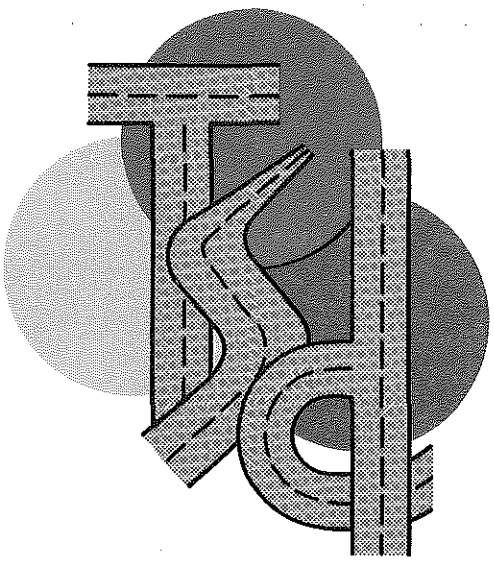
Report TSD-266-73

A TRAFFIC ACCIDENT ANALYSIS AND A TRAFFIC CONTROL DEVICES INVENTORY IN BERRIEN COUNTY



TRAFFIC and SAFETY DIVISION

DEPARTMENT OF STATE HIGHWAYS
STATE OF MICHIGAN

Michigan Department

of

State Highways and Transportation

Report TSD-266-73

A TRAFFIC ACCIDENT ANALYSIS AND A TRAFFIC CONTROL DEVICES INVENTORY IN BERRIEN COUNTY

JOSEPH L. MESZAROS

TRAFFIC ENGINEERING SERVICES

April 1974

PREPARED BY

Traffic Engineering Services
Traffic and Safety Division
Michigan Department of State Highways and Transportation

in cooperation with
The Michigan Office of Highway Safety Planning
and
The U. S. Department of Transportation
Federal Highway Administration

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MICHIGAN DEPARTMENT OF STATE POLICE

Lt. Zane Gray
Lt. Charles Weirman
Sgt. Miller Richter

BERRIEN COUNTY

Ralph B. Hornbeck - Chairman
Dale Douthett - Member
Martin J. Tretheway - Member
Thomas A. Webb - Engineer-Manager
Frank Rupe - Engineer

MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

G. J. McCarthy	Deputy Director - Highways
M. N. Clyde	Engineer of Traffic and Safety
R. L. Kuzma	Supervising Engineer
U. L. Savage	Project Engineer
K. J. O'Berry	Assisting Technician
D. J. McDonald	Assisting Technician
D. V. Wilson	Assisting Technician

MICHIGAN OFFICE OF HIGHWAY SAFETY PLANNING

Noel C. Bufe - Director

FHWA Project MCD-73-001B

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INTRODUCTION

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

Purpose

Highway Safety Standard 4.4.13, Traffic Engineering Services, is one of those standards. The purpose of Standard 4.4.13 is

> "to assure the full and proper application of modern traffic engineering principles and uniform standards for traffic control to reduce the likelihood and severity of traffic accidents.".

This standard includes the identifying of specific locations or sections of streets and highways which have a high accident experience or potential as a basis for establishing priorities for improvement, selective enforcement or other practices that will eliminate or reduce the hazards. It provides an orderly inventory of all traffic control devices, which include those signs, signals, markings and devices placed on, over or adjacent to a street or highway to regulate, warn and guide vehicular and pedestrian traffic.

The State of Michigan carries out a service of this type on the state trunkline system; however, many of the city and county agencies lack the financial and technical prerequisites necessary to pursue similar programs with similarly defined objectives. To insure that this additional highway safety standard is met and to improve the overall evaluation of the accident picture in Michigan, the Michigan Department of State Highways and Transportation requested and received through the Office of Highway Safety Planning in the Department of State Police, a federally funded project entitled "Traffic Engineering Services 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 corrections to those conditions which may be contributing to accidents; and additionally will recommend the upgrading of traffic control devices where necessary.

Scope

The intent of this program is to improve traffic safety on all Michigan streets and roads by expanding the traffic engineering evaluation of factors causing accidents, and by providing uniform standards for traffic control to reduce the likelihood and severity

of traffic accidents.

Study Procedures

The study procedures for this project involve a review of high accident locations, and an inventory of traffic control devices. The review of high accident locations includes: basic data collection, identifying and locating high accident locations, an accident analysis of these high accident locations, technical evaluation of accident facts, and consequent remedial recommendations.

The traffic control devices inventory includes: a field review of all major non-trunkline routes noting the placement, condition and adequacy of traffic control devices, tabulating the field data, determining priorities for upgrading of traffic control devices and determining costs for this program.

Study Area

Berrien County is located in the southwest corner of the state (Figure 1). It is bordered on the south by the state of Indiana, on the east by Cass and Van Buren Counties and on the west by Lake Michigan.

The road system of Berrien County, according to the Twenty-Second Annual Progress Report as compiled by the Local Government Division of the Michigan Department of State Highways and Transportation, consists of 179.25 miles of state trunkline, 467.42 miles of county primary roads and 975.77 miles of county local roads for a total of 1,622.64 miles of roadway.

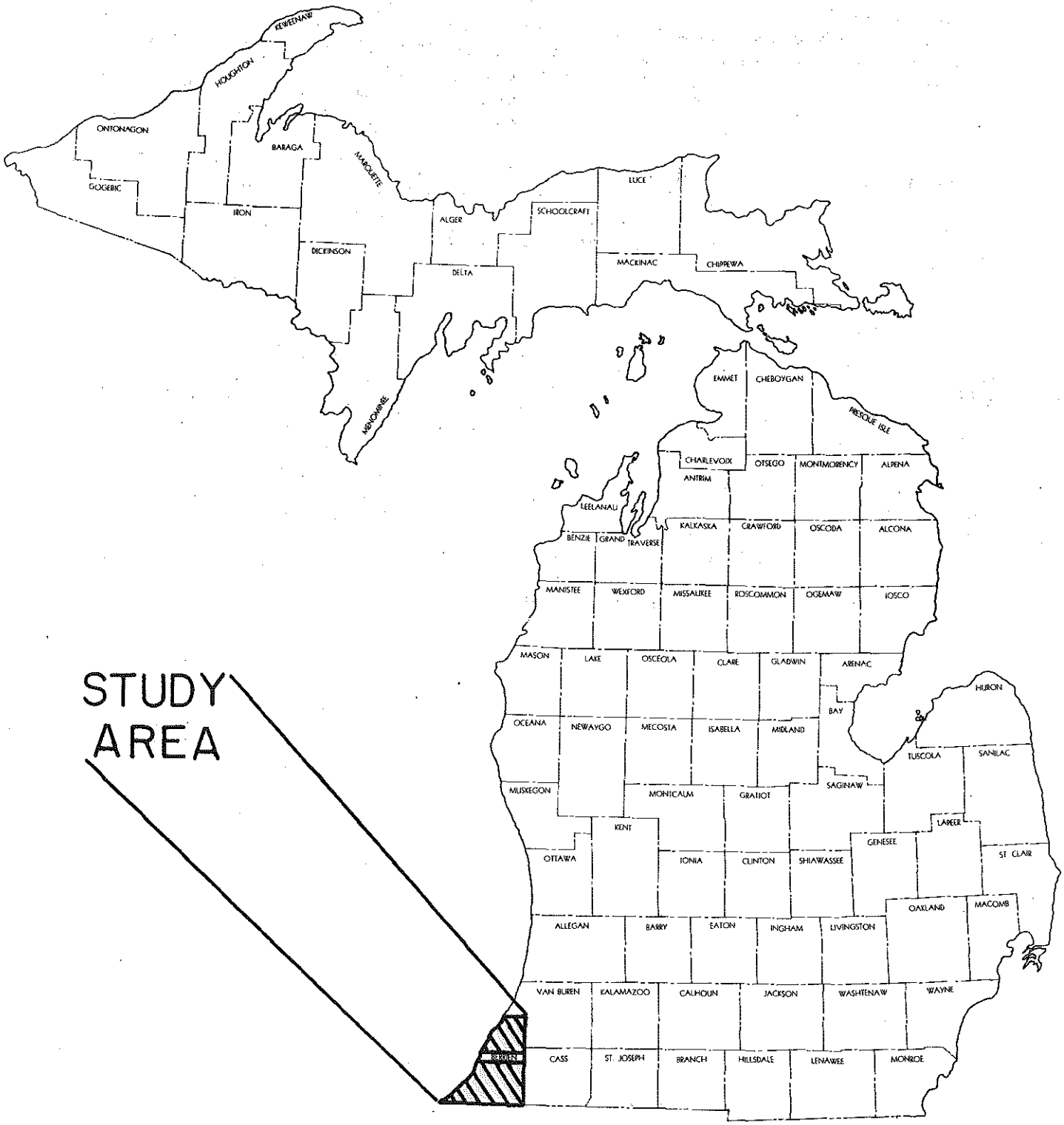
KEWEENAW
HOUGHTON
ONTONAGON
BARAGA
MARQUETTE
GOGEBIC
IRON
DICKINSON
ALGER
SCHOOLCRAFT
LUCE
DELTA
MACKINAC
CHIPPEWA
MENOMINEE
EMMET
CHEBOYGAN
PRESQUE ISLE
CHARLEVOIX
OTSEGO
MONTMORENCY
ALPENA
ANTRIM
LEELANAU
BENZIE
GRAND TRAVERSE
KALKASKA
CRAWFORD
OSCODA
ALCONA
MANISTEE
WEXFORD
MISSAUKEE
ROSCOMMON
OGEMAW
IOSCO
MASON
LAKE
OSCEOLA
CLARE
GLADWIN
ARENAC
HURON
BAY
OCEANA
NEWAYGO
MECOSTA
ISABELLA
MIDLAND
TUSCOLA
SANILAC
MUSKEGON
MONTCALM
GRATIOT
SAGINAW
KENT
LAPEER
GENESEE
OTTAWA
IONIA
CLINTON
SHIAWASSEE
ST CLAIR
OAKLAND
MACOMB
ALLEGAN
BARRY
EATON
INGHAM
LIVINGSTON
VAN BUREN
KALAMAZOO
CALHOUN
JACKSON
WASHTENAW
WAYNE
BERRIEN
CASS
ST. JOSEPH
BRANCH
HILLSDALE
LENAWEE
MONROE
STUDY AREA

FIGURE 1

TRAFFIC ENGINEERING ANALYSIS

Control Devices Inventory

Collection of Field Data - In the traffic control devices inventory, all county-maintained control devices on the County Primary Road System including the Federal-Aid Secondary routes (Figure 2) within Berrien County were surveyed. All county-maintained signs on this system were inventoried, including "Stop", "Yield" and advance warning signs on other roads which intersect the inventoried routes. Traffic control devices which are adequate in their present state were tabulated by the field crews and are included on the inventory sheets. Additional traffic control devices and those in need of replacement were also located on the inventory sheets by establishing their distance in miles from a major crossroad, city or village limit, or the county line.

All signs on the County Primary Road System were inventoried by driving west to east or south to north, depending on the basic direction of the route, except for those with directional arrows along the roadway alignment indicating the inventoried direction. In the case of two intersecting inventoried routes, the "Stop" and "Yield" signs at such intersections were inventoried on their respective routes. All signs are shown at each intersection.

Traffic Control Orders for speed and parking control zones on the County Primary Road System were checked with the Department of State Police. All areas along the inventoried routes were checked to ensure compliance with these Traffic Control Orders, as well as the "Michigan Manual of Uniform Traffic Control Devices".

Conversion of Field Data - Two simple forms (Inventory Sheets and Quantity Sheets) were developed upon which to record the collected field data. These forms will enable the Berrien County Road Commission's personnel to determine the necessary work which must be done per route and countywide.

Inventory Sheets - The inventory sheets are 11" x 16" ozalid reproductions that show existing traffic controls and those controls that are needed in order to bring the inventoried route up to standards.

Those signs which are adequate in their present state are merely shown on these sheets. At locations where alterations in the present signing are necessary, a description

5

LEGEND

APPROVED FEDERAL AID SYSTEM	PROPOSED REVISIONS
INTERSTATE	ADDITION TO _____ SYSTEM
INTERSTATE AND PRIMARY	DELETION FROM _____ SYSTEM
PRIMARY	
SECONDARY (STATE)	FEDERAL-AID URBAN BOUNDARY
SECONDARY (COUNTY)	REVISED TO JANUARY 1, 1973
URBAN	

FOR FEDERAL - AID SYSTEM DETAILS SEE FEDERAL - AID SYSTEM AND URBAN AREA BOUNDARY MAP.

KEY TO COUNTIES

L A K E

M I C H I G A N

I N D I A N A

FIGURE 2

FEDERAL AID SYSTEMS

BERRIEN COUNTY

MICHIGAN

STATE HIGHWAY DEPARTMENT

DATA OBTAINED FROM

HIGHWAY PLANNING SURVEY

CONDUCTED IN COOPERATION WITH

U.S. DEPARTMENT OF COMMERCE

BUREAU OF PUBLIC ROADS

BERRIEN COUNTY MICHIGAN 11

of these alterations is shown on the Inventory Sheets. A number is circled at each location where work must be done. This number designation shows the priority by which the work should be completed. The two priorities are as follows:

Sign Work

(1) Work which should be completed as soon as possible.
(2) Work which should be completed when and if the existing signing is replaced with symbol signing.

