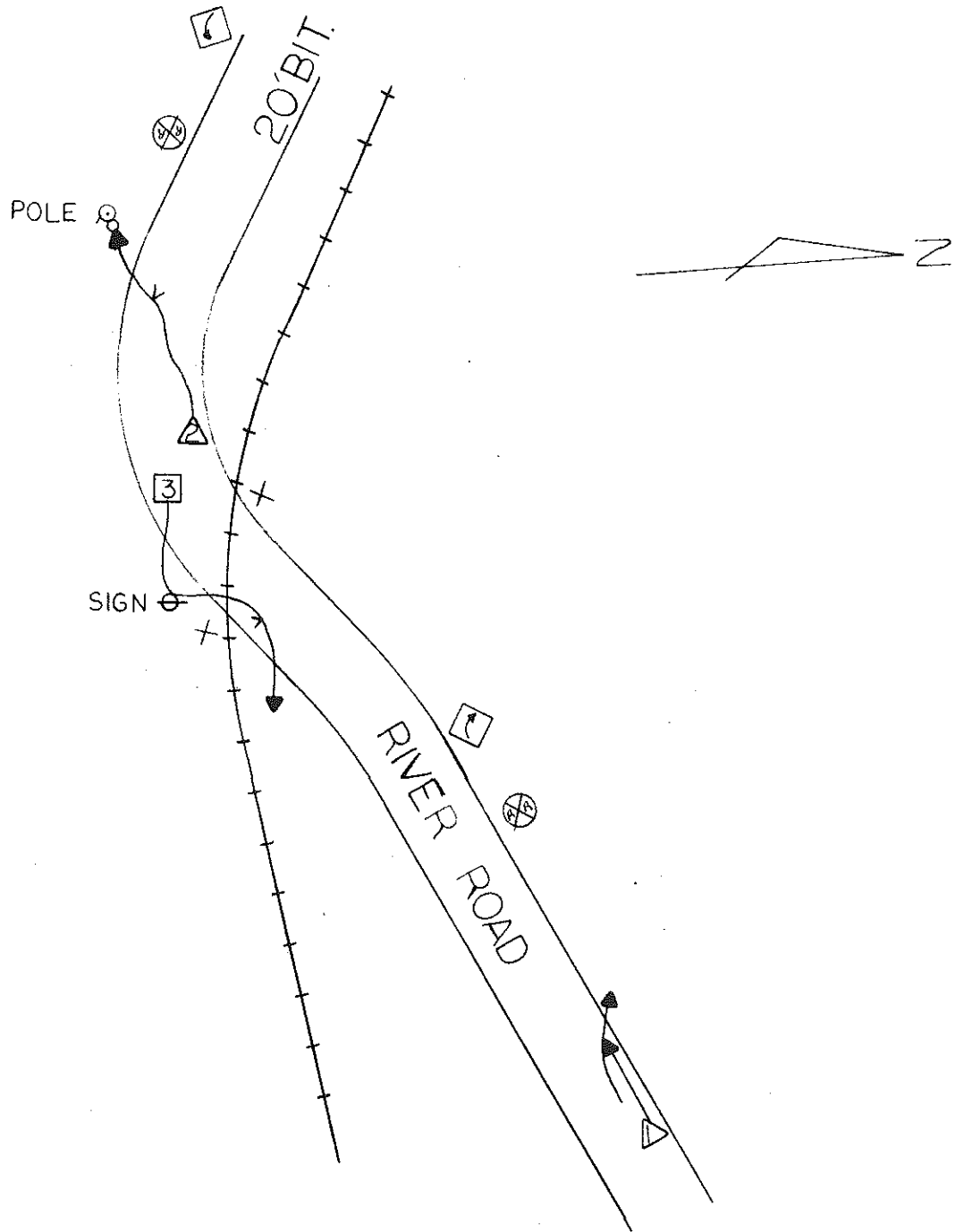
Recommendations:

We recommend that target arrows (W1-6-48, Appendix II, p. 84) be erected in target position for the curve west of the railroad crossing. There should be one such sign for each direction of traffic.

We also recommend that the existing curve signs be replaced by W1-1-30 turn signs (Appendix II, p. 79) and that they be supplemented with a 25 mph advisory speed panel for northwestbound traffic and a 30 mph advisory speed panel for southeastbound traffic. The appropriate panel legend was determined by using a devil level indicator and the theory outlined in Appendix II, pps. 86-87.

The following averages were obtained during field investigation.

	MPH	Devil Level Readings 1st Curve
Southeastbound Traffic	20	4°
	25	10°
	30	14°
Northwestbound Traffic	20	6°
	25	12°
	30	16°



- 1966
- △ 1967
- 1968
- ◇ 1969

X-R.R. CROSSING SIGN

FIGURE 8

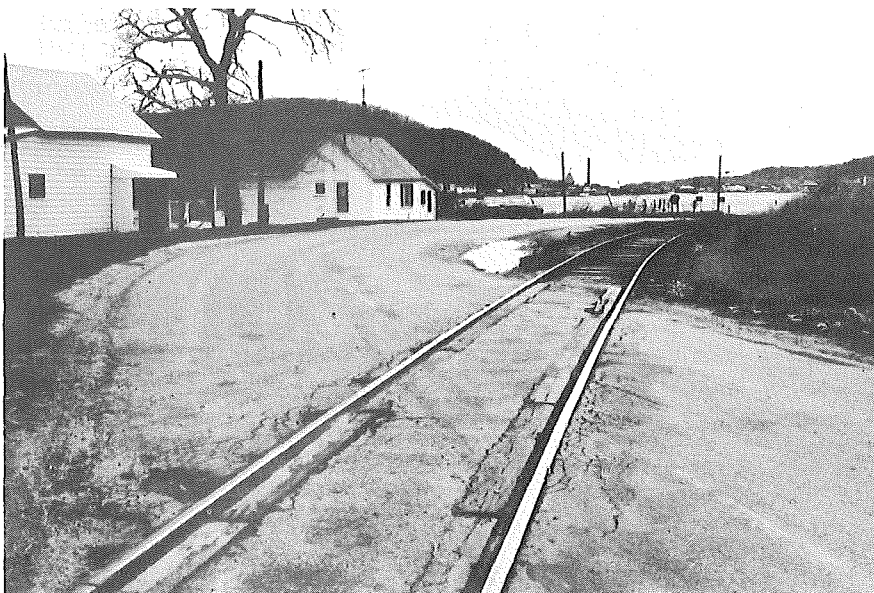
LEGEND		MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION	
Stop & Go Signal	Stop Sign	Location #8 RIVER ROAD 0.1 MI. SOUTHEAST OF M-22 CRYSTAL LAKE TWP, SECS. 26+35 BENZIE CO.	
Flashing Beacon	Yield Sign	Period: <u>1966 THRU 1969</u>	
Fatal	Pedestrian	Accidents - Total <u>3</u>	P.D. <u>1</u>
Injury	Tree	Injury <u>2</u> (<u>2</u>)	Fatal <u>0</u> (<u> </u>)
Skidding	Out of Control	C.S. _____ Miles _____	Drawn <u>DJM</u>
Jackknife	Driver Intent	Plan No. _____	Date <u>2-16-71</u>
Overturned	Deer		
Backing	Violator		



