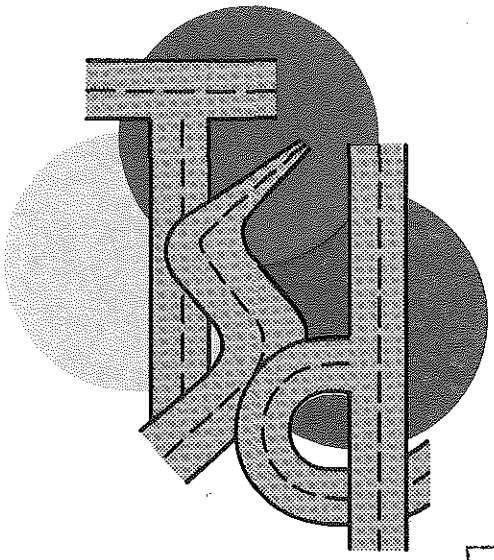
Evaluation of Changing the Assignment of Vehicle Right-of-Way at a Rural Trunkline Intersection

TSD-SS-128-70



TRAFFIC and SAFETY DIVISION

DEPARTMENT OF STATE HIGHWAYS
STATE OF MICHIGAN

65-6748

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

Evaluation of Changing the Assignment of Vehicle Right-of-Way at a Rural Trunkline Intersection

TSD-SS-128-70

South Junction of M-46 with M-37
in Muskegon County

Prepared By

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Synopsis

This report is an evaluation of accidents affected by removing the traffic stop control from the north leg of the south junction of M-46 and M-37 near Casnovia in Muskegon County, and establishing it on the east and west legs.

This revision contributed in reducing the total number of accidents from 29 to 21 and the number of persons injured and killed from 25 to 8. A savings of $45,500 was realized by the motoring public as a result of the reduction in accidents and severity according to National Safety Council criteria. The total cost of the project was $1,135.

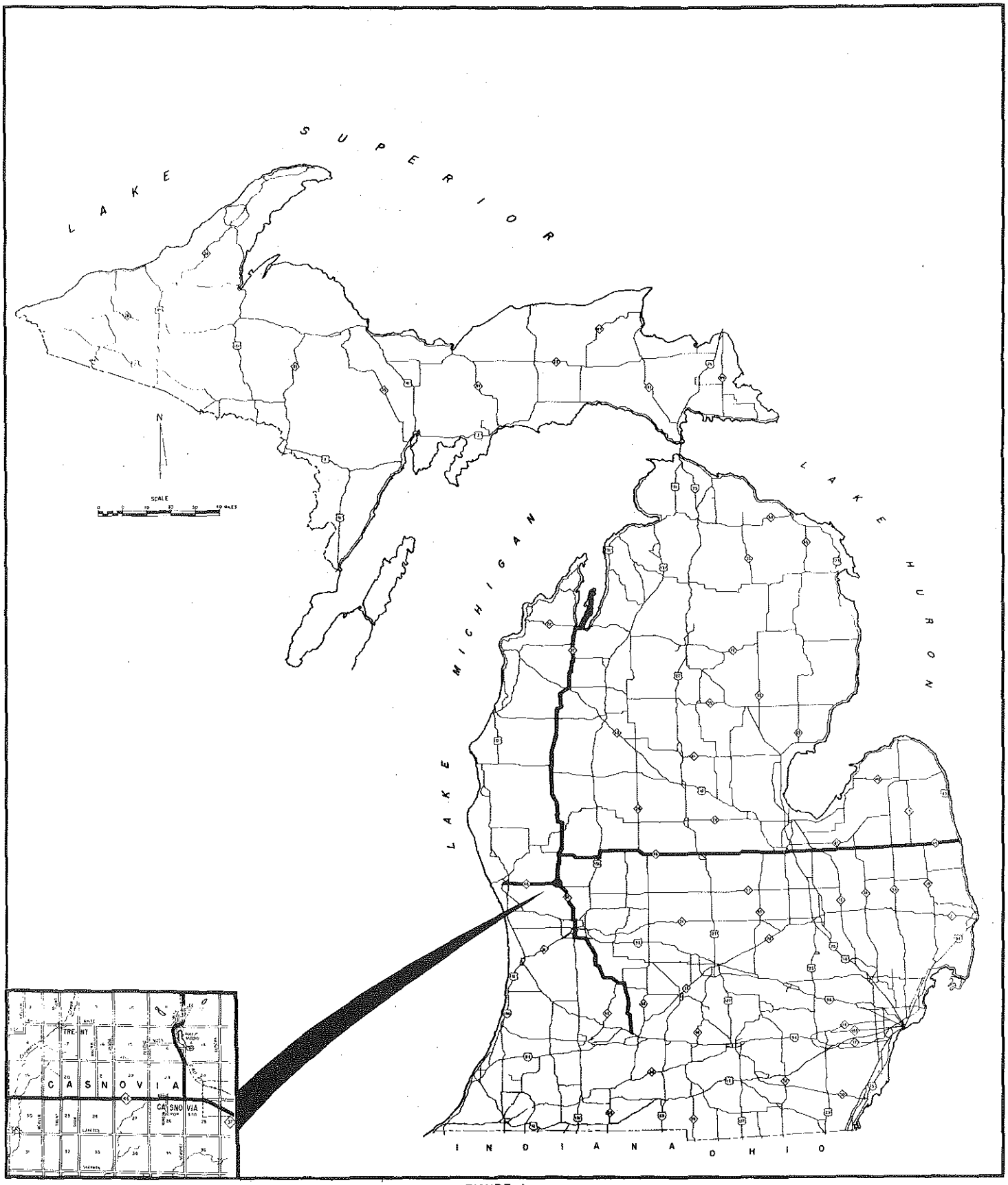
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
N
SCALE
0 10 20 30 40 MILES
TRENT
CASNOVIA
CASNOVIA
INDIANA
OHIO