Quantity Sheets - There are two sets of quantity sheets, one set for the county wide signs and one set for each route. The county wide quantity sheets (located in the beginning of the 11" x 16" book) indicate the total number of signs which are needed under priority one and priority two and those signs requiring no change. The quantity sheets for each route (located at the beginning of each route in the 11" x 16" book) indicate the number of signs which are needed under priority one and priority two and the number of signs requiring no change. Signals and flashers appearing at the junction of two inventoried routes will be found on the quantity sheet pertaining to the east-west route.

Maintenance of Inventory - The Inventory sheets (both ozalid and cronaflex copies) show those signs which should be erected, those which must be removed, those which must be relocated and those which are adequate in place. It is recommended that all unnecessary notes and priority numbers be erased (from the cronaflex copies) as each portion of work is completed. When all of the work has been completed and the necessary erasures made on the Inventory (cronaflex copy) sheets, the signs remaining will be those which are in place on the road system.

It is recommended that the Berrien County Road Commission make the necessary corrections to the inventory as future signs are installed, removed or altered.

Signs

Regulatory

A comprehensive study of traffic control devices on the Berrien County Primary Road System has established a need for installation or maintenance of approximately 32 percent of the required regulatory signs. The primary reason for this deficiency was the lack of "STOP" (R1-1) signs, "YIELD" (R1-2)

signs, Multiway Stop (R1-3) panels, Speed Limit (R2-1) signs, "REDUCED SPEED _____ AHEAD" (R2-5b) signs, Lane-Use Control (R3-5) signs, "NO PARKING AT ANY TIME" (R7-1) signs, and Railroad Crossbucks (R15-1) signs.

There are two locations along the inventoried routes where speed control signs are in place, but are not legal, due to the lack of the necessary Traffic Control Order. It was noted on the Inventory sheets that the signs relating to these illegal speed control zones be removed. However, if these speed control signs are necessary, the Berrien County Road Commission should contact the Department of State Police and pursue the legal requirements for determining and establishing these speed control zones. The areas in question are:

F.A.S. 1377 (Lincoln Avenue) from 0.1 mile South of Vineland Drive to 0.1 mile North of Clemens Avenue (School Speed Limit 25) (2 signs).

F.A.S. 1614 (Galien-Buchanan Road) from Broceus School Road to Bakertown Road (45 mph) (1 sign).

It is recommended that speed control signs be installed at approximately one-half mile intervals within the speed control zones to confirm the speed of that zone.

There are 20 locations along the inventoried routes where parking control signs are in place, but are not legal, due to the lack of necessary Traffic Control Orders. It was noted on the Inventory sheets that the signs relating to the illegal parking control zones be removed. However, if these parking control signs are necessary, the Berrien County Road Commission should contact the Department of State Police and pursue the legal requirements for determining and establishing these parking control zones. The areas in question are:

F.A.S. 1 (Territorial Road) from Crystal Avenue to Euclid Avenue on both sides ("No Parking") (4 signs)

F.A.S. 247 (Napier Avenue) from St. Joseph River to Broadmoor Drive on both sides ("No Parking At Any Time") (12 signs)

F.A.S. 247 (Napier Avenue) west of Colfax Avenue on the north side ("Parallel Parking Only") (2 signs)

F.A.S. 247 (Napier Avenue) west of Colfax Avenue on the south side ("No Stopping Standing Parking") (1 sign)

F.A.S. 1376 (Sawyer Road) from Wolcott Avenue to Peck Avenue on the north side ("Angle Parking Only") (5 signs)

F.A.S. 1376 (Sawyer Road) from Wolcott Avenue to Peck Avenue on the south side ("Parallel Parking Only") (2 signs)

F.A.S. 1376 (Sawyer Road) from Wolcott Avenue to Peck Avenue on the south side ("No Parking At Any Time") (2 signs)

F.A.S. 1376 (Sawyer Road) from Wolcott Avenue to Peck Avenue on the south side ("No Parking Between Signs") (2 signs)

F.A.S. 1615 (Dayton Road) from US-12 to Depot Street on the east side ("No Parking At Any Time") (2 signs)

F.A.S. 1620 (Lemon Creek Road) west of Gray Road on the north side ("No Parking This Side") (1 sign)

F.A.S. 1623 (Glenlord Road) west of Roosevelt Road on the south side ("Parallel Parking Only") (2 signs)

F.A.S. 1626 (River Road) from Dutch Lane to Naomi Road on the east side ("No Parking At Any Time") (2 signs)

F.A.S. 1664 (Pipestone Road) from Downing Avenue to Lynn Avenue on either side ("No Parking At Any Time") (3 signs)

F.A.S. 1700 (Red Bud Trail) north of Grange Road on the west side ("No Parking At Any Time") (4 signs)

F.A.S. 1800 (Red Arrow Highway) from Prairie Road to Springbend Road on the north side ("No Parking At Any Time") (3 signs)

F.A.S. 1800 (Red Arrow Highway) from Linco Road to Livingston Road on the west side ("No Parking") (2 signs)

F.A.S. 1801 (Red Arrow Highway) east of the E. City Limits of Watervliet on the south side ("No Parking") (2 signs)

County Primary (3rd Street) south of the S. City Limits of Niles on the east side ("No Parking") (1 sign)

County Primary (North Shore Drive) from Higman Park Road to Ridgeway Road on the west side ("No Parking On Hill") (1 sign)

County Primary (North Shore Drive) from Collins Road to Blue Star Highway (US-33) on the west side ("No Parking This Side") (3 signs)

There is one location along the inventoried routes where a parking control sign is in place, but is not legal, since the Traffic Control Order on file has been rescinded. It was noted on the Inventory sheets that the sign relating to the illegal parking control zone be removed. The area in question is:

County Primary (North Shore Drive) south of Higman Road on the east side ("No Parking At Any Time") (1 sign)

Warning

The inventory indicates a need for installation of approximately 55 percent of the required warning signs. The most evident deficiency is the need for additional Turn (W1-1) signs, Curve (W1-2) signs, Reverse Turn (W1-3) signs, Reverse Curve (W1-4) signs, Target Arrows (W1-6) signs, Bi-Directional Target Arrows (W1-7) signs, "STOP AHEAD" (W3-1) signs, Type III Object Markers, Advisory Speed (W13-1) plates, School Advance (S1-1) signs and School Crossing (S2-1) signs.

The traffic control devices inventory also reveals a need for many Type III Object Marker panels. It is permissible to use reflective liquids in place of Type III Object Markers where the obstruction would not be hidden by weeds growing along the road. For the purpose of estimating costs, it is assumed that Berrien County will use the Type III Object Marker panels at all locations.

No-Passing Zones

It was noted that there were approximately 750 no-passing zones designated by signs and/or markings on the County Primary Road System in Berrien County. A no-passing zone is defined as a section of roadway having insufficient passing sight distance. It is recommended that, as time and resources of the County Road Commission permit, a field survey be completed on all sections of hard-surfaced roads where sight distances are restricted. Such a field survey should result in any necessary corrections being made to the limits of existing no-passing zones and the establishment of new zones where necessary.

After the field survey is completed, no-passing zones should be indicated by solid yellow lines applied along the limits established by the survey. Then "DO NOT PASS" (R4-1) and "PASS WITH CARE" (R4-2) signs may (at the option of the County Road Commission) be placed at the limits of the no-passing zones; however, when either of these signs is used, they shall both be erected. Where additional notice is deemed necessary for a no-passing zone, a pennant-shaped "No Passing Zone" sign (W14-3) shall be located on the left side of the roadway opposite the beginning of the zone.

Pavement Markings at Railroad Crossings

The approach pavement at several of the railroad crossings was not properly marked. The pavement marking in advance of a railroad crossing shall consist of an X, the letters RR, a no-passing marking, and certain transverse lines. They should be placed on all paved approaches to railroad crossings. These markings, if physically feasible, shall be placed at all grade crossings where railroad crossing signals or automatic gates are operating, and at all other crossings when the prevailing speed of highway traffic is 40 mph or greater.

The markings shall also be placed at crossings when engineering studies indicate there is a significant potential conflict between vehicles and trains. At minor crossings or in urban areas, these markings may be ommitted if engineering studies indicate that other devices installed provide suitable protection. Such markings shall be white except for the no-passing markings.

Cost Estimate

The cost estimate for the work shown on the Inventory sheets, including materials, labor costs involved in

installing signs, sign supports, or straightening signs or supports, is as follows:

Priority 1	$ 71,116.10
Priority 2	704.00

Date of Field Survey

The inventory of all the traffic control devices on the County Primary Road System in Berrien County was completed in June 1973.

Accident Analysis

Collection and Analysis of Field Data

The Department of State Police examined their records and transmitted to the Traffic and Safety Division of the Michigan Department of State Highways and Transportation a list of 11 high accident locations (Figure 3) on the county road system. An automated system of locating accidents on local roads has not yet been established on a statewide basis; therefore, the high accident locations for Berrien County were determined by manually extracting and compiling those locations with the highest number of accidents from the 1970 county accident reports.

Once the problem locations were identified, additional accident information for the years 1969 and 1971 was compiled in order to expand the accident base at each location. The 11 high accident locations accounted for 438 accidents during the three-year period. Traffic volumes on the County Primary Road System in Berrien County vary from moderate in outlying areas to heavy near the Cities of Benton Harbor and St. Joseph and along Red Arrow Highway. It is understandable then that the high concentration of accidents will be in these areas (Figure 4).

The second portion of the data collection, which is the responsibility of the Department of State Highways and Transportation, involves the following basic steps: 1) preparation of collision diagrams and physical condition diagrams for each location; 2) obtaining traffic and speed study counts where necessary; and 3) conducting skidometer tests at locations where wet pavement accidents reoccur.

The analysis portion of the high accident location review involves the analysis of the summarized facts and field data from the viewpoint of a highway traffic engineer with special attention focused on the effect which the highway environment may have had on the accident. Thus,