WESTBOUND RIVER ROAD
APPROACHING RAILROAD CROSSING



WESTBOUND RIVER ROAD
APPROACHING THE CURVE



WESTBOUND RIVER ROAD
AT THE RAILROAD CROSSING

EASTBOUND RIVER ROAD
APPROACHING THE CURVE



EASTBOUND RIVER ROAD
AT THE CURVE



EASTBOUND RIVER ROAD
AT THE RAILROAD CROSSING



FIGURE 8B

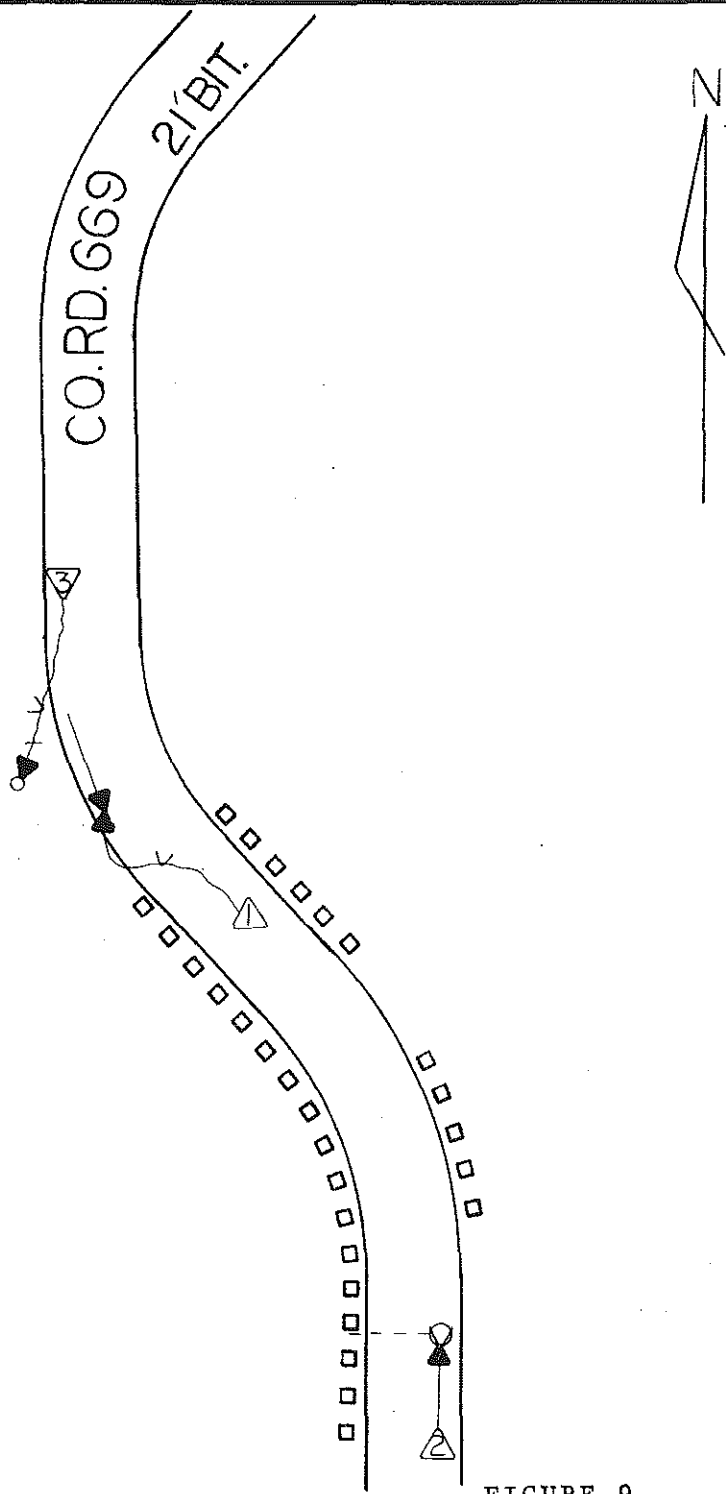
9. County Road #669 (Thompsonville Highway), 0.5 Miles
North of King Road, Colfax and Weldon Townships

This section of County Road #669 is characterized by changes in vertical and horizontal alignment. The roadway has a 21 ft wide bituminous surface with six to eight foot sod shoulders. At this location County Road #669 crosses the Betsie River (via culvert). There are guard posts present at the crossing and at the curves on both sides of the roadway.

Of the three accidents occurring at this location one was a car-deer accident and the remaining two involved vehicles that were unable to negotiate the curves.













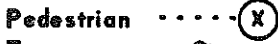





Recommendation:

We recommend that a reverse curve sign (W1-4-30, Appendix II, p. 82) be erected in advance of the first curve encountered by northbound traffic and an additional reverse curve sign be erected in advance of the second curve encountered by southbound traffic.



- 1966
- △ 1967
- 1968
- ⬡ 1969

FIGURE 9

LEGEND		MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION	
Stop & Go Signal  Stop Sign S  Flashing Beacon  Yield Sign Y 	Stop Sign S  Yield Sign Y 	Location # 9 CO RD 669 0.5 MI NORTH OF KING ROAD COLFAX TWP SEC. 19 AND WELDON TWP SEC. 24 BENZIE CO.	
Fatal  Injury  Skidding  Jackknife  Overturned  Backing 	Pedestrian  Tree  Out of Control  Driver Intent  Deer  Violator 	Period: <u>1966 THRU 1969</u> Accidents - Total <u>3</u> P.D. <u>2</u> Injury <u>1</u> (<u>2</u>) Fatal <u>0</u> (<u> </u>) C.S. <u> </u> Miles <u> </u> Drawn <u>DJM</u> Plan No. <u> </u> Date <u>2-15-71</u>	



SOUTHBOUND THOMPSONVILLE ROAD
AT THE CURVE



NORTHBOUND THOMPSONVILLE ROAD
APPROACHING THE CURVE



NORTHBOUND THOMPSONVILLE ROAD
AT THE CURVE

10. Almira Road @ Reynolds Road, Almira Township

These two roads intersect on a skew angle. Almira Road is a 21 ft bituminous roadway with five to seven foot shoulders and centerline markings. It has guardrail present on the south side of the road throughout the location. Reynolds Road is a 21 ft wide bituminous roadway with seven foot shoulders and centerline markings. Reynolds Road has a minus gradient as it approaches the intersection. Both roads have a 25 mph speed control zone. The intersection is inside the village limits of Lake Ann.

