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FIFTH ANNUAL REPORT

OF

MICHIGAN'S OVERALL HIGHWAY

SAFETY IMPROVEMENT PROGRAM

August 31, 1978

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OF
STATE HIGHWAYS AND TRANSPORTATION

This Report was prepared by the Traffic and Safety, Local Government, and Maintenance Divisions, and the Railroad Contact Section, Bureau of Highways.

The opinions, findings, and conclusions expressed in this publication are those of the author and not necessarily those of the Federal Highway Administration.

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Introduction

This is the fifth annual report on Michigan's overall highway safety improvement program. An in-depth discussion of the separate programs detailing the types of projects which qualify, the review process and evaluations of completed projects is provided where available. The intent is that the most pertinent information will be available to any reader thereby creating a single source of data for implementing the various types of programs.

The first section of the report contains an overview of the Categorical Safety Program. It should be noted that Michigan has, for the first time, used Pavement Marking Demonstration Program funds on the trunkline system.

The second section of the report is devoted to Michigan's 100 percent state funded Safety (Ms) Program. Included is an evaluation of completed Ms projects based on two-year before and after periods of projects,

Section 3 contains data on state and federally funded projects which include safety related work as part of the improvements. The types of projects funded include, but are not limited to, resurfacing, bridge deck repairs, nonmotorized facilities, minor construction, interstate improvements, yellow book upgrading, and the installation of impact attenuators.

Also included in Section 3 are discussions on the Michigan Accident Location Index (MALI) and the activities provided local agencies through the department's Traffic Engineering Services Subunit within the Traffic and Safety Division.

Sections 4 and 5 discuss recent developments in highway safety that have been completed or are being studied for implementation within Michigan's safety activities. We have included discussions on a Positive Guidance Demonstration Project; Broad Emergency Assistance Radio (BEAR); Special Waterwall Attenuator Project; Network Simulation Model (NETSIM); Fixed-Object Accident Study; Traffic Signal Evaluations, and a special evaluation of five completed safety projects sponsored by the FHWA as part of a national study. Other items are also discussed in more detail.

The Michigan Department of State Highways and Transportation established, during the 1977 fiscal year, an overall prioritization safety program to determine the immediate and long-range goals of the department relating to safety. We again refer to this plan commenting on our progress during the past year. An update of projects in this program is provided on pages iv to vi.

Michigan's Overall Prioritized Safety Program

1. Interstate Freeway System

A. Continue "Yellow Book" program on the interstate system.

To date, 65 percent of this program has been completed, while 32 percent has been programmed and is in the design stage and 3 percent is unprogrammed or inactive. However, since safety guidelines have changed over the years, it will be necessary to make safety improvements to some of the earlier Yellow Book projects. This work will consist mainly of bridge rail replacements, ramp and crossroad safety improvements and replacement of Type A guardrail.

B. Develop and implement improved interstate safety spot improvement program based upon accident data to provide cost-beneficial expenditures (priority ranking of interchanges).

The Michigan Accident Location Index (MALI) program is now operational on the state's total trunkline system and in 34 of 83 counties. Through this program we can identify high accident locations on all roadways.

Phase 2 of the Interchange Prioritization Study outlines the procedures to be followed in the analyzation/prioritization process. This phase addresses alternate solutions, estimated costs and benefits, and cost effectiveness. Currently we are in step 1 of this process which consists of gathering the required data.

C. Develop and implement program sensitive to run-off-roadway accidents to allow cost-beneficial expenditures using interstate funding.

We have developed a prioritization program using a five-year accident history for the total freeway system in Michigan. Attention is focused on accident severity for segments of roadways. However, we can analyze any type of accident pattern that occurs over that five-year period which includes run-off-roadway type accidents.

2. Noninterstate Freeway System

A. Develop and implement improved Michigan Safety (Ms) spot improvement program based upon accident data.

Now that the Michigan Accident Location Index (MALI) is completed on the state trunkline system and Stage I of the MIDAS model is operational, the department will be able to improve the effectiveness of the Ms program. For instance, we now have available a high ranking list of trunkline locations according to type of accidents which focuses on concentrations of correctable accident patterns.

- B. Develop and implement a program sensitive to run-off-roadway accident data using available funding. See response to 1C..
- C. Complete "Yellow Book" work with available funds other than Ms.

To date, 188 miles or 38 percent of the total noninterstate freeway mileage has either been completed or let to contract.

3. Free Access Trunkline System

- A. Develop and implement improved Michigan Safety Spot Improvement Program based upon accident data. See response to objective 2A.
- B. Insert greater safety awareness into MCP (minor construction program).