SPOT MAP
OF HIGH ACCIDENT LOCATIONS
IN
BERRIEN COUNTY
1969—1971

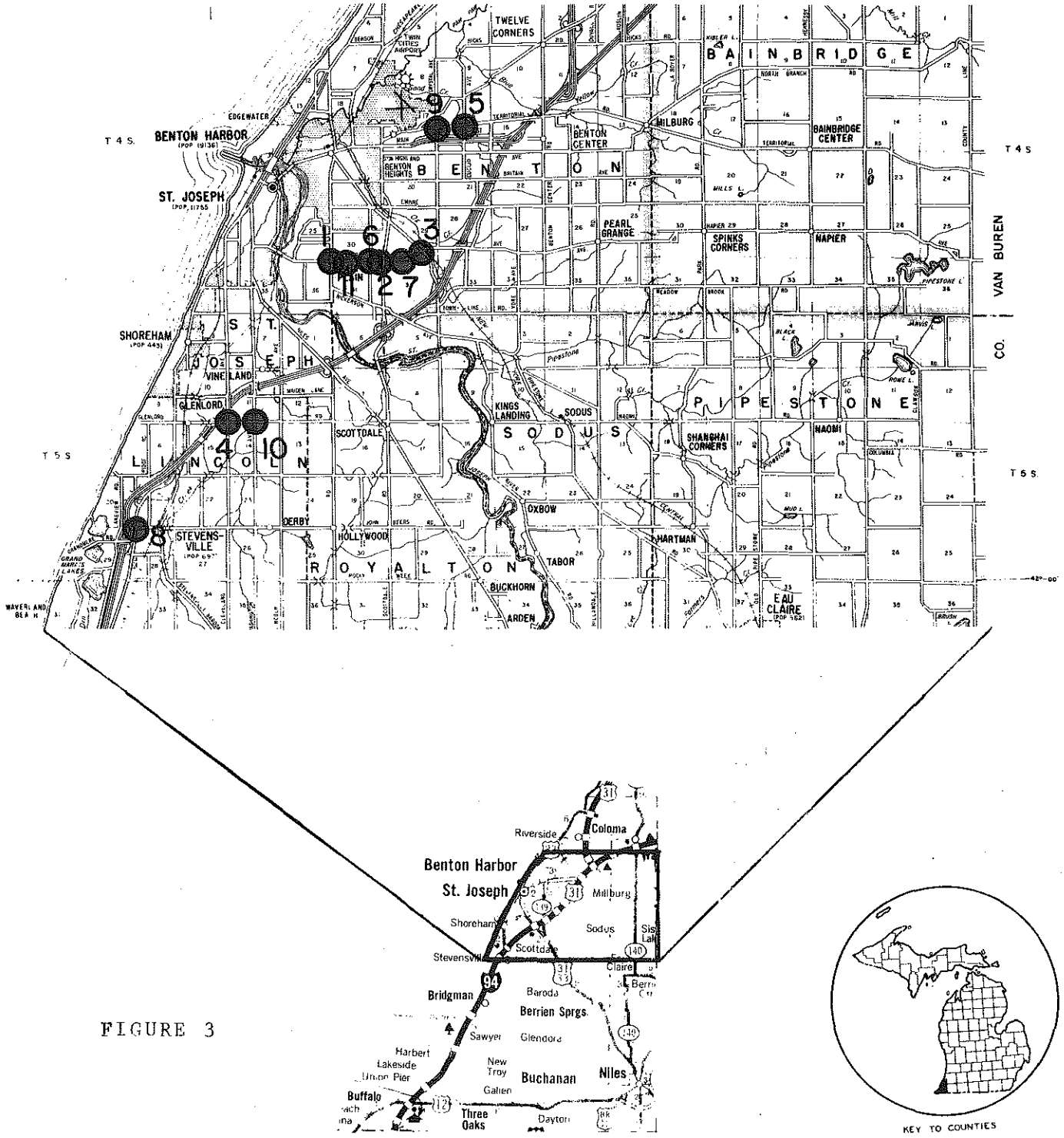

FIGURE 3

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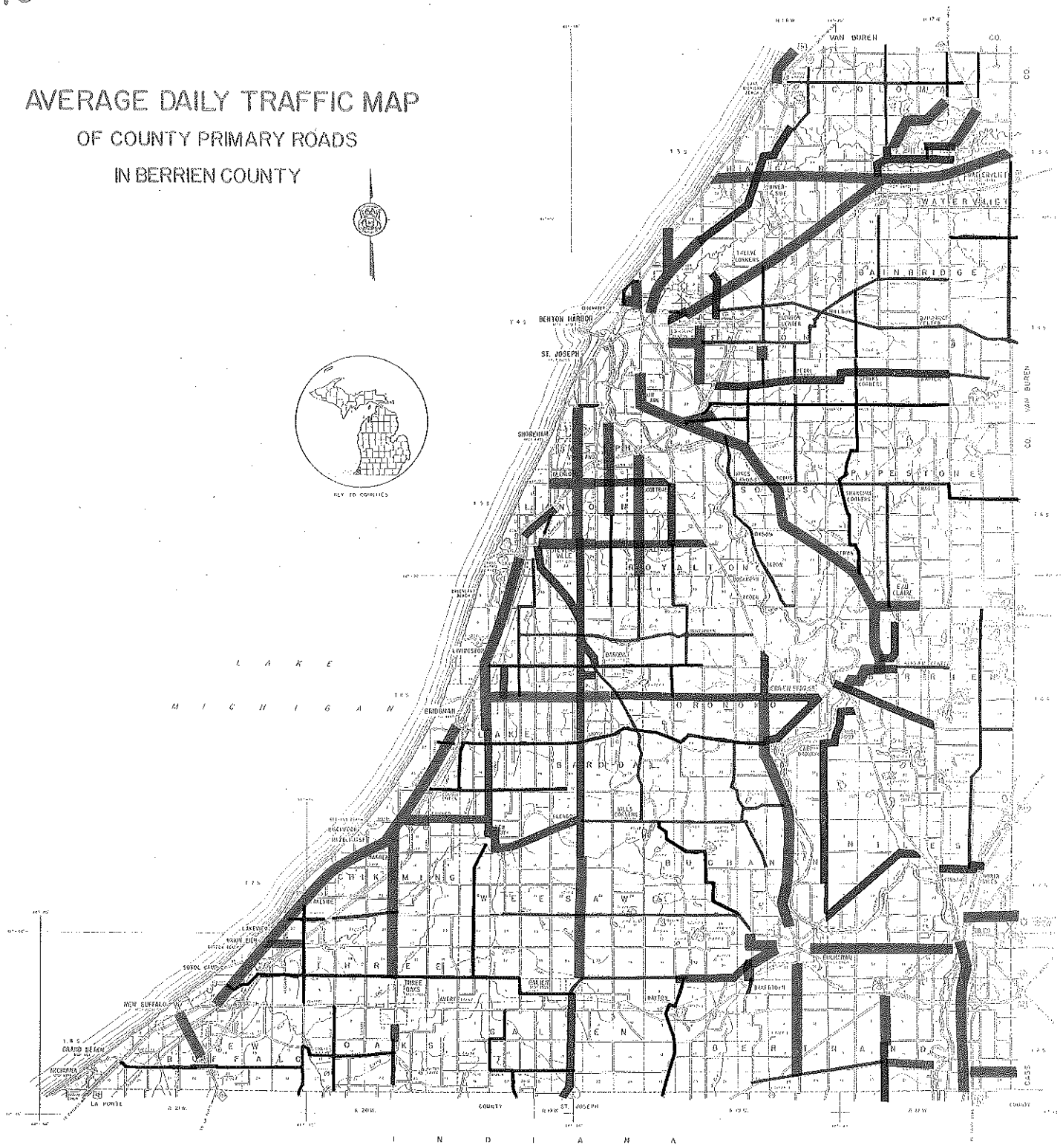
AVERAGE DAILY TRAFFIC MAP

OF COUNTY PRIMARY ROADS

IN BERRIEN COUNTY



LEGEND

- 2000 -- OVER
- 1500 -- 1999
- 1000 -- 1499
- 500 -- 999
- 0 -- 499

DATA OBTAINED FROM THE HIGHWAY NEEDS STUDY COMPILED BY THE TRANSPORTATION PLANNING DIVISION, MICHIGAN DEPARTMENT OF STATE HIGHWAYS.

FIGURE 4

BERRIEN COUNTY

MICHIGAN
STATE HIGHWAY COMMISSION
DEPARTMENT OF STATE HIGHWAYS

DATA OBTAINED FROM
HIGHWAY PLANNING SURVEY
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

BERRIEN COUNTY MICHIGAN

at each high accident location, individual accident reports were reviewed in detail and collision diagrams were prepared for each location in order to identify accident patterns and to locate the accident in relation to the intersection or approaches to the intersection. The analysis results in evaluating the total information and prescribing the proper treatment at each location.

County Wide Recommendations

Traffic Signals

In Berrien County there is one high accident location that involves signalization. This signalized location has only one overhead vehicular signal head. According to the new Manual a minimum of two signal faces per approach shall be provided. Some reasons for the two signal faces are:

1. Two (or more) properly located overhead faces will in almost all cases provide drivers with a signal indication even though trucks or buses may momentarily obscure one signal face.

2. Multiple faces provide a safety factor where the signals must compete with a brilliant background such as advertising signs or the sun.

3. The occasional inevitable lamp failure in one face will not leave an approach without any signal indication.

Therefore, it is recommended that this location and all other signalized intersections under the county jurisdiction be provided with two signal faces per approach.

Driveway Controls

Field observations reveal that driveway controls at or near some of the high accident locations were nonexistent. It is therefore recommended that Berrien County initiate a policy concerning proper driveway control. As the county develops and more commercial establishments are erected, driveways will continue to be a serious problem. Without having a specific driveway, vehicles enter and exit indiscriminately, creating a potential accident hazard. New driveway permits should include regulations that conform to the driveway standards as set forth by the Michigan

Department of State Highways and Transportation in the booklet, "Administrative Rules Regulating Driveways, Banners and Parades On and Over Highways".

Clear Vision Areas

In order to provide ample sight distances at intersections, the corners of these intersections must not be overgrown with foliage nor have other obstructions. Although sometimes buildings or other permanent obstacles create inadequate visibility, most of the time removable objects such as trees, signs or parked vehicles prohibit adequate sight distances. It is therefore recommended that Berrien County not only establish a program to create clear vision corners at all intersections, but also begin a maintenance program to insure that all corners are kept clear of obstacles.

4-Way Stops

In Berrien County there appears to be a substantial use of 4-Way Stops to control traffic at certain high accident locations. The Michigan Manual states that a "4-Way Stop" installation is useful as a safety measure at some locations and should ordinarily be used only where the volume of traffic on the intersecting roads is approximately equal.

Any of the following conditions may warrant a 4-Way Stop sign installation:

1. Where traffic signals are warranted and urgently needed, the 4-Way Stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the signal installation.

2. An accident problem, as indicated by five or more reported accidents of a type susceptible of correction by a 4-Way Stop installation in a 12-month period. Such accidents include right and left turn collisions as well as right-angle collisions.

3. Minimum traffic volumes:
   (a) The total vehicular volume entering the intersection from all approaches must average at least 500 vehicles per hour for any eight hours of an average day, and
   (b) The combined vehicular and pedestrian volume from the minor street or highway must average at

least 200 units per hour for the same eight hours, with an average delay to minor street vehicular traffic of at least 30 seconds per vehicle during the maximum hour, but
(c) When the 85-percentile approach speed of the major street traffic exceeds 40 miles per hour, the minimum vehicular volume warrant is 70 percent of the above requirements.

It is recommended that these warrants be applied at locations where the 4-Way Stop operation is being considered as a safety installation.

New Construction

Of the many techniques employed in reducing accidents and increasing capacity at intersections, one of the most effective methods is through the use of construction to aid in eliminating deficiencies that have been created as the traffic increases and as the intersection's geometrics become outdated. In 1970 Napier Avenue, between M-139 and Colfax Avenue, was widened from two lanes for moving traffic to four lanes through construction. This segment of roadway included three high accident locations: Napier Avenue at Milton Street, Napier Avenue at Union Street, and Napier Avenue at Broadway Street. The accident record at two of these locations after construction indicated a dramatic reduction in accidents with the other location showing an increase in accidents. However, the overall results indicate a reduction with 65 accidents occurring before construction and 39 accidents occurring after construction.

Estimated Costs

Since final construction plans are not available the lump sum of $5.00 per square foor of pavement has been used in estimating the construction costs. The costs for all other recommendations are based on Department unit prices and using Department personnel for the work.

High Accident Locations

After our analysis of the 11 high accident locations was complete, engineering recommendations were formulated for six of these locations. In the five other locations, Berrien County incorporated sufficient changes at each location during or just after the study period to correct the deficiencies at these locations. These corrective measures included such techniques as new construction which occurred at three locations (Locations 2, 6 and 10) and

and conversion of two locations (Locations 4 and 9) to 4-Way Stop operation. An analysis of the accident data suggests that this action was correctly undertaken at all five of these locations.

The high accident locations for the study period (1969-1971) are as follows:

	Location	Accidents
1.	Napier Avenue and Colfax Avenue	108
2.	Napier Avenue and Milton Street	52
3.	Napier Avenue and Pipestone Road	43
4.	Cleveland Avenue and Glenlord Road	38
5.	Euclid Avenue and Territorial Road	35
6.	Napier Avenue and Union Street	32
7.	Napier Avenue East of M-139	31
8	Red Arrow Highway and John Beers Road	29
9.	Territorial Road and Crystal Avenue	25
10.	Washington Avenue and Glenlord Road	25
11.	Napier Avenue and Broadway Street	20

COLFAX AVENUE AT NAPIER AVENUE

Operational Analysis:

Colfax Avenue intersects Napier Avenue to form a right-angle intersection operating under traffic signal control. The right-of-way assignment is based on a 60 second cycle with a 60-40 percent split, yellow clearance intervals of five percent (3.0 seconds) and a three percent (1.8 second) all red phase. This signal is not coordinated with other signalized intersections along Napier Avenue. There are numerous driveways and narrow approach lanes on each leg at this intersection.

Accidents:

Type	1969	1970	1971	Total
Rear End	11	19	15	45
Right Angle	7	8	5	20
Head On-Left Turn	6	4	5	15
Sideswipe	3	1	4	8
Turning	1	5	1	7
Misc.	2	9	2	13
Total	30	46	32	108

The miscellaneous types include five improper backings, four ran off roadway, two bicycle-vehicles, one involving an open car door and one pedestrian. The accident rate at this location was 3.3 acc/MV during the study period.

Thirty-four of the accidents occurred on wet pavement. Seventy-five percent of the right-angle accidents involved vehicles exiting and/or entering driveways and were not involved with the operation of the intersection.

Since only one lane is available for thru and right turn movement on each approach leg, there has developed a capacity deficiency at this location.