Traffic control for eastbound Almira Road is a 30 in. reverse curve sign (W1-4-30, Appendix II, p. 82). Traffic controls for southbound Reynolds Road are a 24 in. x 24 in. "T" symbol sign (see Figure 10A, p. 59), a 30 in. stop ahead sign and a 24 in. stop sign.

There were two accidents at this location during the study period. Both accidents occurred under snowy or icy conditions. One of the accidents occurred at the end of Reynolds Road and resulted in two injuries. Subsequent to this accident, there were major changes in signing made at this location.

Recommendation:

We recommend that a W1-6-48 target arrow sign be erected in target position in the northwest quadrant of the subject

intersection for southbound Reynolds Road traffic. We further recommend that the existing 24 in. x 24 in. "T" symbol sign be removed. This sign should not generally be used on an approach where traffic is required to stop before entering the intersection.

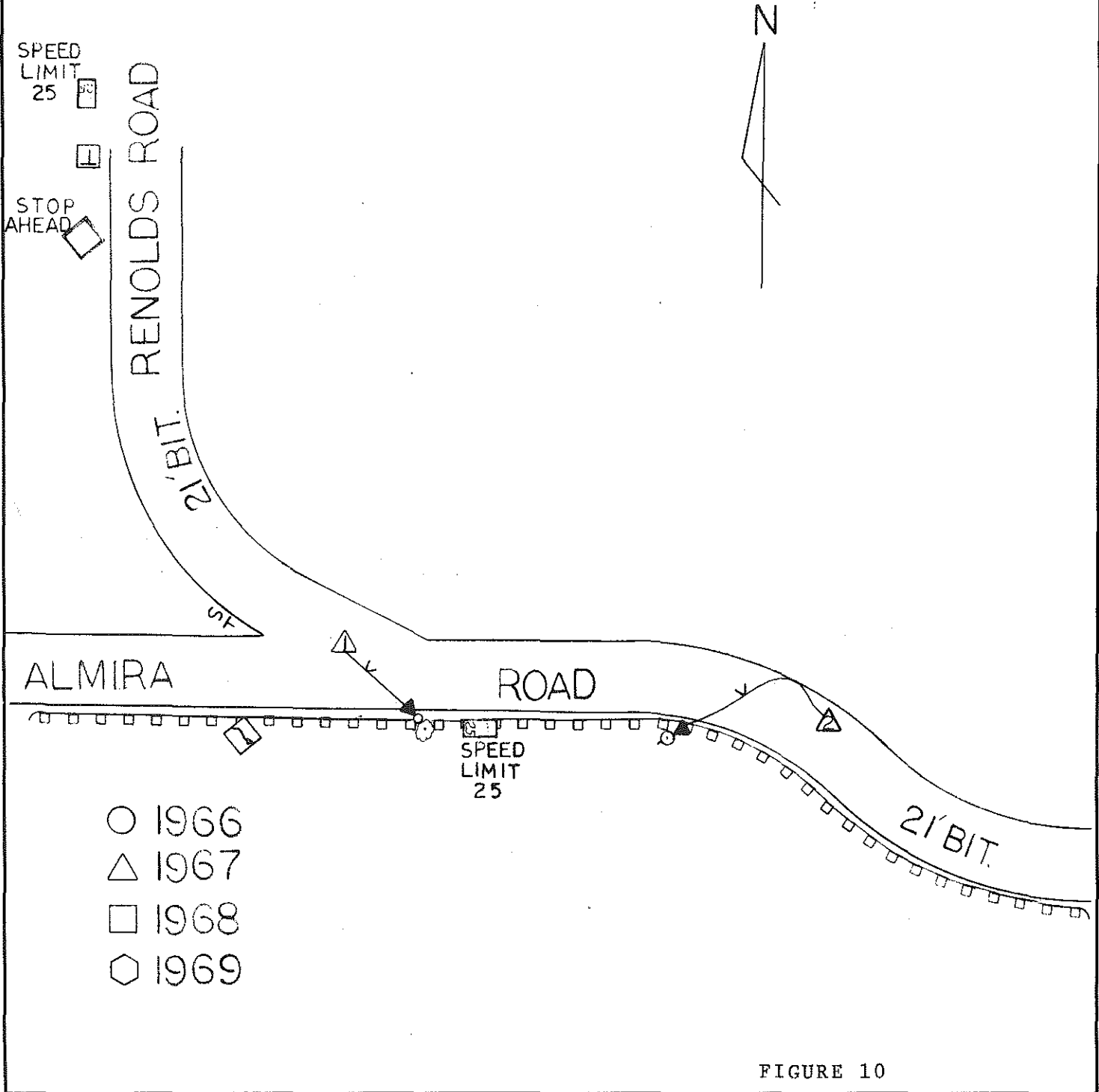


FIGURE 10

LEGEND		MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC AND SAFETY DIVISION	
Stop & Go Signal	Stop Sign	Location #10 ALMIRA ROAD AT RENOLDS ROAD ALMIRA TWP. SEC. 22, 23 BENZIE CO.	
Flashing Beacon	Yield Sign		
Fatal	Pedestrian	Period: 1966 THRU 1969	
Injury	Tree	Accidents - Total <u>2</u> P.D. <u>1</u>	
Skidding	Out of Control	Injury <u>1</u> (<u>2</u>) Fatal <u>0</u> (<u> </u>)	
Jackknife	Driver Intent	C.S. <u> </u> Miles <u> </u> Drawn <u>DJM</u>	
Overtaken	Deer	Plan No. <u> </u> Date <u>2-15-71</u>	
Backing	Violator		