FIGURE 1

Introduction

This report is an evaluation of a safety project which resulted after a study period by the Michigan Department of State Highways with the cooperation of the Michigan Department of State Police.

Traffic operational changes were made after reviewing the collision pattern and traffic turning movements in addition to making a field investigation of the site. The study determined that the two heaviest turning movements were westbound to northbound (for which a connector in the northeast quadrant is utilized) and southbound to eastbound (see Figures #2 and #6). Due to the large southbound to eastbound turning movement, and the accident pattern at the intersection, a recommendation was made to assign the right-of-way to allow traffic entering the intersection from the north to "free-flow" instead of stopping. This change resulted in reducing the accidents and their severity.

Location

M-46 is a state primary, east-west road extending from Muskegon on the west side of the state to Port Sanilac on the east side. M-37 is a state primary, north-south road extending from Battle Creek in the southwestern part of the state to the northern tip of "Old Mission" peninsula just north of Traverse City (see Figure #1).

The east leg of the intersection is designated as M-37 and the west leg as M-46, while the north leg carries both M-37 and M-46. The south leg is a local county road (Newaygo Road).

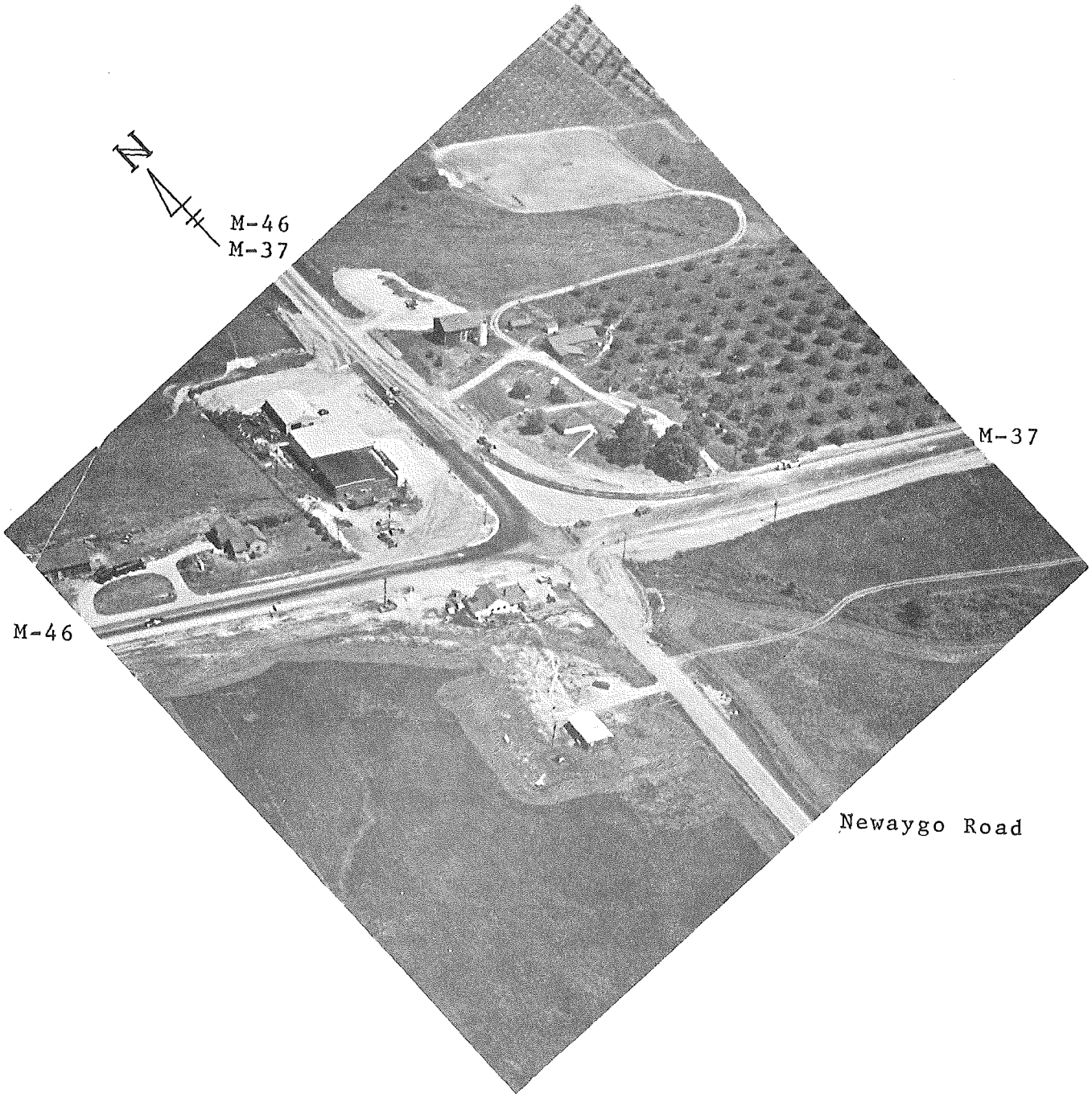