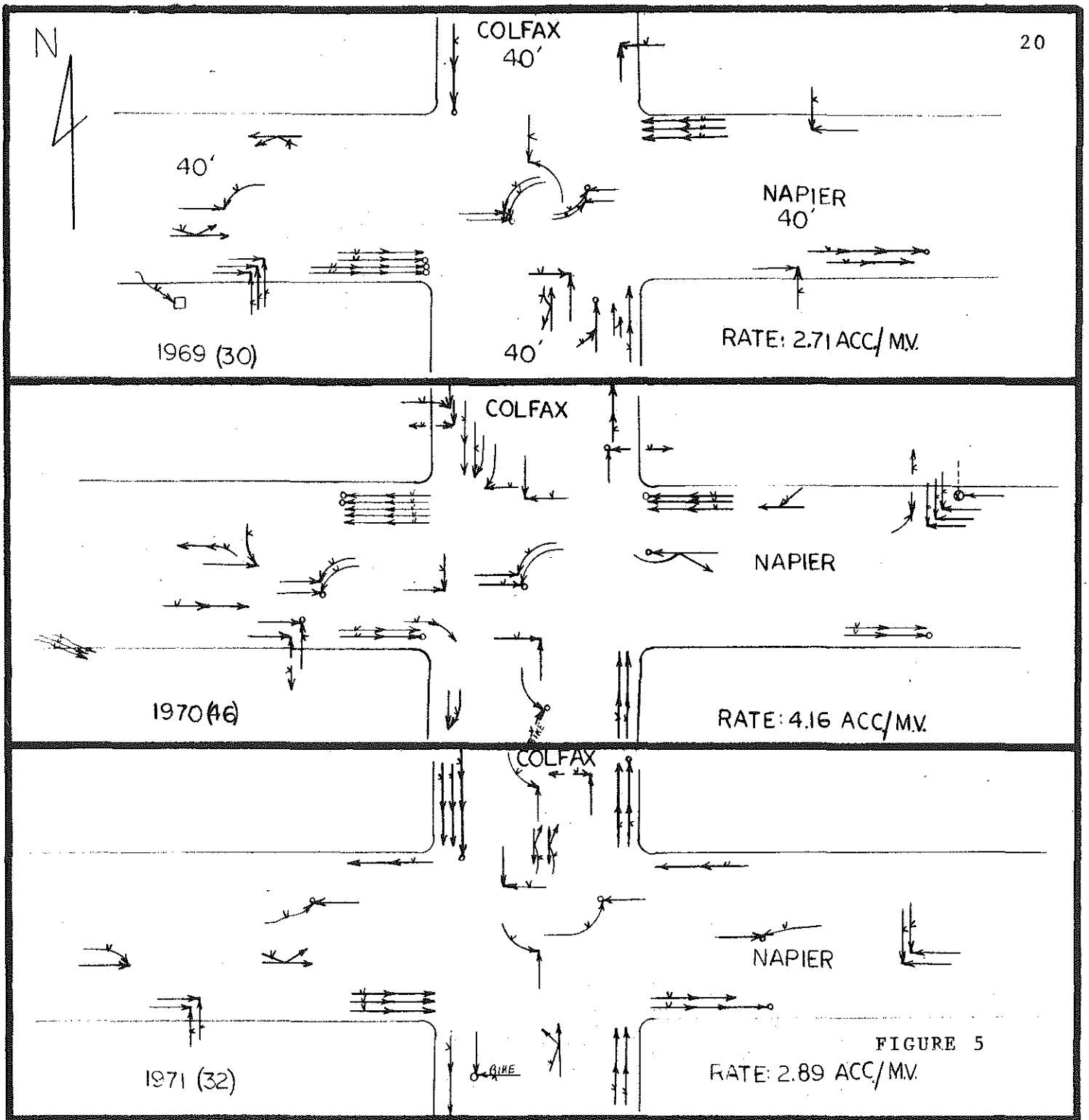


FIGURE 5

LEGEND

Stop & Go Signal (S, R) — Stop Sign S
Flashing Beacon (F, Y) — Yield Sign Y

Fatal
Injury
Skidding
Jackknife
Overturned
Backing
Pedestrian (X)
Tree
Out of Control
Driver Intent
Deer
Violator (V)

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRAFFIC AND SAFETY DIVISION

Location COLFAX AT NAPIER
BERRIEN CO.

Period: 1969 THRU 1971 — 3.25 ACC/M.V.
Accidents – Total 108 **P.D.** 79
Injury 29 ( ) **Fatal** 0 ( )
C.S. _____ **Miles** _____ **Drawn** DJM
Plan No. LOCATION **Date** 10-1-73

NORTHBOUND COLFAX AVENUE

SOUTHBOUND COLFAX AVENUE

FIGURE 6

EASTBOUND NAPIER AVENUE

WESTBOUND NAPIER AVENUE

FIGURE 7

RECOMMENDATIONS

	Type	Estimated Costs
1.	Construct a center lane for left turns on Napier and Colfax Avenues to improve the capacity at this location.	$ 107,500.00
2.	Modernize this signalized location by installing another signal head as per the recommendation of the Manual. Increase the yellow clearance interval to 7 percent (4.2 seconds).	442.00
3.	Apply pavement marking arrows to stress the function of each lane.	420.00
4.	Install a four way case sign at this intersection with the legend "Left Turn Lane" (R3-10) with a down arrow.	255.00
	TOTAL	$ 108,617.00

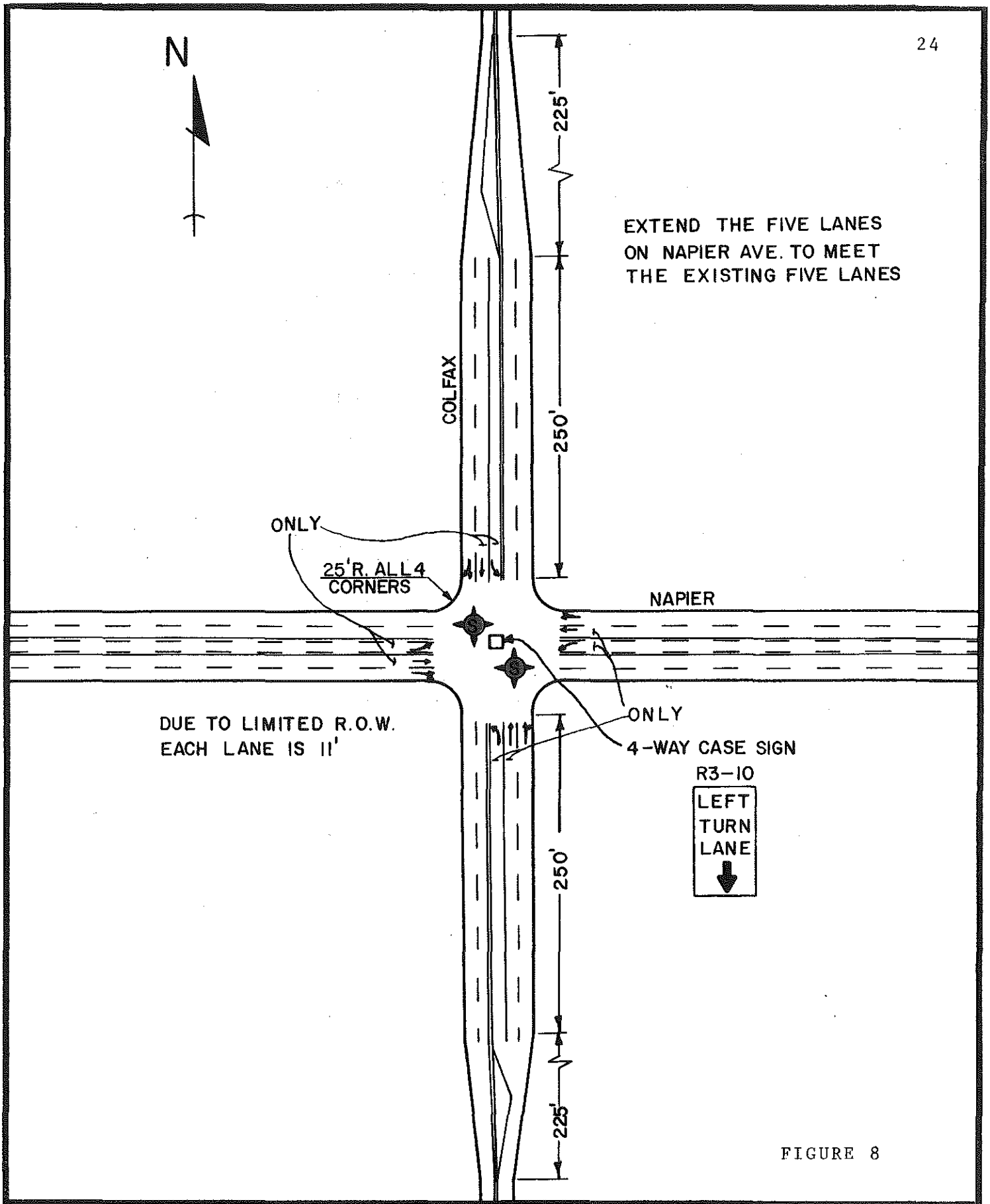


FIGURE 8

STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN DJM	PROPOSED INTERSECTION APPROACH DIAGRAM
	CONT. SEC.	DATE 1/29/74	
	REF.	SCALE	
	SHEET OF	PLAN	

PIPESTONE ROAD AND NAPIER AVENUE

Operational Analysis:

Pipestone Road intersects Napier Avenue to form a right-angle intersection. This 4-Way Stop intersection is controlled by four 36 in. "Stop" signs with supplemental "4-Way" signs.

Accidents:

Type	1969	1970	1971	Total
Rear End	3	8	9	20
Right Angle	3	2	3	8
Ran Off Roadway	1	--	4	5
Misc.	5	4	1	10
	12	14	17	43

The miscellaneous types include two improper backings, two head on-left turns, two defective equipment, one improper turning, one sideswipe, one parking and one bicycle accident. The accident rate at this intersection was 2.2 acc/MV for the study period.

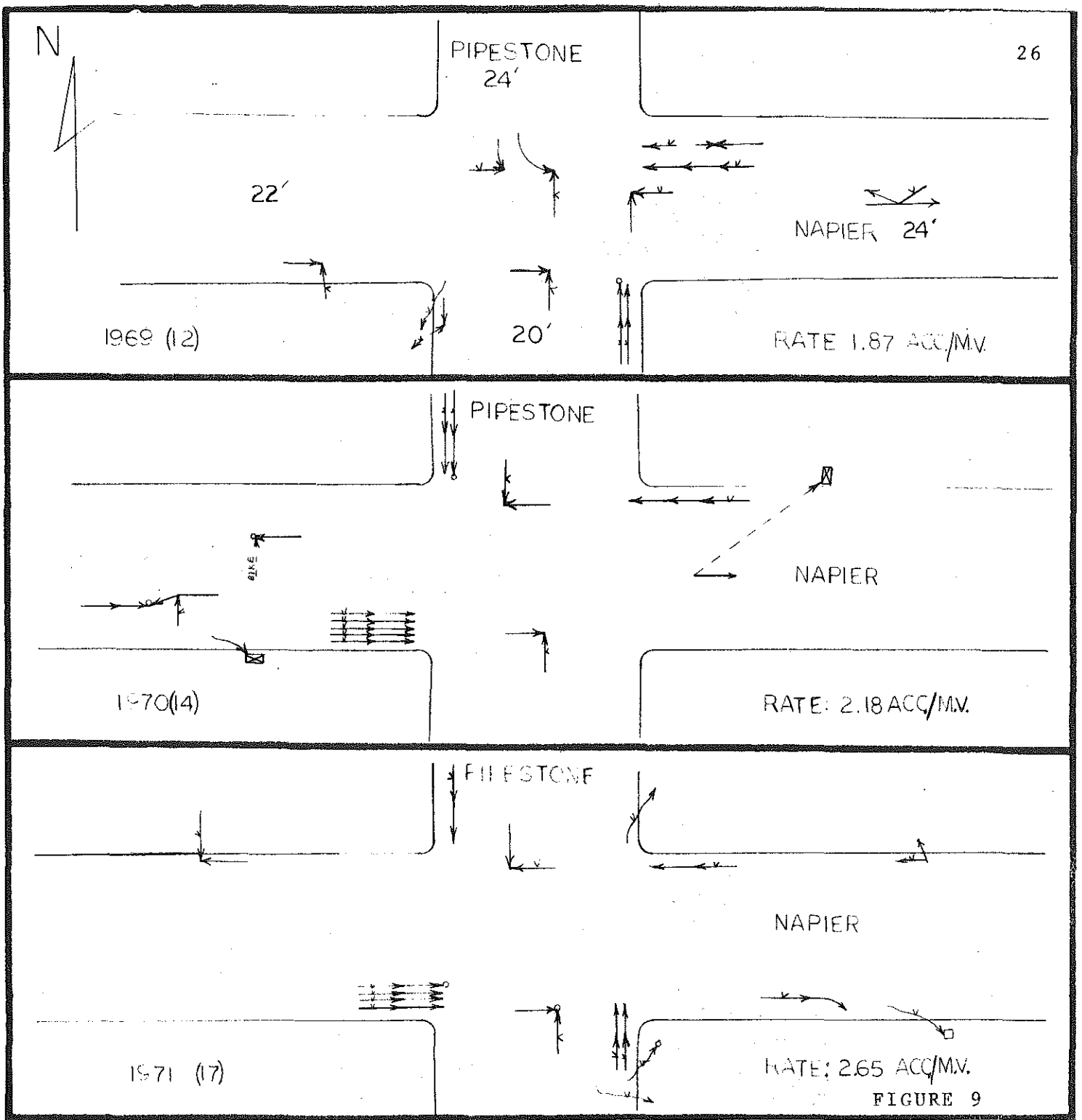


FIGURE 9

LEGEND

Stop & Go Signal — S — R
Flashing Beacon — Y — F — Y
Stop Sign — S
Yield Sign — Y

Fatal
Injury
Skidding
Jackknife
Overturned
Backing
Pedestrian — X
Tree
Out of Control
Driver Intent
Deer — V
Violator — V

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRAFFIC AND SAFETY DIVISION

Location PIPESTONE AT NAPIER
BERRIEN CO.