SOUTHBOUND
REYNOLDS ROAD



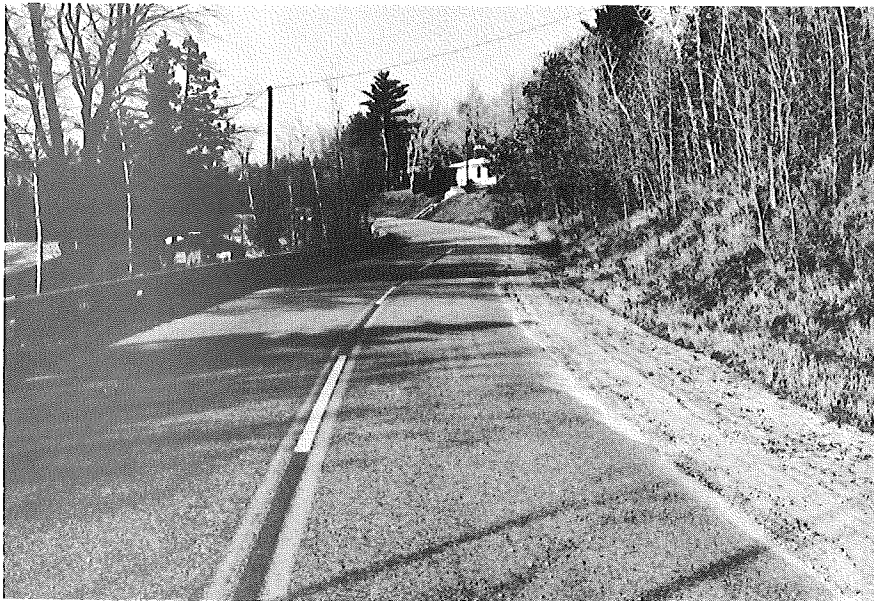
SOUTHBOUND
REYNOLDS ROAD



SOUTHBOUND
REYNOLDS ROAD



SOUTHBOUND REYNOLDS ROAD
AT THE INTERSECTION



WESTBOUND ALMIRA ROAD
APPROACHING THE INTERSECTION



WESTBOUND ALMIRA ROAD
AT THE INTERSECTION

FIGURE 10B



EASTBOUND ALMIRA ROAD
APPROACHING THE INTERSECTION



EASTBOUND ALMIRA ROAD
AT THE INTERSECTION

SUMMARY AND CONCLUSIONS

There was a total of 533 accidents on Benzie County roads during the study period 1966 through 1969 for an average of 133 accidents per year. The number of accidents remained fairly constant during the study period.

The information summarized in Table 2 shows that during the years 1966 through 1969 a total of 40 accidents occurred at the ten highest accident locations. This figure represents 7.5% of the total number of accidents for all county roads during the same period.

Fifteen of the 40 accidents occurring at the ten high accident locations resulted in personal injury and 24 were property damage. There was one fatal accident during this period at the locations studied.

Table 3 shows that the peak accident month was September accounting for 15% of the accidents. It also shows that Friday was the peak accident day with Friday and Saturday accounting for over 47% of the total accidents at the study locations.

The figures in Table 4 indicate that the peak accident hour occurs between 8 and 9 p.m. This hour together with the hour between 7 and 8 p.m. accounted for 27.5% of the accidents occurring at the ten high accident locations.

The information contained in Table 6 shows that 62% of the drivers involved in accidents at the study locations were

local residents. Table 7 shows that 77% of the accidents occurred when the weather was generally clear. As shown in Table 8, 65% of the accidents occurred when the pavement was dry, 12.5% when the pavement was wet and the rest when it was either snowy or icy.

There is no high concentration of accidents at any one location in the county. In fact the highest total for any location is seven accidents for the four years studied.

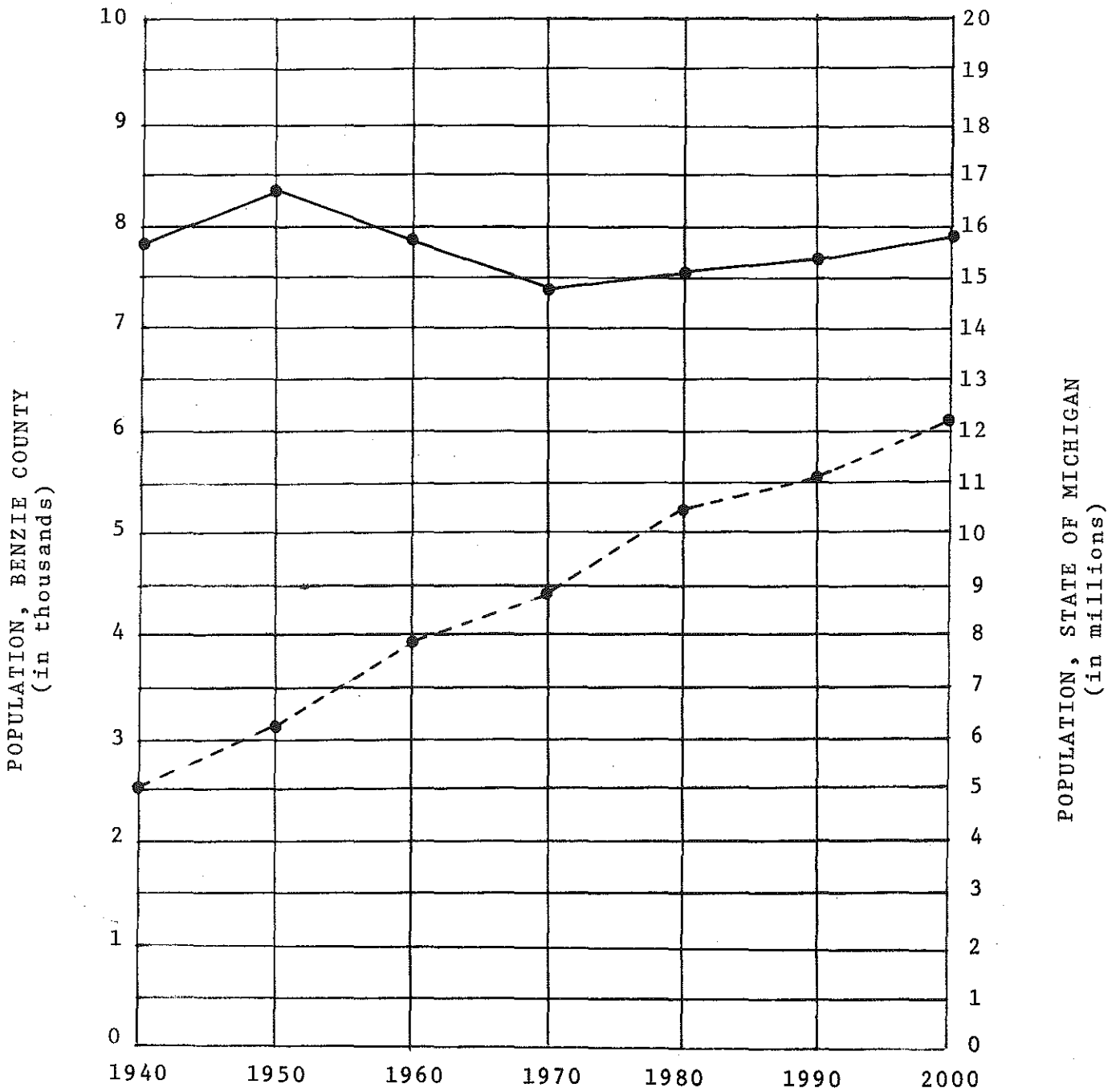
Our analysis of the accident problem on county roads in Benzie County in relationship to spot or high accident locations reveals that there are no critical problems which cannot be eliminated by the modest engineering means related to a spot improvement program.

The accident information summarized in Tables 2 through 8 may yield some basic information needed by those agencies interested in highway safety from the standpoint of driver education, law enforcement and street patrol activities.