FIGURE #2

Site Location

All legs of the intersection are two lanes wide with two-way operation, except the north leg, which has a southbound right turn lane. Another exception is a special one lane turning roadway in the northeast quadrant which accommodates the large number of northbound M-37 right turns (see Figure #2). The north approach is on an upgrade at the intersection and is preceded by a hill crest located about 0.4 of a mile from the intersection (see Figures #3 and #4).

Problem

In reviewing the accident record, Table #1, it was found that 29 accidents occurred at this intersection during the two year before period (June 24, 1964 to June 23, 1966). Of these accidents, one was classed as a fatal, nine as injury, and 19 as property damage. These accidents resulted in one death and 24 injuries. It was noted that the accidents and the severity, in the "before" and "after" periods, were almost evenly distributed between the two years for each of these periods.

TABLE #1
ACCIDENT RECORD TABLE

	BEFORE 6-24-64 to 6-23-66	AFTER 7-26-66 to 7-25-68
SEVERITY OF ACCIDENT		
Total accidents	29	21
Property damage	19	16
Injury	9 (23*)	5 (8*)
Fatal	1 (1*, 1**)	0
TYPE OF ACCIDENT		
Turning from southbound M-46, M-37	7	2
Turning from eastbound M-46	9	1
Rear end (all legs)	9 (2***)	7
Lost control (all Legs)	4 (1***)	11

* Number of persons injured.
** Number of persons killed.
*** Number of accidents occurring approximately 0.4 miles north of the intersection.