Period: 1969 THRU 1971 2.23 ACC/M.V.
Accidents – Total 43 **P.D.** 36
Injury 7 ( ) **Fatal** 0 ( )
C.S. _____ **Miles** _____ **Drawn** DJM
Plan No. LOCATION **Date** 9-27-73

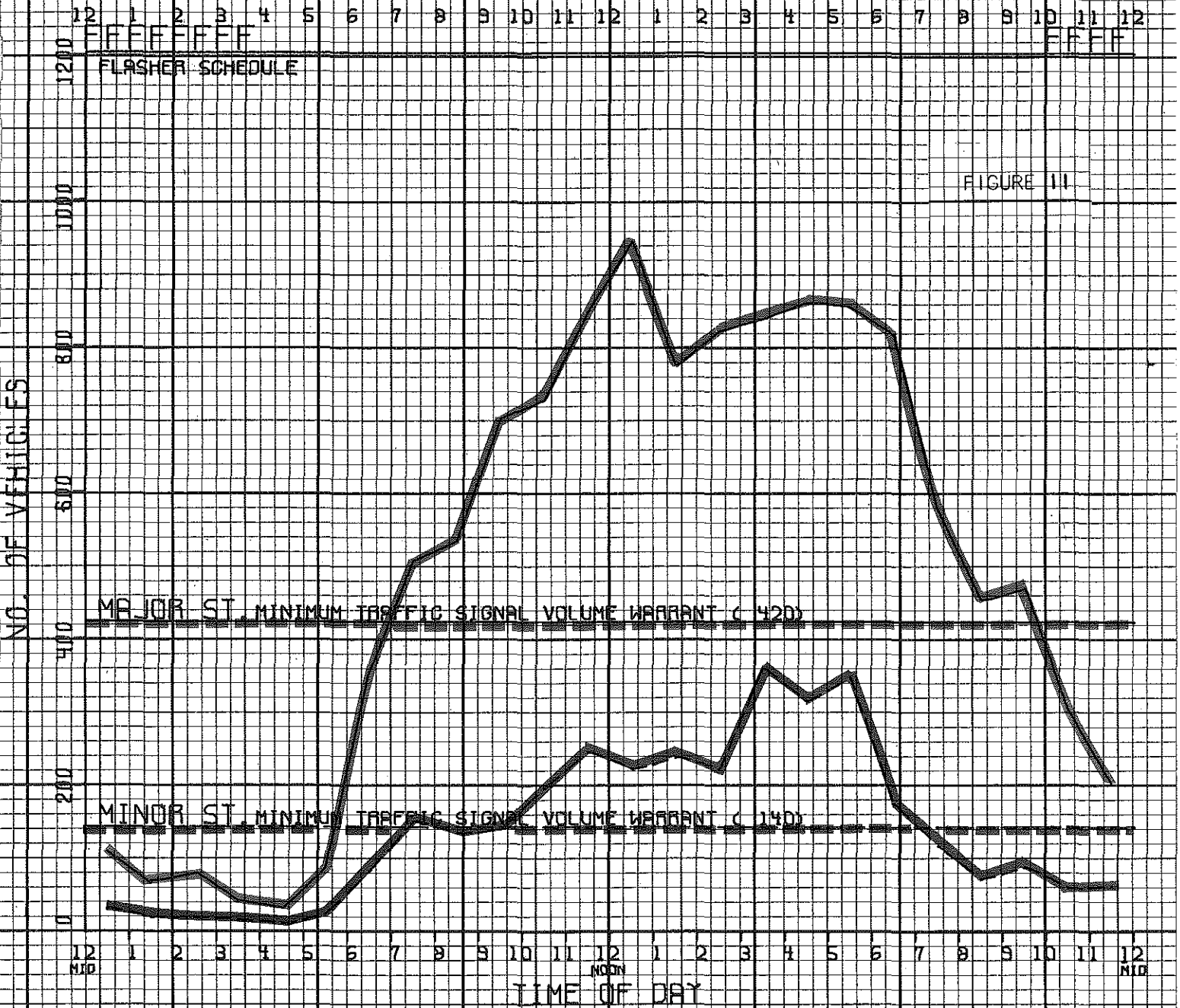
NORTHBOUND PIPESTONE ROAD

SOUTHBOUND PIPESTONE ROAD

FIGURE 10

TRAFFIC SIGNAL WARRANT GRAPH

FIGURE 11



ANALYSIS

APPLICABLE WARRANT RURAL VEHICULAR

MAJOR STREET MEETS WARRANT 15 HOURS OF REQUIRED 8 HOURS

MINOR STREET MEETS WARRANT 10 HOURS OF REQUIRED 8 HOURS

____ ACCIDENTS REPORTED IN _____ . RATE _____ /M.V.

____ ACCIDENTS REPORTED IN _____ . RATE _____ /M.V.

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

TRAFFIC & SAFETY DIVISION

SURVEY TAKEN	PLAN NO.	DATE
11-21-72	11000-00	01-11-73

____ NAPIER AVE AT

____ PIPESTONE RD

BENTON TWP BERRIEN CO

EASTBOUND NAPIER AVENUE

WESTBOUND NAPIER AVENUE

FIGURE 12

RECOMMENDATIONS

	Type	Estimated Costs
1.	Widen all legs of the intersection to 55 ft (5 lanes). The center lane to be used for left turns only.	$ 206,250.00
2.	Install a traffic control signal with dual overhead vehicular signal heads. This signal should operate on a 60 second cycle with a 60-40 percent split favoring Napier Avenue and a 7 percent (4.2 second) yellow clearance interval. The change from stop control to traffic signal control at this intersection was based on the fact that the minimum volume warrants for traffic signal control were met (Figure 12).	5,000.00
3.	Apply pavement marking arrows to indicate the function of each lane.	280.00
4.	Install a 4-Way illuminated case bearing the legend "Left Turn Lane" (R3-10) with a down arrow.	255.00
	TOTAL	$ 211,785.00

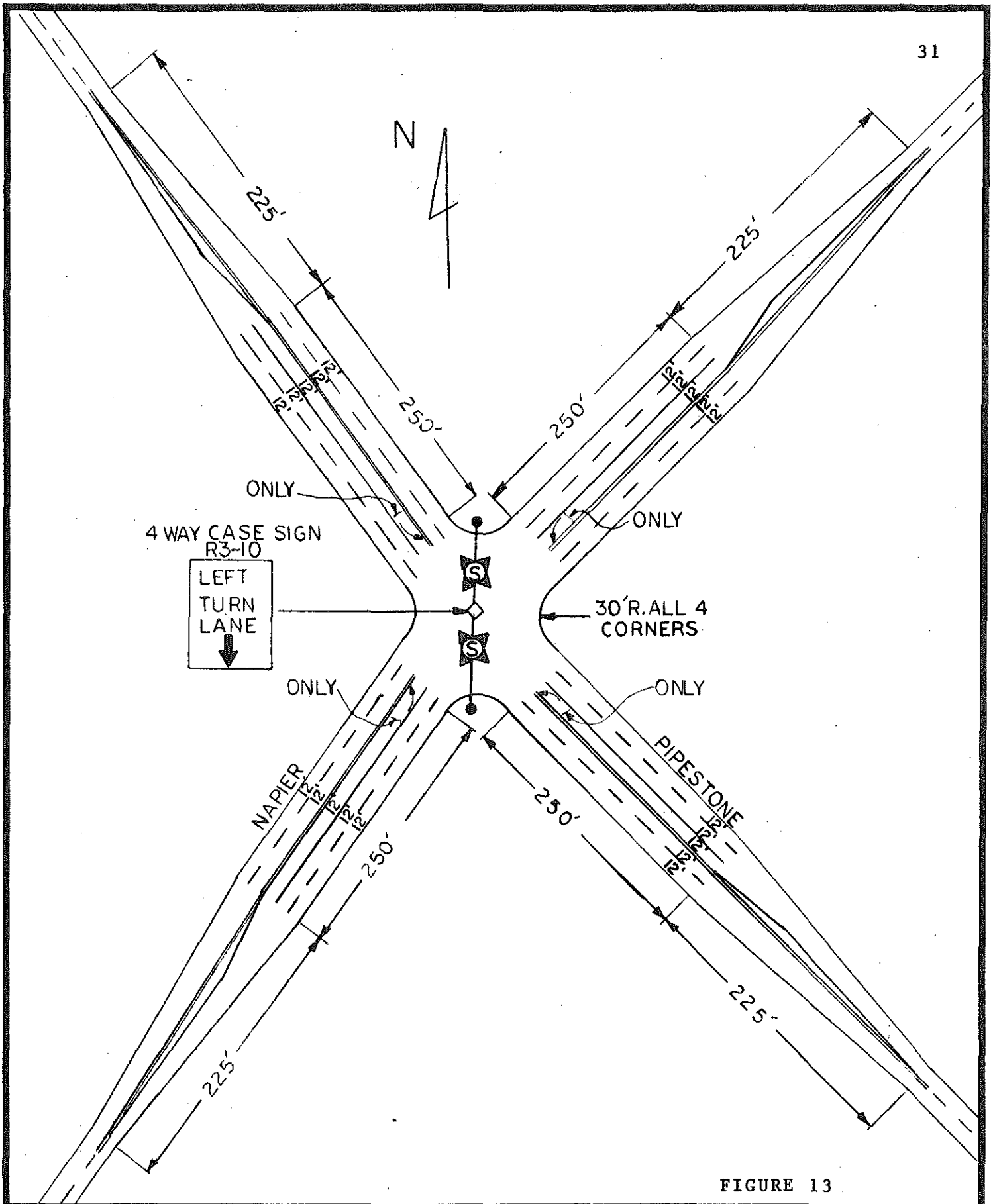


FIGURE 13

STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN DJM	PROPOSED INTERSECTION APPROACH DIAGRAM
	CONT. SEC.	DATE 1/29/74	
	REF.	SCALE	
	SHEET OF	PLAN	

EUCLID AVENUE AT TERRITORIAL ROAD

Operational Analysis:

Euclid Avenue intersects Territorial Road to form a right-angle intersection. Euclid Avenue operates under stop (two 36 in. signs) control.

Accidents:

Type	1969	1970	1971	Total
Right Angle	1	6	9	16
Rear End	2	3	2	7
Turning	2	--	2	4
Misc.	3	4	1	8
TOTAL	8	13	14	35

The miscellaneous types include three ran off roadways, three sideswipes and two head on-left turn accidents. The accident rate at this intersection was 4.3 acc/MV during the study period.

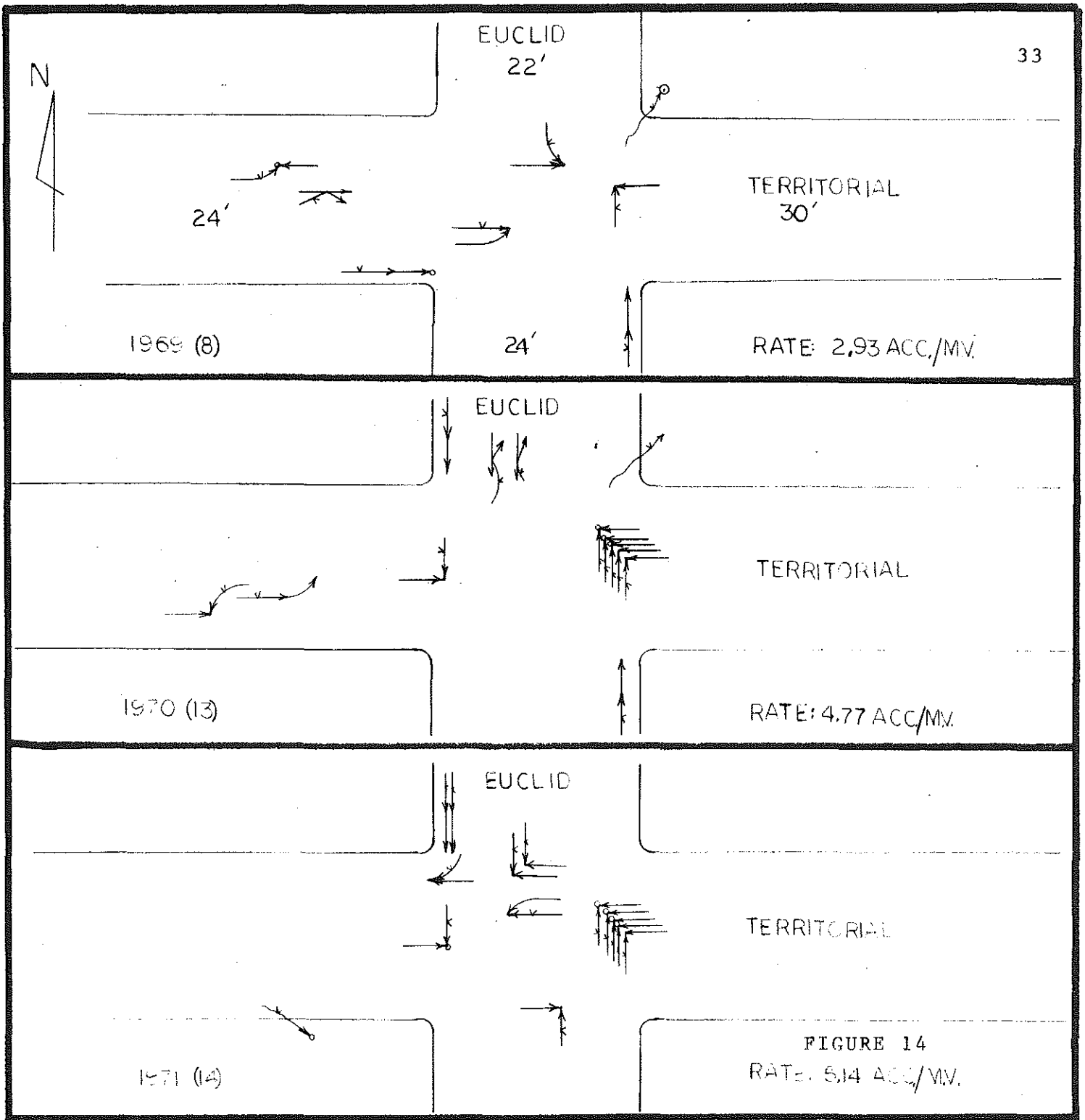


FIGURE 14

LEGEND

Stop & Go Signal — S, R
Flashing Beacon — Y, F, Y
Stop Sign — S
Yield Sign — Y

Fatal
Injury
Skidding
Jackknife
Overturned
Backing
Pedestrian — X
Tree
Out of Control
Driver Intent
Deer — V
Violator

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRAFFIC AND SAFETY DIVISION

Location EUCLID AT TERRITORIAL
WAYNE CO.