APPENDIX I

Chart 1

BENZIE COUNTY POPULATION
STATE OF MICHIGAN POPULATION
1940-2000



State of Michigan - - - - -
Benzie County _____

Sources: U. S. Bureau of Census

Michigan Department of Commerce,
Office of Economic Expansion

REPORTED TRAFFIC ACCIDENTS IN BENZIE COUNTY

Year	Property Damage	Injury	Fatal	Total	County Road	State Route	Inter- state	Persons	Persons
								Injured	Killed
1966	188	100	2	290	128	162	0	168	3
1967	202	75	4	281	121	160	0	134	4
1968	221	90	2	313	144	169	0	149	2
1969	217	85	1	303	140	163	0	144	2

COMPARISON OF ACCIDENT FREQUENCY

Year	Benzie County Roads	Total Accidents State of Mich.
1966	128	302,880
1967	121	299,004
1968	144	305,495
1969	140	331,223

PERCENT CHANGE FOR ABOVE TOTALS

1966-67	-5.5	-1.3
1967-68	19.0	2.2
1968-69	-2.8	8.4

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VEHICLE REGISTRATION IN BENZIE COUNTY

Year	Pass.	Comm.	Farm Vehicle	Trailer	Trailer Coach	Motor- cycles	Muni- cipal	Total Plates
1966	3,431	-	-	-	-	-	-	5,286
1967	3,510	779	99	743	51	150	1	5,333
1968	3,598	841	94	839	63	133	3	5,565
1969	3,712	1,023	1,150	-	-	136	3	6,024

ACCIDENT ANALYSIS

Table 2

ANNUAL ACCIDENT SUMMARY

TEN HIGH ACCIDENT LOCATIONS IN BENZIE COUNTY

Period Studied: 1966 through 1969

Accident Type	Day	Night	Total
Fatal Accident		1	1
Personal Injury Acc.	8	7	15
Property Damage Acc.	8	16	24
TOTAL	16	24	40

Month	Fatal		Injury		Property Damage		Sub Total		Total
	Day	Night	Day	Night	Day	Night	Day	Night	
January				1		1		2	2
February					1		1		1
March						1		1	1
April						1		1	1
May			2		2	1	4	1	5
June			1	1	1		2	1	3
July			1	2			1	2	3
August			1			3	1	3	4
September		1	2		1	2	3	3	6
October				1	1	2	1	3	4
November			1	1		3	1	4	5
December				1	2	2	2	3	5
Sub Total		1	8	7	8	16	16	24	40
TOTAL		1	15		24		40		40

ACCIDENT ANALYSIS

Table 3

MONTHLY AND DAILY ACCIDENT OCCURRENCE

TEN HIGH ACCIDENT LOCATIONS IN BENZIE COUNTY

Period Studied: 1966 through 1969

Month	Day of the Week							Monthly Total	Percent of Total
	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.		
January						1	1	2	5.0
February			1					1	2.5
March						1		1	2.5
April		1						1	2.5
May			1		2	1	1	5	12.5
June			1		2			3	7.5
July	1	1					1	3	7.5
August				3		1		4	10.0
September		1		1	1	2	1	6	15.0
October		1			2	1		4	10.0
November		3			1	1		5	12.5
December	1		1		2	1		5	12.5
Day Total	2	7	4	4	10	9	4	40	100.0
% of Total	5.0	17.5	10.0	10.0	25.0	22.5	10.0	100.0	

Peak Accident Day: FridayPeak Accident Month: September

ACCIDENT ANALYSIS

Table 4

DAILY AND HOURLY ACCIDENT OCCURRENCE
TEN HIGH ACCIDENT LOCATIONS IN BENZIE COUNTY

Period Studied: 1966 through 1969

Hour	Day of the Week							Hour Total	% of Total
	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.		
12 - 1AM		1				1		2	5.0
1 - 2AM				1	1	1		3	7.5
2 - 3AM									
3 - 4AM						1		1	2.5
4 - 5AM									
5 - 6AM									
6 - 7AM		1		1				2	5.0
7 - 8AM				1				1	2.5
8 - 9AM									
9 - 10AM									
10 - 11AM									
11 - 12AM						1	1	2	5.0
12 - 1PM									
1 - 2PM			1		1			2	5.0
2 - 3PM									
3 - 4PM			1		1	1		3	7.5
4 - 5PM					3			3	7.5
5 - 6PM		1					1	2	5.0
6 - 7PM						1		1	2.5
7 - 8PM	1	1			1	1	1	5	12.5
8 - 9PM		3			1	1	1	6	15.0
9 - 10PM			1					1	2.5
10 - 11PM	1		1	1	1			4	1.0
11 - 12PM					1			1	2.5
Not Stated						1		1	2.5
Day Total	2	7	4	4	10	9	4	40	100.0
% of Total	5.0	17.5	10.0	10.0	25.0	22.5	10.0	100.0	

Peak Accident Hour: 8 - 9 p.m.

Peak Accident Day: Friday

ACCIDENT ANALYSIS

Table 5

AGE OF DRIVERS INVOLVED IN ACCIDENTS
TEN HIGH ACCIDENT LOCATIONS IN BENZIE COUNTY

Period Studied: 1966 through 1969

Age Group	Number of Drivers Involved in				Percent
	Fatal	Injury	Prop. Damage	Total	
Under 16					
16-19	1	4	11	16	33.4
20-24		4	1	5	10.4
25-34		3	3	6	12.5
35-44		3	2	5	10.4
45-54		1	4	5	10.4
55-64		1	2	3	6.3
65-74		1	3	4	8.3
75 & Over					
Not Stated		1	3	4	8.3
Total	1	18	29	48	100.0

Table 6

RESIDENCE OF DRIVERS INVOLVED IN ACCIDENTS

Residence	Number of Drivers Involved in				Percent
	Fatal	Injury	Prop. Damage	Total	
Local	1	9	20	30	62.5
Michigan		5	7	12	25.0
Out of State		4	1	5	10.4
Not Stated			1	1	2.1
Total	1	18	29	48	100.0

ACCIDENT ANALYSIS

Table 7

WEATHER CONDITIONS AT SCENE OF ACCIDENTS
TEN HIGH ACCIDENT LOCATIONS IN BENZIE COUNTY

Period Studied: 1966 through 1969

Weather	Severity of Accident				Percent
	Fatal	Injury	Prop. Damage	Total	
Clear or Cloudy	1	11	19	31	77.5
Rain		1	1	2	5.0
Fog		2	1	3	7.5
Snow or Sleet		1	3	4	10.0
Not Stated					
Total	1	15	24	40	100.0

Table 8

PAVEMENT CONDITIONS AT SCENE OF ACCIDENTS

Pavement	Severity of Accident				Percent
	Fatal	Injury	Prop. Damage	Total	
Dry	1	10	15	26	65.0
Wet		2	3	5	12.5
Snowy/Icy		3	6	9	22.5
Icy					
Not Stated					
Total	1	15	24	40	100.0

APPENDIX II

Section B. Regulatory Signs

Regulatory Signs shall be used to inform highway users of traffic laws or regulations that apply at given places or on given highways. They are essential to indicate the applicability of legal requirements that would not otherwise be apparent. Great care must be exercised to see that they are erected wherever needed to fulfill this purpose, but unnecessary mandates should be avoided.