FIGURE #3

Just north of the intersection on M-37, M-46 facing south

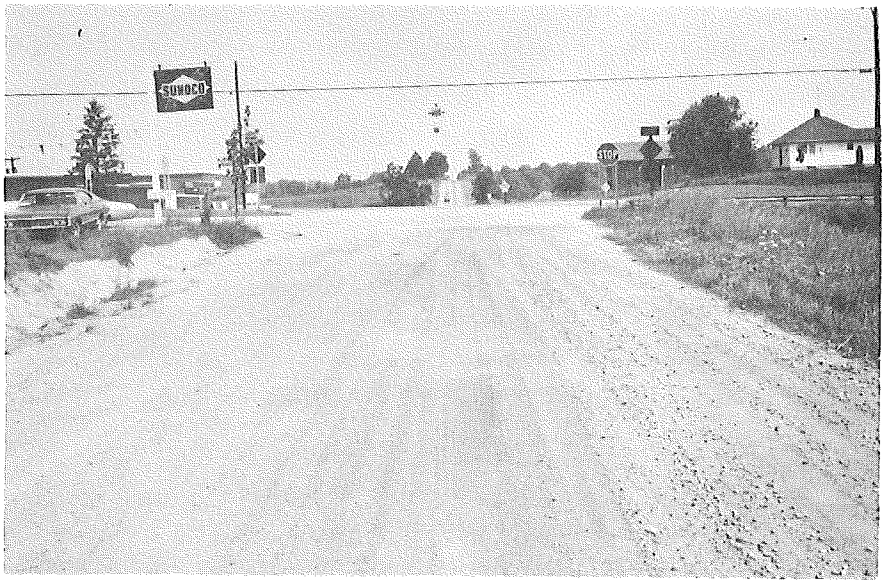

FIGURE #4

Just south of the intersection on Newaygo Road facing north

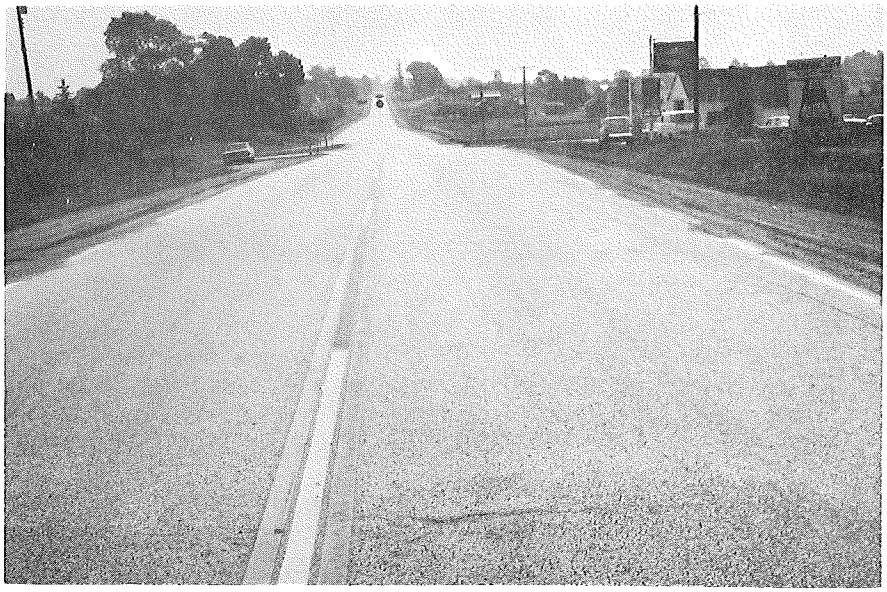

FIGURE #5

West of the intersection on M-46 facing east

A disproportionately high number of turning accidents, as shown in Table #1, sometimes can be relieved by a reassignment of right-of-way following an evaluation of the traffic flow pattern. The traffic flow occurring on a typical summer Saturday is shown in Figure #6, and the average daily traffic is shown in Table #2.

TABLE #2

Year	East Leg	West Leg	North Leg	Average ADT
1964	5,000	2,300	3,700	5,500
1965	4,900	2,400	4,300	5,800
1966				6,800*
1967	5,000	2,600	5,000	6,300
1968	5,500	3,400	5,000	6,950

* All the ADT information was obtained from the yearly ADT maps except 1966, which was estimated.