Period: 1969 THRU 1970 4.28 ACC/M.V.

Accidents – Total 35 **P.D.** 24

Injury 11 ( ) **Fatal** 0 ( )

C.S. _____ **Miles** _____ **Drawn** D. J. M

Plan No. LOCATION **Date** 9-27-73

NORTHBOUND EUCLID AVENUE

SOUTHBOUND EUCLID AVENUE

FIGURE 15

EASTBOUND TERRITORIAL ROAD

WESTBOUND TERRITORIAL ROAD

FIGURE 16

RECOMMENDATIONS

	Type	Estimated Costs
1.	Adequate clear vision corners should be maintained at this location. Special attention should be focused on the large tree in the southeast corner.	$ 500.00
2.	Apply stop lines on Euclid Avenue to indicate to drivers the desired position for stopping at this intersection.	25.00
3.	Replace the Cross Road Warning sign (W2-1) for eastbound Territorial Road traffic because of its poor condition.	30.00
4.	Install a 12 in. flashing beacon at this intersection with the flashing yellow lens for Territorial Road and flashing red lens for Euclid Avenue.	3,000.00
	TOTAL	$ 3,555.00

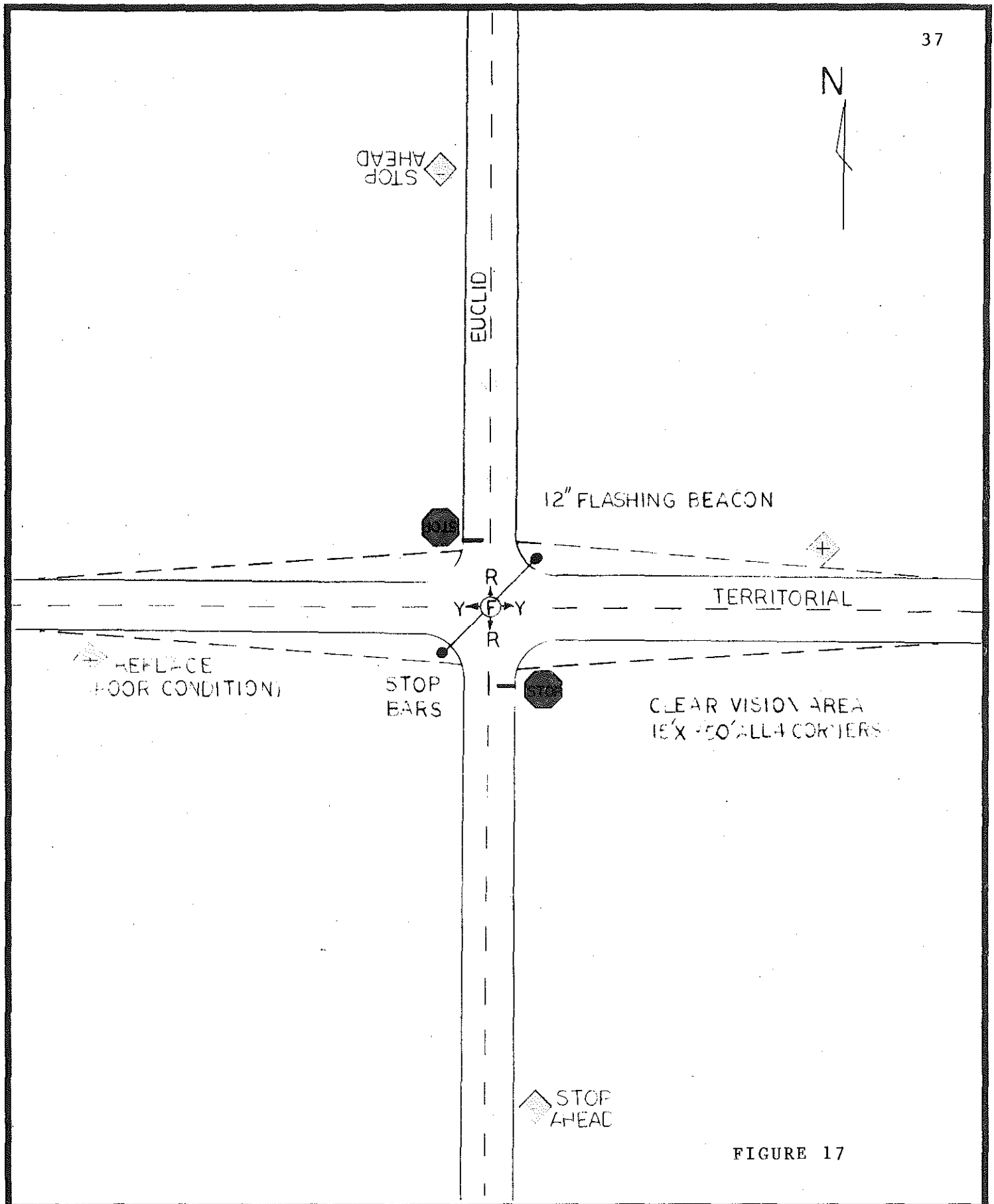


FIGURE 17

STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN DJM	PROPOSED INTERSECTION DIAGRAM
	CONT. SEC.	DATE 1/29/74	
	REF.	SCALE	
	SHEET OF	PLAN	

NAPIER AVENUE EAST OF M-139

Operational Analysis:

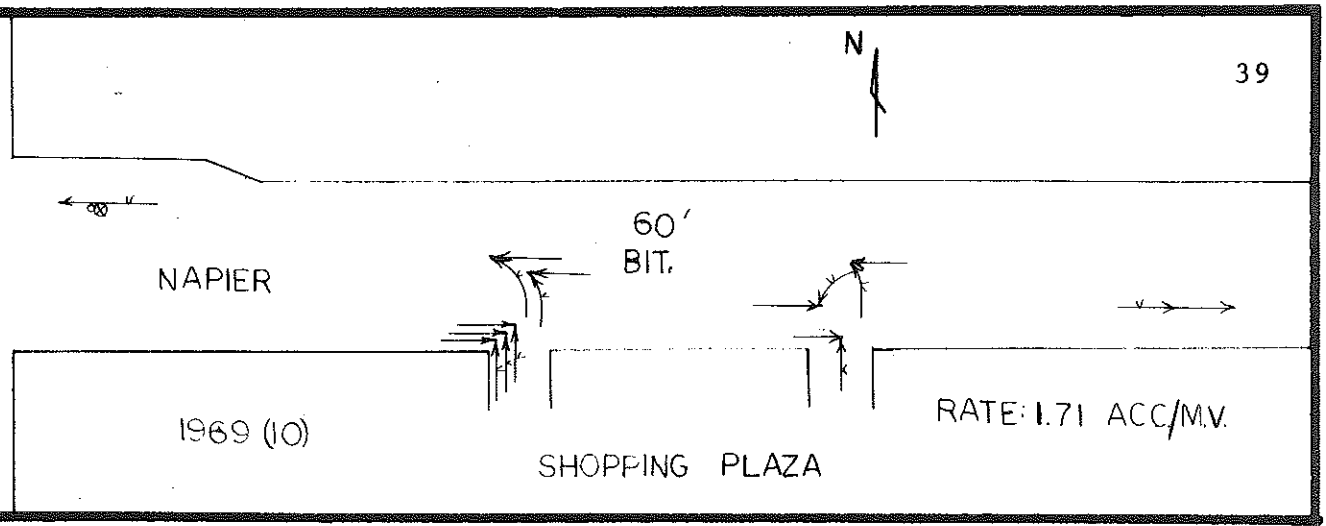
This accident location is a 0.1 mile segment of Napier Avenue located east of M-139. This section of Napier Avenue is a 60 ft wide five lane roadway with the center lane for left turns. On the south side of the roadway in this area are two commercial driveway openings to the Fairplain Plaza Parking Lot.

Accidents:

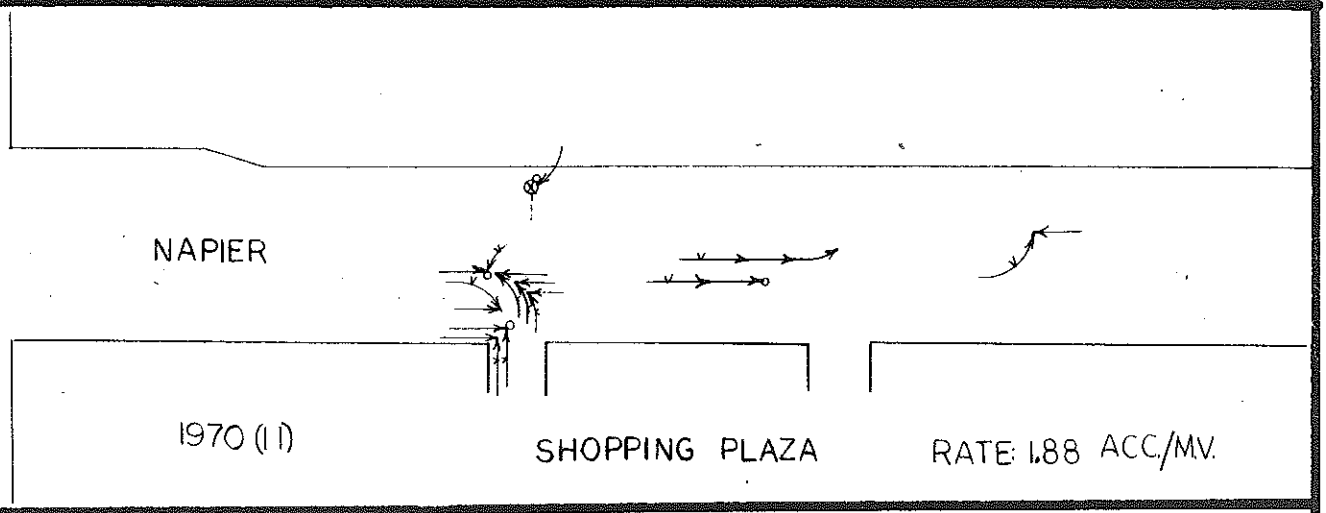
Type	1969	1970	1971	Total
Right Angle	4	2	5	11
Turning	3	4	2	9
Misc.	3	5	3	11
TOTAL	10	11	10	31

The miscellaneous types include five rear ends, four head on-left turns and two pedestrian accidents. The accident rate at this location was 1.8 acc/MV during the study period.

M-139



M-139



M-139

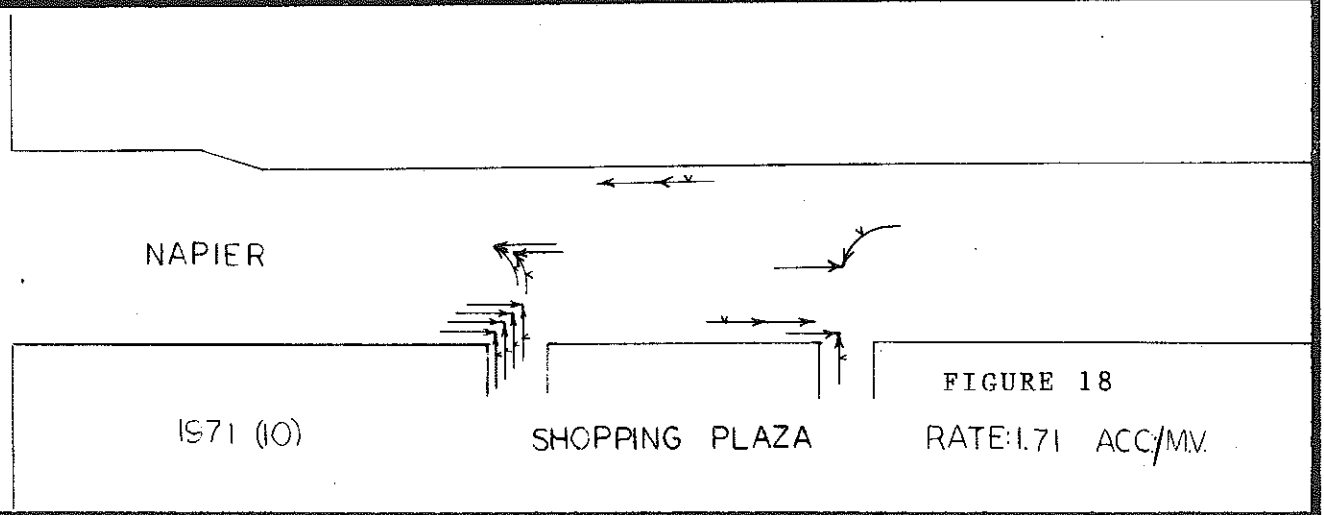


FIGURE 18

LEGEND

Stop & Go Signal — S, R
Flashing Beacon — F, Y, Y
Stop Sign — S
Yield Sign — Y

Fatal
Injury
Skidding
Jackknife
Overturned
Backing

Pedestrian — X
Tree
Out of Control
Driver Intent
Deer — V
Violator — V

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRAFFIC AND SAFETY DIVISION

Location NAPIER AVE. E. OF M-139
BERRIEN CO.