Included among regulatory signs are some, like those marking the end of a restricted zone, that are related to operational controls though not in themselves imposing any obligations or prohibitions.

Regulatory signs shall be erected at those locations where the regulations apply and shall be mounted so as to be easily visible and legible to the motorist whose actions they are to govern. Signs that have been erected but are no longer applicable shall be removed. Regulatory signs cannot be expected to command respect and obedience unless the regulations thereon set forth are adequately enforced.

Regulatory signs are classified in the following groups:

- | | | |
|-----|-----------------|-------------|
| (1) | Right-of-Way | (R1 Series) |
| | a. "STOP" Sign | |
| | b. "YIELD" Sign | |
| (2) | Speed | (R2 Series) |
| (3) | Movement | (R3 Series) |
| | a. Turning | |
| | b. Alignment | |
| | c. One Way | |
| | d. Exclusion | |
| (4) | Parking | (R4 Series) |
| (5) | Pedestrian | (R5 Series) |
| (6) | Miscellaneous | (R6 Series) |

With few exceptions, hereinafter detailed in the specifications for individual signs, regulatory signs are rectangular in shape with the larger dimension vertical and have black legends on white backgrounds. The principal exceptions referred to are the "STOP" sign, the Yield sign, the One Way arrow, and the Parking signs.

STOP SIGN



Reflectorized

R1-1-24	24" x 24"	(8" letters)
R1-1-30	30" x 30"	(12" letters)
R1-1-36	36" x 36"	(12" letters)

All "STOP" signs shall be reflectorized or internally illuminated so that the shape, color, and legend will be comparable to that in day time conditions and will not produce detrimental glare to traffic.

The "STOP" sign may be supplemented by two alternating red flashing beacons in the face or by one red flashing beacon directly above the sign. Such beacon(s) shall be operated continuously.

Place at the point where it is desired to have traffic stop, or as near thereto as possible at the following locations:

1. On streets or highways intersecting a through street or highway.
2. Railroad crossing where a stop is required by order of the appropriate public authority.
3. Opposite all Stop lines applied on the pavement, except at intersections controlled by a traffic control signal.
4. At intersections where a flashing red beacon exists.

There shall be no "STOP" signs on approaches to an intersection where such approaches are controlled by a traffic control signal.

An overhead internally illuminated "STOP" sign may be used in lieu of roadside "STOP" signs.

Secondary messages shall not be used on the face of a "STOP" sign. At a four-way stop intersection, each "STOP" sign may

be supplemented by a separate panel reading "4-WAY". Where this panel is used in conjunction with an R1-1-24, it shall be 24" x 9" with 5-inch legend. Where used with an R1-1-30 or R1-1-36, it shall be 30" x 12" with a 7-inch legend. Each panel shall have a black legend and border with a white reflectorized background. No additional sign shall be displayed with a "STOP" sign except one of the following: R3-1, R3-2, R3-3, R3-5, R3-6, or R3-23.

A hand held "STOP" sign may be used by Traffic Regulators as provided in Part II, Section E. Drivers facing the hand held "STOP" sign shall come to a complete stop and remain standing until an indication is given to proceed.

For placement see figures 1-3 and 1-4 and for special interim application see page 409.

YIELD SIGN



Reflectorized

R1-2-36 36" Equilateral Triangle (8", 3" and 2½" letters)

All Yield signs shall be reflectorized or internally illuminated so that the shape, color, and legend will be comparable to that in day time condition and will not produce detrimental glare to traffic.

Place at the point where it is desired to have traffic yield or as near thereto as possible at the following locations:

1. At the approach to an intersection where it is necessary to assign right-of-way to the major road, but where a stop is not necessary at all times.
2. At any location where a special problem exists and where an engineering study indicates the problem to be susceptible to correction by use of the Yield sign.

An overhead internally illuminated Yield sign may be used in lieu of roadside Yield signs.

For placement see figures 1-3 and 1-4.

SPEED LIMIT SIGN



Reflectorized

R2-1-24 24" x 30" (4" letters and 10" numerals)

R2-1-48 48" x 60" (8" letters and 16" numerals)

The "SPEED LIMIT" sign shall be located at the point of change from one speed limit to another and at additional locations, as just beyond major intersections, where it is necessary to remind motorists of the applicable limit. Where the sign cannot be placed at the exact point of change in limit (such as at the center of an intersection), it shall be placed as near as practicable, but in advance of the point of change for a decrease, and beyond such point for an increase. Signs shall be installed at maximum intervals of $\frac{1}{2}$ mile within any Speed Control Zone to confirm the speed of that zone. On freeways, the R2-1-48 sign shall be used.

For placement see figures 1-5 and 1-35.

Section C. Warning Signs

Introduction

Warning signs shall be used for the purpose of warning traffic of existing or potentially hazardous conditions either on or adjacent to the roadway. Warning signs require caution on the part of the motorist and may call for reduction of speed or other maneuver in the interest of his own safety and that of other motorists and pedestrians. Adequate warnings are of great assistance to the vehicle operator and are valuable in safeguarding and expediting traffic. However, the use of warning signs should be kept to a minimum. Too frequent use of them or their unnecessary use to warn of conditions which are apparent tends to bring disrespect for all signs.

The conditions warranting warning signs are classified in the following groups according to the type of conditions to which they are applied:

- | | |
|---------------------------------------|----------------|
| 1. Changes in Horizontal Alignments | (W1 Series) |
| 2. Intersections | (W2 Series) |
| 3. Advance Warning of Control Devices | (W3 Series) |
| 4. Converging Traffic Lanes | (W4 Series) |
| 5. Narrow Roadways | (W5 Series) |
| 6. Changes in Highway Design | (W6 Series) |
| 7. Grades | (W7 Series) |
| 8. Roadway Surface Conditions | (W8 Series) |
| 9. Schools and Pedestrians | (W9 Series) |
| 10. Railroad Crossings | (W10 Series) |
| 11. Entrances and Crossings | (W11 Series) |
| 12. Miscellaneous | (W12 Series) |
| 13. Construction and Maintenance | (W13 Series) * |

Warning signs with certain exceptions shall be diamond-shaped (square with one diagonal vertical) and shall have a "Highway Yellow" background with black legend. These exceptions are

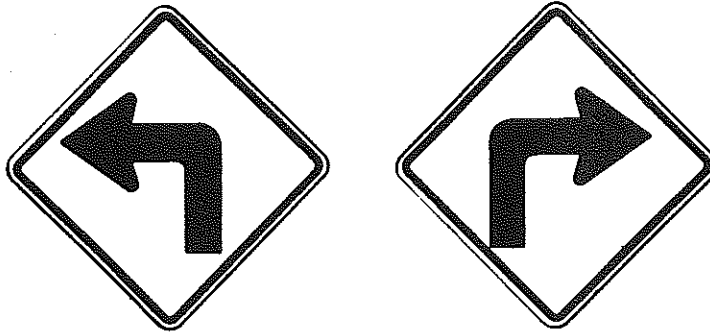
*Special warning signs for highway construction and maintenance projects are to be found in Part II of this Manual.

the Railroad Crossing signs, the Target Arrow signs, the Curve Speed panel, the Exit Speed sign, the Obstruction panel, and the Lattice Background. Other exceptions to the diamond shape are provided for in the case of temporary signs for highway construction and maintenance.