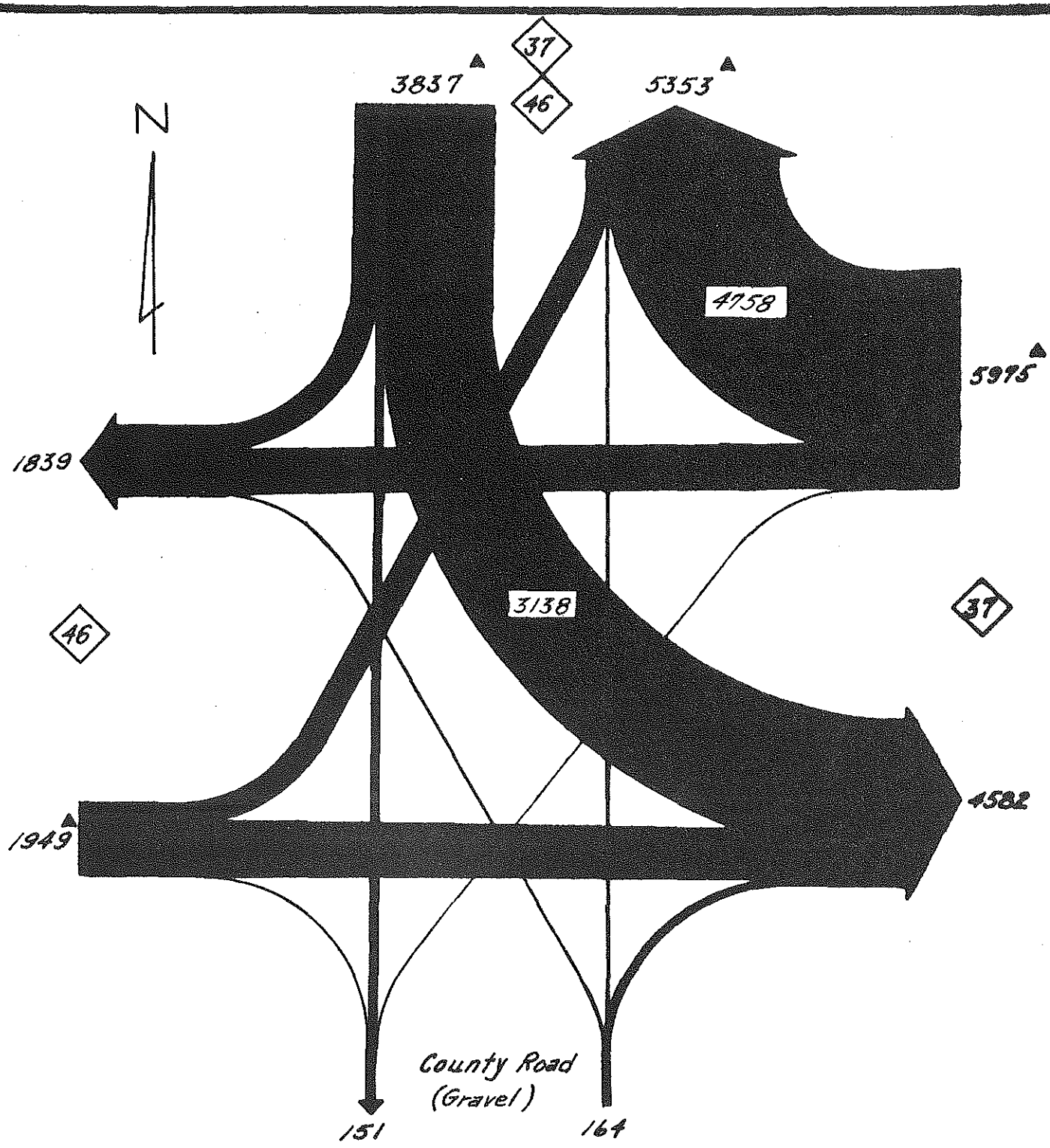

FIGURE 6

▲ Volumes from 24 hour Machine counts taken on Saturday August 14, 1965. All others are computed.