Period: 1969 THRU 1971 1.76 ACC/M.V.
Accidents – Total 31 **P.D.** 26
Injury 5 ( ) **Fatal** 0 ( )
C.S. _____ **Miles** _____ **Drawn** D J M
Plan No. LOCATION **Date** 9-28-73

NORTHBOUND PLAZA DRIVE

EASTBOUND NAPIER AVENUE

FIGURE 19

WESTBOUND NAPIER AVENUE

EASTBOUND NAPIER AVENUE

FIGURE 20

RECOMMENDATIONS

	Type		Estimated Costs
1.	Convert the drive openings to function as directional driveways in an attempt to provide improved overall traffic operation for the shopping center.		$ 9,476.00
		TOTAL	$ 9,476.00

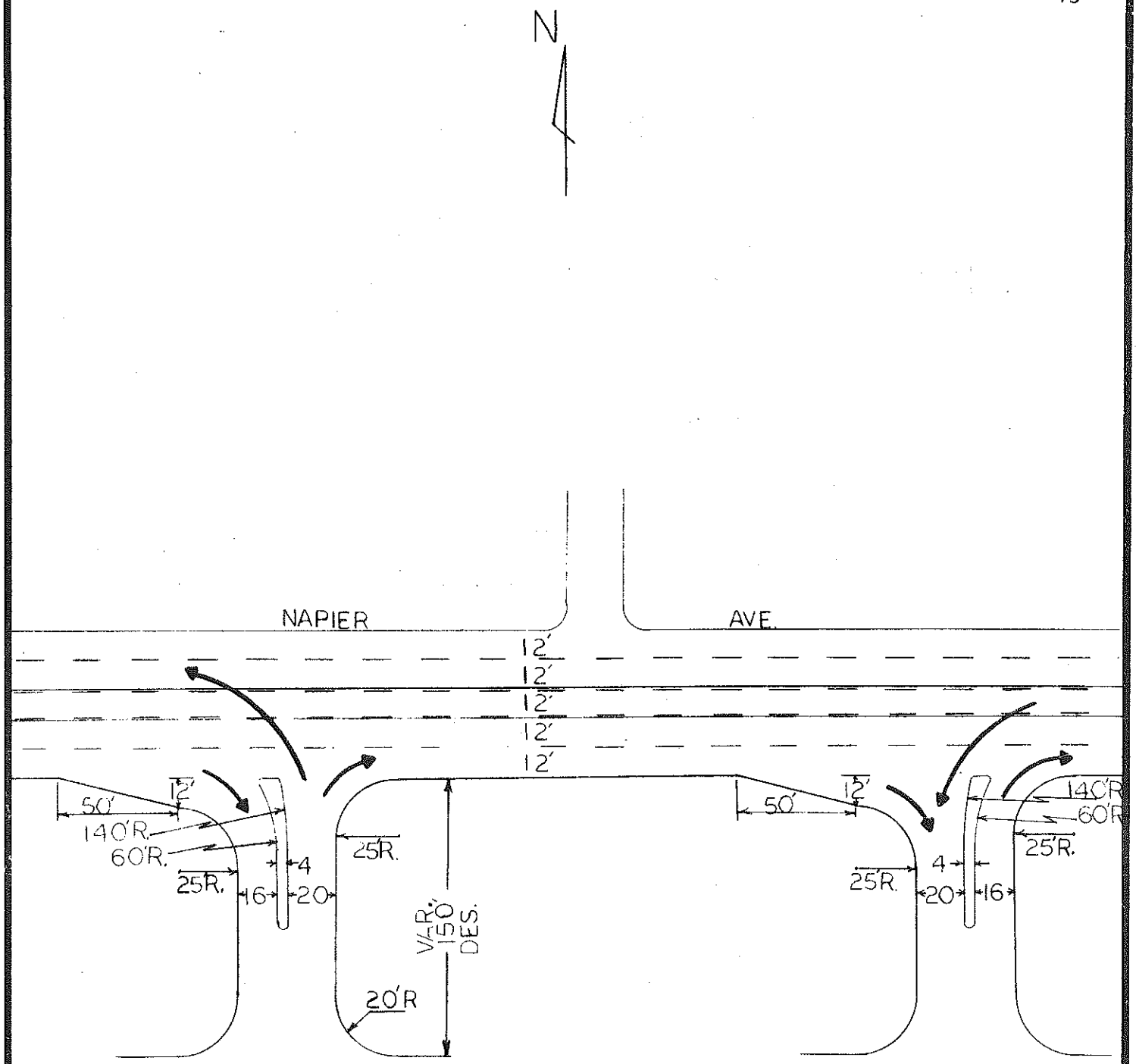


FIGURE 21

STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN DJM	PROPOSED DIRECTIONAL DRIVEWAY DESIGN
	CONT. SEC.	DATE 1/29/74	
	REF.	SCALE	
	SHEET OF	PLAN	

RED ARROW HIGHWAY AT JOHN BEERS ROAD

Operational Analysis:

Red Arrow Highway intersects John Beers Road to form a right-angle intersection. John Beers Road operates under stop control (a 24 in. and a 36 in. stop sign). In addition, a flashing beacon with an 8 in. lens has been installed to supplement the stop signs.

Accidents:

Type	1969	1970	1971	Total
Right Angle	4	7	4	15
Rear End				
Red Arrow Highway	--	--	2	2
John Beers Road	1	2	1	4
Misc.	1	1	6	8
Total	6	10	13	29

The miscellaneous types include four head on-left turns, two improper turns and two improper backing accidents. The accident rate at this intersection was 2.3 acc/MV during the study period.

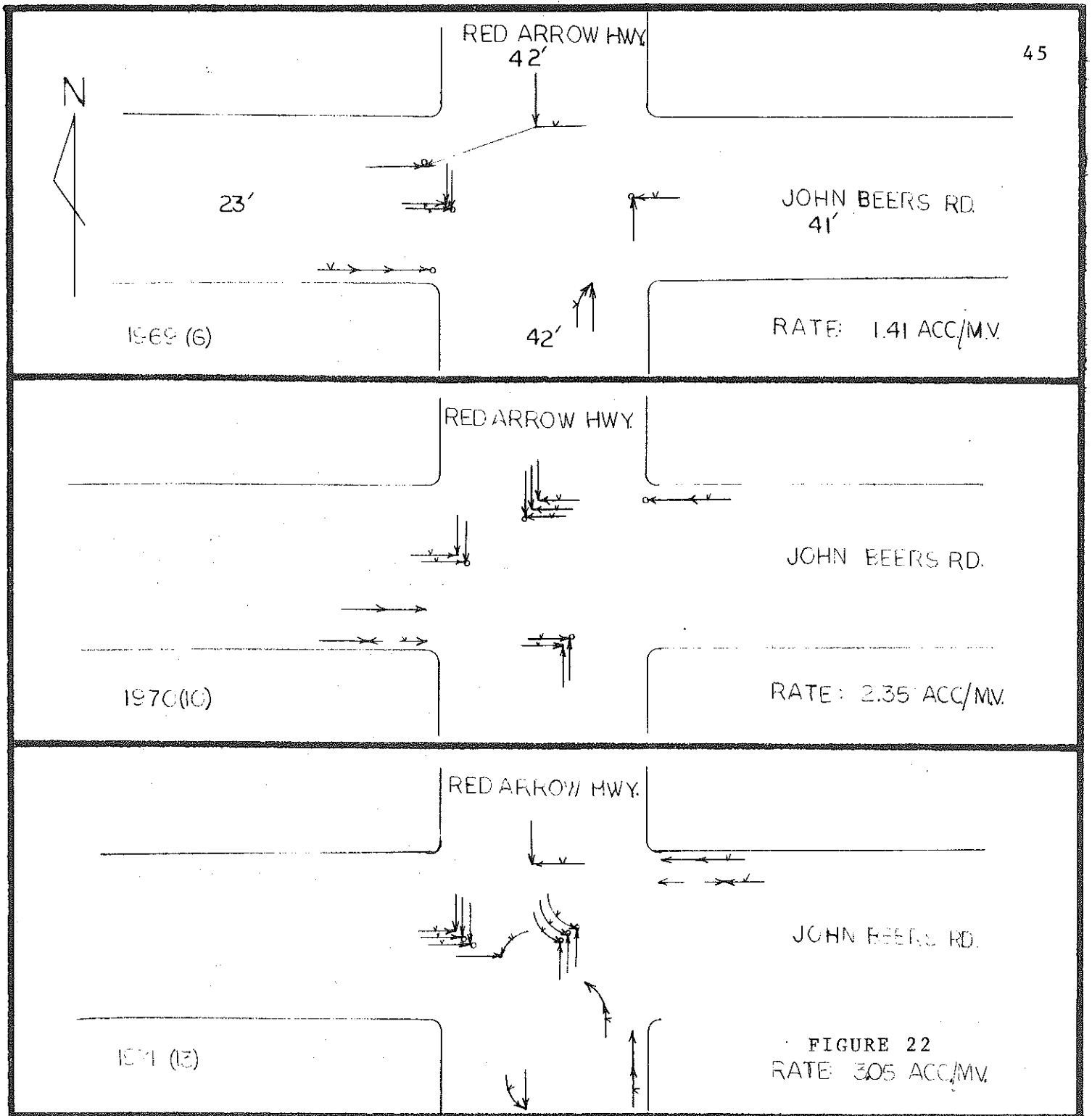


FIGURE 22

LEGEND

Stop & Go Signal — S, R, Y, F
Flashing Beacon
Stop Sign — S
Yield Sign — Y

Fatal
Injury
Skidding
Jackknife
Overturned
Backing
Pedestrian — X
Tree
Out of Control
Driver Intent
Deer
Violator — V

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRAFFIC AND SAFETY DIVISION

Location RED ARROW HWY AT JOHN BEERS RD
BERRIEN CO.

Period: 1969 THRU 1971 — 227 ACC/M.V.
Accidents – Total 29 **P.D.** 15
Injury 14 ( ) **Fatal** 0 ( )
C.S. _____ **Miles** _____ **Drawn** D.J.M.
Plan No. LOCATION **Date** 9-28-73

NORTHBOUND RED ARROW HWY.

SOUTHBOUND RED ARROW HWY.

FIGURE 23

EASTBOUND JOHN BEERS ROAD

WESTBOUND JOHN BEERS ROAD

FIGURE 24

RECOMMENDATIONS

	Type	Estimated Costs
1.	Install larger (12 in.) lens on the flasher beacon to alert traffic on Red Arrow Highway that traffic is crossing the highway.	$ 80.00
2.	Erect 36 in. Cross Road Warning signs in advance of the intersection.	32.00
3.	Relocate stop sign on the east leg of this intersection closer to the intersection and for emphasis increase the sign size to a 36 in. sign.	30.00
	TOTAL	$ 142.00

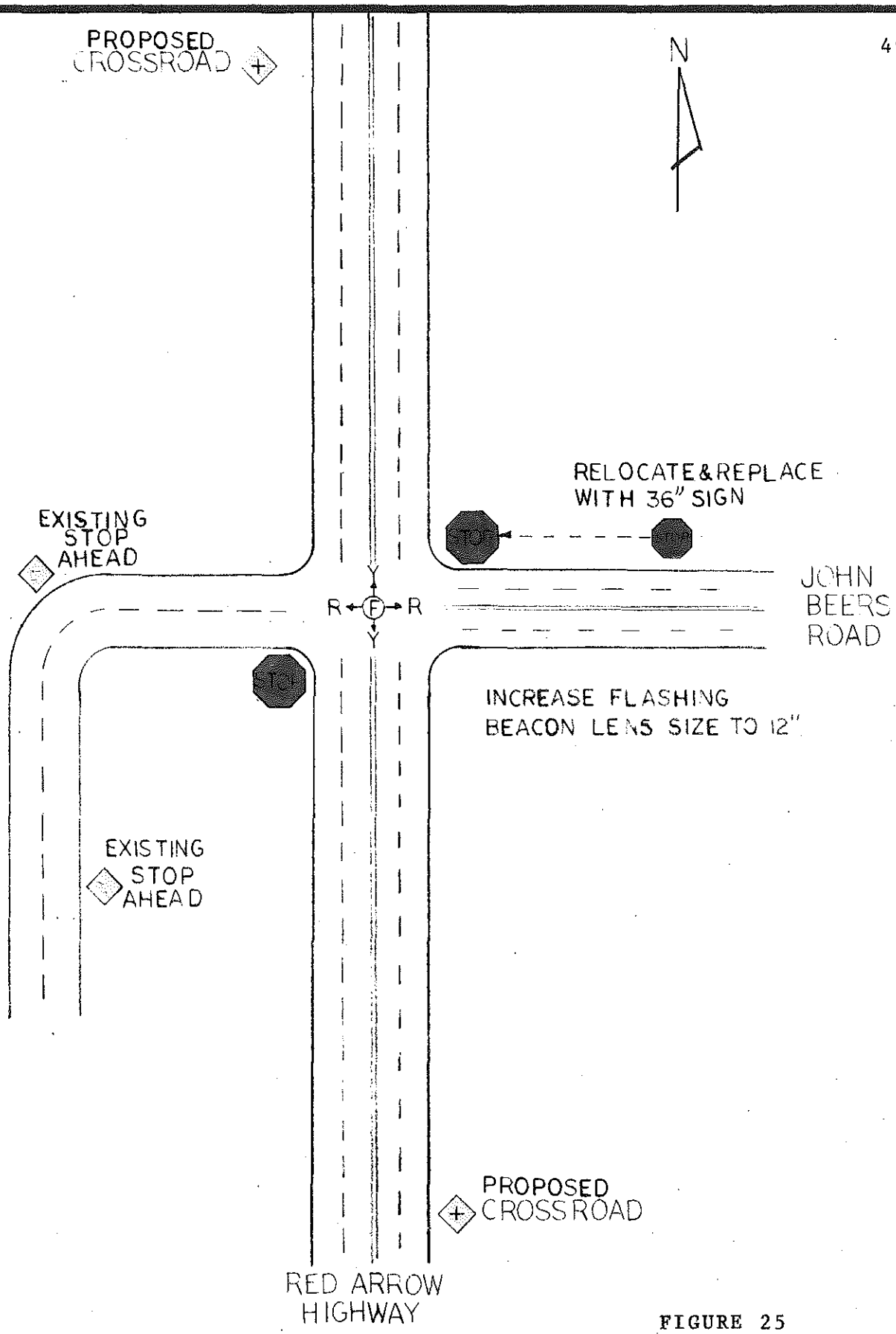


FIGURE 25

STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS — TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN DJM	PROPOSED INTERSECTION DIAGRAM
	CONT. SEC.	DATE 1/29/74	
	REF.	SCALE	
	SHEET OF	PLAN	

CRYSTAL AVENUE AT TERRITORIAL ROAD

Operational Analysis:

Crystal Avenue intersects Territorial Road to form a right-angle intersection. Crystal Avenue operates under stop (a 36 in. and a 30 in. sign) control.