The use of warning signs should be limited to those standard signs set forth in this section. However, after the Engineer has exhausted all possibilities, it may be found that no standard sign fits the situation and warning signs, other than those specified, may be required. Such signs shall conform with the general specifications for size (30" minimum), shape, and color of warning signs. All warning signs having significance during hours of darkness shall be reflectorized or illuminated.

(Rev. 1)

TURN SIGN



Reflectorized

W1-1-30 30" x 30"

W1-1-36 36" x 36"

W1-1-48 48" x 48"

The Turn sign shall be used to denote changes in the horizontal alignment of all roads (except minor roads and streets where in the judgment of the engineer the use of this sign is unnecessary) where a ball bank indicator or Devil Level registers ten degrees or more at a speed of 30 miles per hour or less. Where this sign is warranted, consideration should be given to the use of a Target Arrow (W1-6). Additional protection may be provided by use of the Curve Speed panel (W12-1).

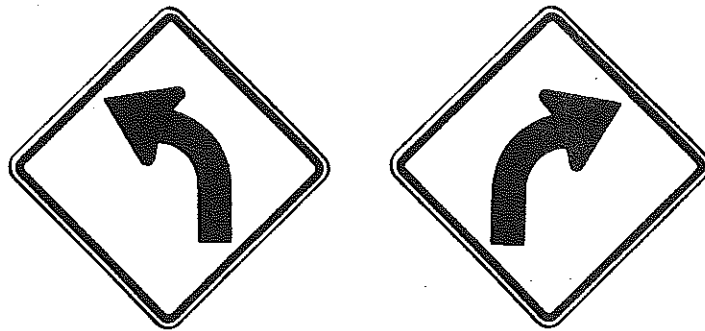
This sign shall be located in advance of the point of curvature at the approximate distance indicated below:

85th Percentile Speed			
35 & Below	36-45	46-55	56 & Over
250'	400'	550'	750'

Turns or a turn and a curve that are less than 400 feet apart shall be designated by the W1-3 sign.

For placement see figure 1-11.

(Rev. 1)

CURVE SIGN

ReflectORIZED

W1-2-30 30" x 30"

W1-2-36 36" x 36"

W1-2-48 48" x 48"

The Curve sign shall be used to denote changes in alignment where a ball bank indicator or Devil Level registers 10° or more at speeds between 30 and 60 miles per hour, and at such other locations where the change in alignment of the roadway is not apparent to the driver. Additional protection may be provided by use of the Curve Speed panel (W12-1).

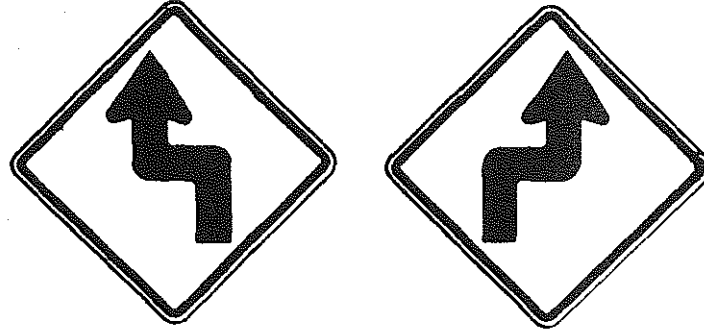
The Curve sign shall be located in advance of the point of curvature at the approximate distance indicated below:

85th Percentile Speed			
35 & Below	36-45	45-55	56 & Over
250'	400'	550'	750'

Curves that are less than 400 feet apart shall be designated by the W1-4 sign.

For placement see figures 1-11 and 1-35.

REVERSE TURN SIGN



ReflectORIZED

W1-3-30 30" x 30"

W1-3-36 36" x 36"

W1-3-48 48" x 48"

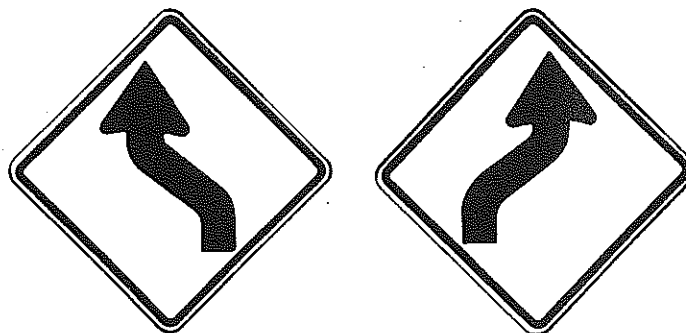
Where two turns or a curve and a turn in opposite directions are separated by a tangent of less than 400 feet a Reverse Turn sign shall be used. Where this sign is warranted, consideration should be given to the use of a Target Arrow (W1-6) in target position at each turn or curve. Additional protection may be provided by use of the Curve Speed panel (W12-1). The speed indication displayed shall be that of the slower turn or curve.

This sign shall be located in advance of the point of curvature of the first curve or turn at the approximate distance indicated below:

85th Percentile Speed			
35 & Below	36-45	46-55	56 & Over
250'	400'	550'	750'

For placement see figure 1-11.

REVERSE CURVE SIGN



Reflectorized

W1-4-30 30" x 30"

W1-4-36 36" x 36"

W1-4-48 48" x 48"

On all roads (except minor roads and streets, where in the judgment of the engineer the use of this sign is unnecessary) where two curves in opposite directions are separated by a tangent of less than 400 feet a Reverse Curve sign shall be used. Additional protection may be provided by use of the Curve Speed panel (W12-1). The speed indication displayed shall be that of the slower curve.

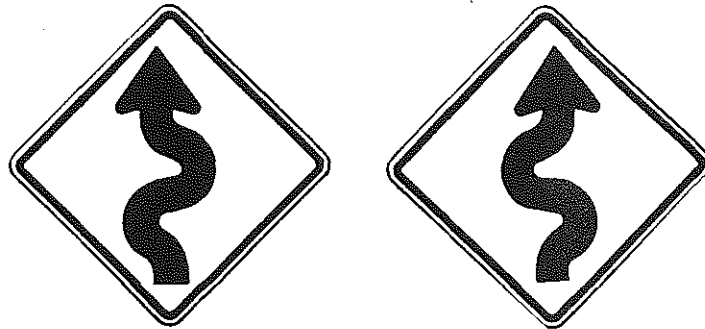
This sign shall be located in advance of the point of curvature of the first curve at the approximate distance indicated below:

85th Percentile Speed			
35 & Below	36-45	46-55	56 & Over
250'	400'	550'	750'

For placement see figure 1-11.