STATE OF MICHIGAN
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TRAFFIC & SAFETY DIVISION

TRAFFIC FLOW DIAGRAM

Improvement

The traffic flow diagram (Figure #6), reveals that when the free-flow right turn to northbound M-37 (east leg) is disregarded, then southbound M-37, M-46 carries 3,837 vehicles in 24 hours, the highest volume approaching the intersection. Of these, 3,799 vehicles (99.0%) were turning either left or right at the intersection while only 38 (1.0%) vehicles continued straight through on the county road. Typically, such a high number of turning movements require relatively long periods of waiting time when motorists search for an adequate gap to execute a safe turning movement. Therefore, it was mutually decided in a meeting between the Department of State Police and the Department of State Highways that the assignment of right-of-way should be changed at the intersection in order to improve safety and expedite operation. It was agreed that traffic on the east, west, and south legs of the intersection should be required to stop while traffic from the north would be allowed to flow freely.

The recommended change was put into effect in two stages to allow for a transitional period to familiarize the motorist.

Stage #1 consisted of putting a four-way stop into effect and was accomplished on June 24, 1966. The following changes were made: (1) a pair of "STOP" signs was installed on both the east and west legs; (2) the existing overhead, two-way, illuminated "STOP" sign was relocated to face the east and west rather than the north and south; (3) the overhead yellow signal flasher lenses were changed to red; (4) a pair of "STOP AHEAD" signs (one for each side of the roadway) was installed on the west approach,

580 feet from the intersection. In addition, two alternating yellow beacon flashers (8 inches in diameter) were added to the sign on the right (south side), and a lattice background was added to the sign on the left; (5) a "STOP AHEAD" sign was installed on the right hand side of the east approach, 1100 feet from the intersection (see Figures #5 and #8).

In Stage #2, the stop control for the north approach was removed July 26, 1966, providing for a free-flow condition for southbound traffic. This free-flow condition involved the changing of the overhead red flasher lens for southbound traffic to a yellow flasher lens. In addition to this, various signs were removed from the north approach; namely, a "PREPARE TO STOP" sign, two "STOP AHEAD" signs, and two "STOP" signs (see Figures #9 and #10).

There were two minor signing changes made on the east leg on June 20, 1968 (one month before the study period ended). The first improvement was the erection of a 90^{o} turn sign with a "25 MPH" advisory speed panel on the existing cantilever for northbound traffic desiring to turn right. The second improvement was the replacement of individual route marker units with a solid background sign in the gore of the turning lane (see Figures #7, #9, and #10).

Results

As can be seen by the accident record, the reassignment of traffic right-of-way was instrumental in reducing both accidents and their severity at this location (see Appendix A for statis-

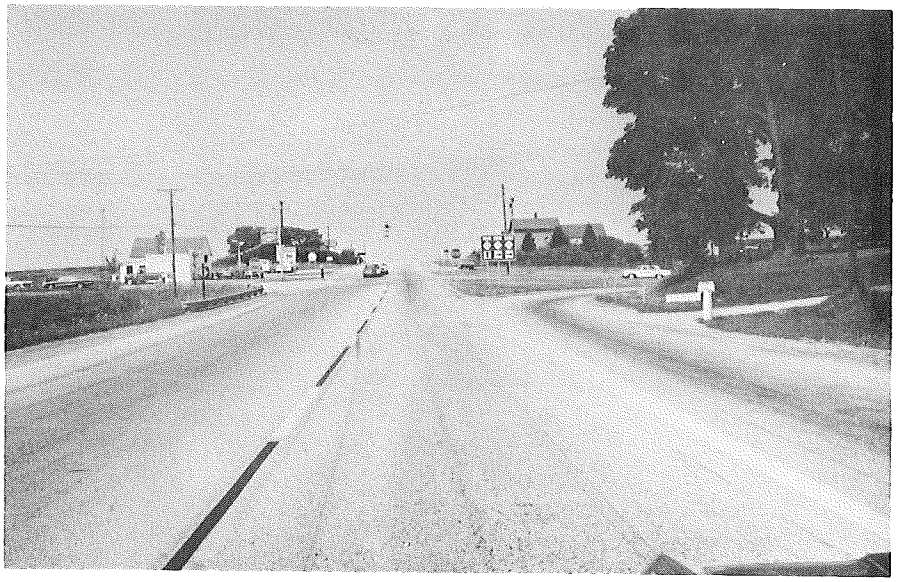


FIGURE #7

On M-37 at the intersection facing west

FIGURE #8

On M-46 facing east showing the advance "STOP AHEAD" warning signs

tical analysis). The turning accidents from southbound M-46, M-37 were reduced from 7 to 2 while the turning accidents from eastbound M-46 were reduced from 9 to 1. The accidents which occurred approximately 0.4 miles north of the intersection due to severe backup were eliminated.