Accidents:

Type	1969	1970	1971	Total
Right Angle	6	3	3	12
Rear End	1	3	2	6
Misc.	--	4	3	7
TOTAL	7	10	8	25

The miscellaneous types include three improper turning, two side-swipes, one head on-left turn and one ran off roadway accident. The accident rate at this location was 3.3 acc/MV during the study period.

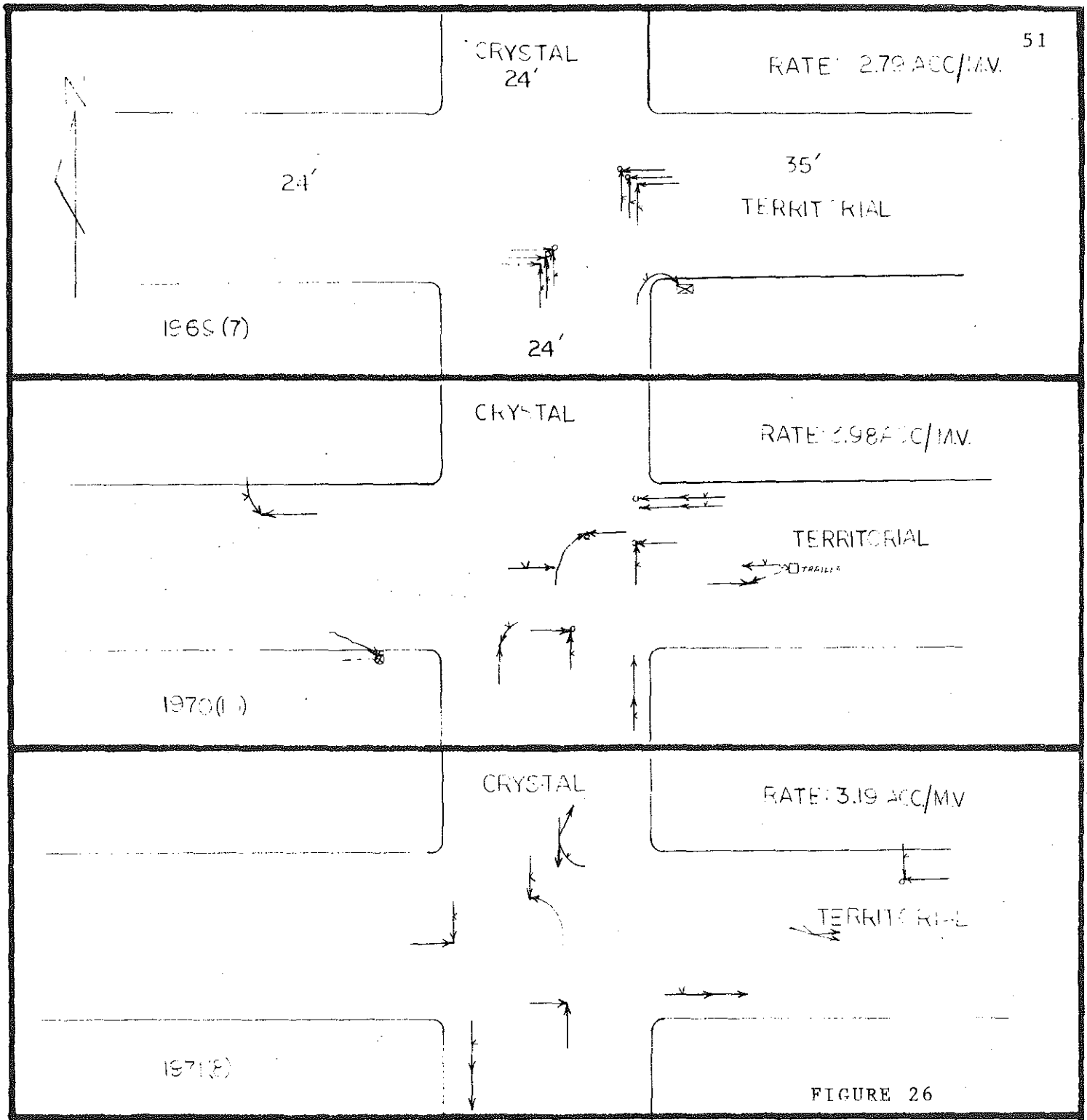


FIGURE 26

LEGEND

Stop & Go Signal — S — R
Flashing Beacon — Y — F — Y
Stop Sign — S
Yield Sign — Y

Fatal
Injury
Skidding
Jackknife
Overturned
Backing
Pedestrian — X
Tree
Out of Control
Driver Intent
Deer — V
Violator — V

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
TRAFFIC AND SAFETY DIVISION

Location CRYSTAL AT TERRITORIAL
BERRIEN CO

Period: 1969 THRU 1971 3.32 ACC/M.V.
Accidents – Total 25 **P.D.** 14
Injury 11 ( ) **Fatal** 0 ( )
C.S. _____ **Miles** _____ **Drawn** EJM
Plan No. LOCATION **Date** 9-26-73

NORTHBOUND CRYSTAL AVENUE

SOUTHBOUND CRYSTAL AVENUE

FIGURE 27

EASTBOUND TERRITORIAL ROAD

WESTBOUND TERRITORIAL ROAD

FIGURE 28

RECOMMENDATIONS

	Type	Estimated Costs
1.	Create clear vision corners at this location to provide adequate visibility for vehicles stopped on Crystal Avenue.	$ 500.00
2.	Apply stop lines on Crystal Avenue to indicate to drivers the location at which to stop.	25.00
	TOTAL	$ 525.00

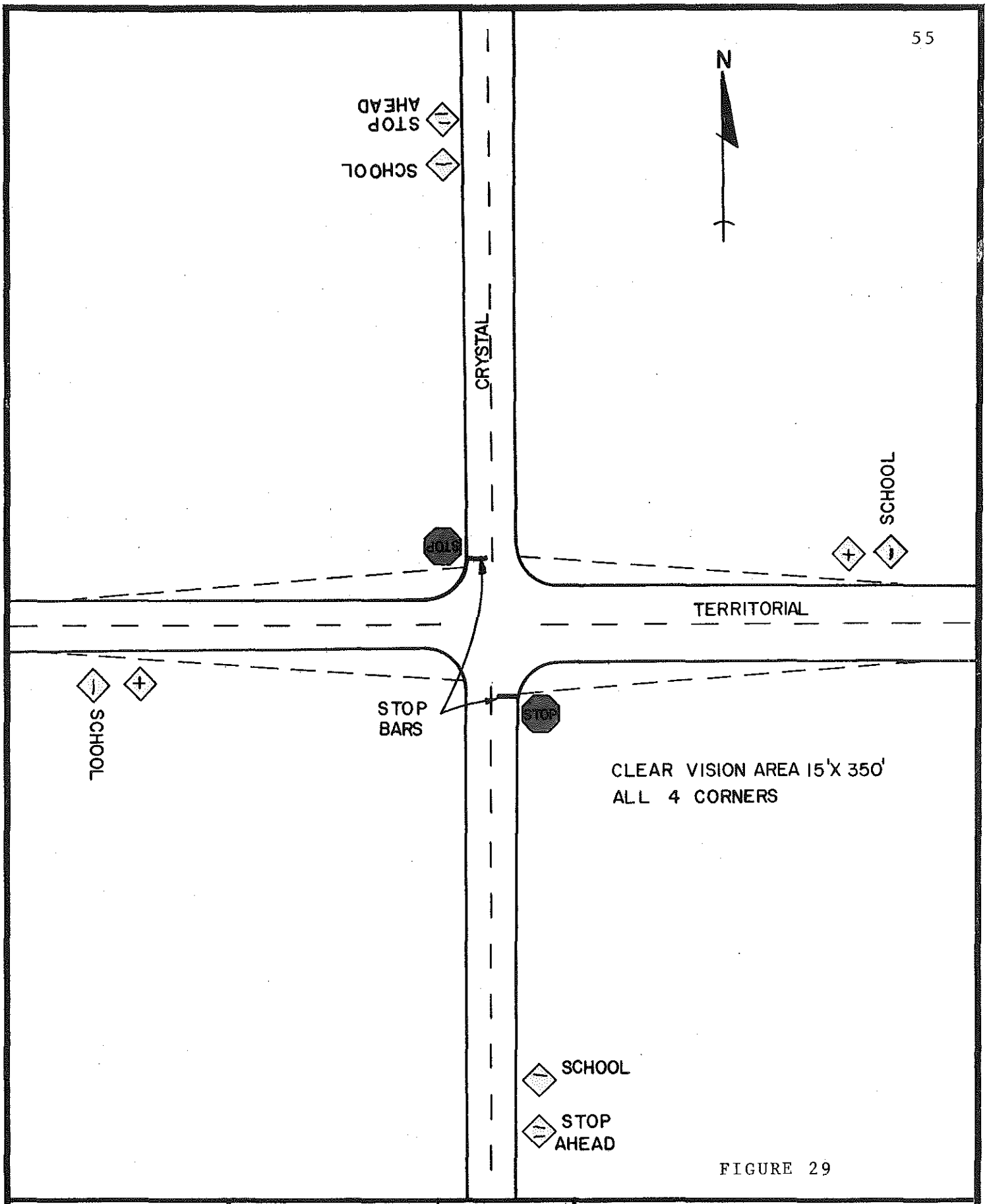


FIGURE 29

STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN DJM	INTERSECTION APPROACH DIAGRAM
	CONT. SEC.	DATE 1/29/74	
	REF.	SCALE	
	SHEET OF	PLAN	

SUMMARY

The Department of State Police submitted 11 high accident locations for Berrien County to the Michigan Department of State Highways and Transportation. After an in depth study of these locations, we formulated recommendations for six of them. The recommendations are as follows:

Location Number	Location Description and Cost Estimates	Recommendations
1	Napier Avenue at Colfax Avenue $108,617	Construct left turn lane. Install another signal head. Increase amber time to 4 seconds. Apply pavement marking arrows. Install 4-Way case sign.
2	Pipestone Road at Napier Avenue $211,785	Widen to five lanes for both roadways. Install dual signal heads. Apply pavement marking arrows. Install 4-Way case sign.
5	Euclid Avenue at Territorial Road $3,555	Clear vision areas. Apply stop bars on Euclid Avenue. Replace W2-1. Install 12 in. flashing beacon.
7	Napier Avenue East of M-139 $9,476	Convert driveways to directional use.
8	Red Arrow Highway at John Beers Road $142	Increase flasher lens size to 12 in. Erect Cross Road Warning sign. Relocate the stop sign on the east leg and increase the sign size to 36 in.
9	Crystal Avenue at Territorial Road $525	Clear vision areas. Apply stop bars on Crystal Avenue.

Furthermore, a few general recommendations were formulated that should be implemented by Berrien County.

1. Since warrants have been established for 4-Way Stops by the Manual, it is recommended that further installation of this type of intersection control follow these warrants.

2. A program should be intitated by the county for removing vision obstructions that are located in clear vision areas at intersections throughout the county.

3. Signalized intersections should be modernized (two overhead vehicular signal heads) as per the recommendations of the Manual.

4. Driveway openings should be controlled to prevent indiscriminate ingress and egress.

5. Approximately 32 percent of the required regulatory signs on the Berrien County Primary Road System are in need of maintenance or new installation.

6. Approximately 55 percent of the required warning signs are in need of maintenance or new installation.

COST ESTIMATE

Control Devices Inventory	$	71,820.10
Engineering Recommendations		334,100.00
TOTAL	$	405,920.10