(Rev. 1)

WINDING ROAD SIGN



Reflectorized

W1-5-30 30" x 30"

W1-5-36 36" x 36"

W1-5-48 48" x 48"

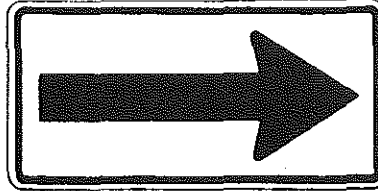
The Winding Road sign shall be used (except on minor roads and streets where in the judgment of the engineer the use of this sign is unnecessary) where there is a series of three or more turns or curves, separated by tangent distances of less than 400 feet. Where this sign is warranted, consideration should be given to the use of a target arrow (W1-6) in target position at each turn or curve. Additional protection may be provided by use of the Curve Speed panel (W12-1). The speed indication displayed shall be that of the slower turn or curve.

This sign shall be located in advance of the point of curvature of the first curve or turn at the approximate distance indicated below:

85th Percentile Speed			
35 & Below	36-45	46-55	56 & Over
250'	400'	550'	750'

For placement see figure 1-11.

(Rev. 1)

TARGET ARROW SIGN

Reflectorized

W1-6-48 48" x 24"

W1-6-96 96" x 48"

This sign may be used as a supplement to a Turn or Curve sign for potentially hazardous turns or curves. To increase its target value and to obscure misleading topography, the sign may be mounted on a Lattice Background (W12-10).

Where further emphasis of the required movement is desired, the W1-6-96 may be used in lieu of the unit consisting of the W1-6-48 and the W12-10.

This sign shall not be used to mark the ends of medians, centerpiers, etc., where there is no change in the direction of travel for all traffic. Further, it shall not be used as a route directional confirmatory marker or in any location where an intersecting street or highway of equal or nearly equal importance presents a choice of movement.

When used, the Target Arrow sign shall be erected in target position and, if possible, mounted high enough to be visible for at least 500 feet. It shall be placed at five feet minimum bottom height and two feet from the edge of the shoulder or curb face.

RAILROAD ADVANCE WARNING SIGN

Reflectorized

W10-1-36 36" diameter (8" letters)

The circular Railroad Advance Warning sign shall be erected in advance of all railroad crossings. The distance from the intersection of the center line of the highway with the nearest rail to the sign location shall be not less than 250 feet nor more than 350 feet. All such signs must be maintained free from obstruction to vision for not less than 300 feet in advance of the sign.

For placement see figure 1-11.

CURVE SPEED PANEL



Reflectorized

W12-1-21 21" x 21" (10" and 3" letters)

W12-1-24 24" x 24" (12" and 3" letters)

The Curve Speed panel may be used as a supplement to the W1-1 through W1-5 signs only and shall display a speed legend in increments of five miles per hour. Since this legend is advisory, no Traffic Control Order is required. The W12-1-21 shall only be used with the appropriate 36 inch W1 sign and the W12-1-24 with the appropriate 48 inch W1 sign.

To determine the accurate negotiable speed on a turn or curve by the use of a ball bank indicator or Devil Level, several runs should be made in the same direction to obtain the most accurate reading possible. Readings obtained from several trial runs in the same direction shall determine the curve speed for that respective direction. Since the comfortable turn or curve speed on a specific turn or curve may vary, depending on direction of travel, the same procedure shall be used to obtain the curve speed for the opposite direction.

The following table indicates the speed to be used on the Curve Speed panel.

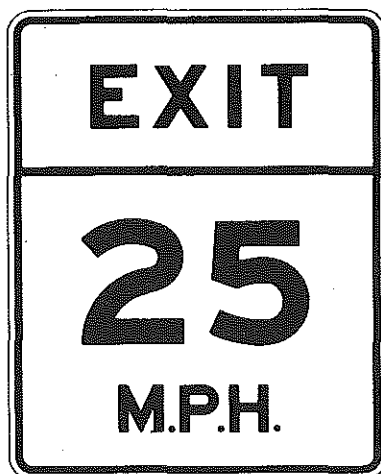
Indicator Reading	Speedometer Reading	Appropriate Panel Legend
10°	60, 59, or 58	60
10°	57, 56, 55, 54, or 53	55
10°	52, 51, 50, 49, or 48	50
10°	47, 46, 45, 44, or 43	45
10°	42, 41, 40, 39, or 38	40
10°	37, 36, 35, 34, or 33	35
12°	32, 31, 30, 29, or 28	30
12°	27, 26, 25, 24, or 23	25

Indicator Reading	Speedometer Reading	Appropriate Panel Legend
14°	22, 21, 20, 19, or 18	20
14°	17, 16, 15, 14, or 13	15
14°	12, 11, or 10	10

The speed legend displayed may equal but never exceed that of the posted speed limit in a Speed Control Zone.

For placement see figure 1-11.

EXIT ____ MILES PER HOUR SIGN



Reflectorized

W12-2-48 48" x 60" (8", 16", and 6" letters)

This advisory sign shall be used only at ramps exiting from freeways where the safe speed of the first curve on the off-ramp, as determined by conditions at each individual location, is found to be less than 70 percent of the design speed for the freeway.

If a safe speed indication is required for a second curve on an off-ramp well beyond the gore, a curve sign with a curve speed panel should be used.

For placement see figure 1-35.

DEER AREA SIGN

Reflectorized

W12-8-36 36" x 36" (8" letters)

This sign may be used in advance of, and at intervals throughout, sections of highway where deer cross in somewhat well defined patterns and evidence exists that such crossings constitute a hazard.

A joint investigation must be made by representatives of the Michigan Department of Conservation and the agency having jurisdiction over the highway before this sign may be installed.

For placement see figure 1-11.

STOP AHEAD SIGN



Reflectorized

W3-1-30 30" x 30" (6" letters)

W3-1-36 36" x 36" (8" letters)

The "STOP AHEAD" sign shall be erected in advance of an intersection where traffic is required to stop and the "STOP" sign is not visible to motorists for a sufficient distance or where emphasis is needed because of poor observance of the stop. The "STOP AHEAD" sign may also be used in advance of a red flashing beacon.

Where required, the W3-1-30 shall be used in advance of a 24-inch "STOP" sign and the W3-1-36 in advance of a 30 or 36-inch "STOP" sign.

Except where used on State trunkline highways at junctions with other State trunkline highways, it shall be located in advance of the required stop at the approximate distance indicated below:

85th Percentile Speed			
35 & Below	36-45	46-55	56 & Over
250'	400'	550'	750'

For location on State trunkline highways see figures 1-17 and 1-26.

For placement see figure 1-11.