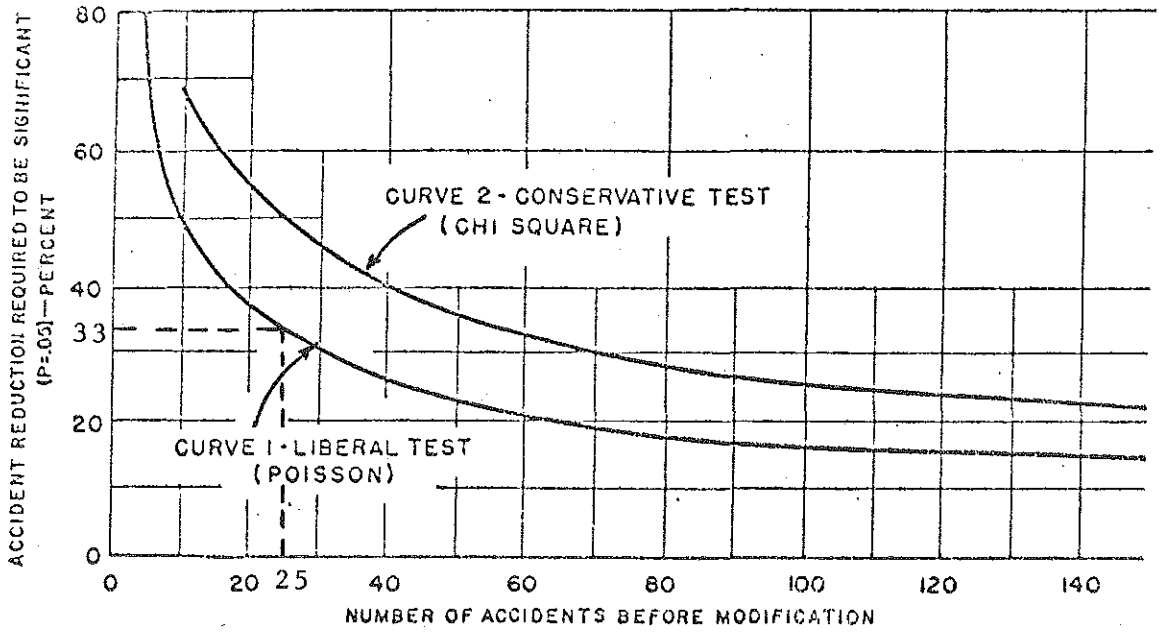
During a two year period following the improvement, the $1,135 project resulted in a public benefit of $45,500 (as determined by a National Safety Council accident criteria).*

* See Appendix B for cost analysis.

APPENDIX A

The Significance of the Accident Severity Reduction

The graph below appeared in an article entitled, "Two Simple Techniques for Determining the Significance of Accident Reduction Measures" by Richard H. Michaels in the September, 1966, issue of Traffic Engineering magazine.



Curves for determining the statistical significance of accident-reducing techniques.

Curve 1 is the liberal curve and may be used where more than minimum accident records are available such as two years before and two years after, as in this case. Curve 2 should be used where data may only be available one year before and one year after. For our improvement, we used the "number of persons killed and injured before modification" rather than the total "number of accidents before modification" which does not alter the validity of the graph.

During the two year period (June 24, 1964 to June 23, 1966) before the improvement, a total of 24 persons were injured and 1 was killed at the location. Combining these two figures, and using Curve 1, the percentage of reduction required to be significant is 33%. There was a 68% reduction in injury-fatalities at the subject location studied in this report.

Therefore, the accident severity reduction at this location after the improvement is statistically significant.

APPENDIX B

Cost Analysis

The method of evaluating accident costs, used below, is given on page 67 of Roy Jorgensen's report of Highway Safety Improvement Criteria, 1966 edition. This same method is given in the Bureau of Public Roads IM 21-3-67.

In the following analysis the costs provided by the National Safety Council are:

Death - $34,000

Non-fatal Injury - $1,800

Property Damage Accident - $310

$$B = \frac{ADT}{ADT_b}a \times (Q \times A_{fi} \times P_{fi} + 310 \times A_{pd} \times P_{pd})$$

where

B = benefit in dollars

ADT_a = traffic volume after the improvement
$6/12 \times 6,950 + 6,300 + 6/12 \times 6,000 = 12,775$

ADT_b = traffic volume before the improvement
$6/12 \times 5,500 + 5,800 + 6/12 \times 6,000 = 11,550$

A_{fi} = annual average number of fatalities and injuries combined at the locations during the two year before period (25)

P_{fi} = percentage reduction in fatalities and injuries

$$\frac{25 - 8}{25} \times 100 = 68\%$$

A_{pd} = property damage accidents in the two year before (19)

P_{pd} = percentage of reduction in property damage accidents

$$\frac{19 - 16}{19} \times 100 = 15.8\%$$

and $$Q = \frac{34,400 + I/F \times 1,800}{1 + I/F}$$

where

I/F = ratio of injuries to fatalities that occurred statewide during 1966 on rural state trunkline highways.

$$I/F = \frac{45,203}{807} = 56.0$$

therefore,

$$Q = \frac{34,400 + (56.0 \times 1,800)}{1 + 56.0} = 2,370$$

Then the computed benefit in dollars for two years after the completion of this project is:

$$B = \frac{12,775}{11,550} \left(2,370 \times 25 \times \frac{68}{100} + 310 \times 18 \times \frac{15.8}{100}\right) = \$45,500$$

N

PREPARE TO STOP

STOP AHEAD

A — A

SOUTH 37 WEST 46

M-46, M-37

MERGING TRAFFIC

DO NOT ENTER

WEST 46 EAST 46 NORTH 37

RIGHT TURN ↓ LANE

↑ MUSKEGON
NEWAYGO →

M- 46

M-37

R

Y F Y

R

STOP

STOP

NEWAYGO RD

NORTH 37 EAST 46 SOUTH 37

↑ GRAND RAPIDS
← NEWAYGO

OVERHEAD ILLUMINATED

APPROXIMATELY 0.4 MILE

2 ACCS.

M-46 M-37

3 ACCS.

2 ACCS.

2 ACCS.

3 ACCS.

M-46

M-37

CO. RD.

BEFORE PERIOD

6-24-64 TO 6-23-66
29 ACCIDENTS
1 FATAL 1 KILLED 1 INJURED
9 INJURY 23 INJURED
19 PROPERTY DAMAGE

LEGEND

FATAL
INJURY
PROPERTY DAMAGE
F FLASHING BEACON
R RED BEACON
Y YELLOW BEACON

FIGURE 9

N

SOUTH 37 WEST 46

M-46, M-37

MERGING TRAFFIC

RIGHT TURN LANE

25 MPH

CURVE SPEED WITH ARROW INSTALLED 6-20-68

STOP AHEAD

DO NOT ENTER

SOUTH 37 WEST 46

WEST 46 EAST 46 NORTH 37

ERECTED 6-20-68

STOP AHEAD

MUSKEGON
NEWAYGO

M-46

M-37

Y
R F R
R

STOP

STOP

NEWAYGO RD.

NORTH 37 EAST 46 SOUTH 37

GRAND RAPIDS
NEWAYGO

STOP AHEAD

ALTERNATING FLASHERS

STOP

OVERHEAD ILLUMINATED

2 ACCS.

M-46, M-37

AFTER PERIOD
7-26-66 TO 7-25-68
21 ACCIDENTS
5 INJURY 8 INJURED
16 PROPERTY DAMAGE

3 ACCS

2 ACCS.

M-46

M-37

CO. RD.

LEGEND

PARKED CAR
INJURY
PROPERTY DAMAGE
F FLASHING BEACON
R RED BEACON
Y YELLOW BEACON

FIGURE 10