This is a continuous activity and has been implemented as a result of coordinating efforts of a departmentwide highway safety steering committee.

- C. "Yellow Book" work (Roadside Safety Improvement Program).

- a. Perform Task 1 on the free access trunkline system. Task 1 includes the installation of buffered-end sections to eliminate straight guardrail endings.

Work authorizations have been issued on all noninterstate trunklines to install buffered-end sections. The work is being completed by state forces and local contract agencies and is 65 percent completed.

- b. Perform Task 2 on the free access state trunkline system. Task 2 includes upgrading guardrails attached to structures, replacement of inadequate structure railings, or retrofitting guardrails to the existing railing system.

A separate 10-year program had originally been developed for Task 2 work. This program is now being accelerated by including this work within other program projects such as resurfacing, shoulder reconstruction, and bridge overlays and is usually funded with 100 percent state funds. It was originally estimated that the total cost of this program would be \$15,000,000.

- c. Perform Task 3 on free access state trunkline system. Task 3 includes complete improvement of the roadside to current "Yellow Book" standards. This work is to be completed with available funds other than Ms.

Due to lack of funds, few specific Task 3 programs have been initiated. However, guardrail modernization work is currently being included with road resurfacing projects as

resources allow. The costs for this Task 3 work are included in the category of Other State Funded Projects on page 3-6.

4. Nontrunkline

- A. Support the rapid development of the Michigan Accident Location Index (MALI).

The MALI project is currently operational on the state trunkline system in all 83 counties and on the local road system in 34 counties. The MALI project on the remainder of the local road system will be completed in January of 1979 by a consultant who began work on August 10, 1977.

- B. Develop and implement spot accident improvement program utilizing available funds.

The Traffic Engineering Services program provides the capability of identifying, analyzing, and correcting problem accident locations on the local road system. During fiscal 1978, 92 spot locations in 30 different local jurisdictions were reviewed and analyzed. The completion of the MALI project on the local system will have a positive effect on this program.

- C. Develop and implement run-off-roadway accident program utilizing available federal funds.

A specific program aimed at the run-off-roadway problem will not begin until the completion of the MALI project on the local road system. We currently have several realignment type projects being processed that directly relate to the run-off-roadway problem.

- D. Encourage the development of local awareness and expertise in highway safety activities.

Traffic safety seminars are continually being offered on the beginning and advanced level by both Wayne State and Michigan State University to local officials responsible for highway safety in their community. In addition, new courses are being developed to serve the needs of graduate engineers starting a career in traffic engineering.

As another means of creating local awareness, Regional Safety Committees have been established in each of the department's nine districts. Membership consists of the same departments that are represented on the State Safety Commission plus an engineer from the affected district office.

The purpose of these committees is to establish a two-way communication system between the Regional Safety Committee and the local officials within their respective district. Each committee operates independently with meetings scheduled generally on a bimonthly basis.

PROGRAM SUMMARY
FISCAL YEAR 1977-78

	<u>Total Costs</u>
FEDERAL CATEGORICAL SAFETY FUNDS-OBLIGATED	
Rail-Highway Crossings	\$ 5,540,173
Pavement Marking Demonstration Program	1,385,531
High Hazard Obstacle	2,751,361
Safer Off-System Safety	8,446,961
Special Bridge Replacement	1,884,581
Transitional Quarter Funds	<u>17,887,090</u>
Total	\$ 37,895,697
OTHER FEDERAL FUNDS	
Interstate Safety (Is)	2,275,451
Yellow Book Program	6,062,549
Urban Programs	18,900,000
Federal Aid Primary Program	4,690,894
Federal Aid Secondary Program	6,935,755
Federal Aid Off System	<u>275,540</u>
Total	\$ 39,140,189
STATE FUNDED SAFETY PROJECTS	
Ms - safety program	\$ 3,481,312
OTHER STATE FUNDED PROJECTS (Safety Items Only)	
Mb - bituminous resurfacing	\$ 3,081,661
Mbr - bituminous reconstruction	3,109,000
M - miscellaneous construction	703,840
Mnm - nonmotorized vehicle facility	294,802
Msh - shoulder edge treatment	1,728,004
Mbd - bridge deck	<u>119,385</u>
Total	\$ 9,036,692
SPECIAL PROJECTS	
Impact Attenuators	\$ 785,080
STATE-LOCAL MATCHING MONIES	<u>12,861,384</u>
Total Safety Expenditures	\$103,200,354

SECTION 1

THE 1976

HIGHWAY SAFETY ACT IN MICHIGAN

PART 1

CATEGORICAL SAFETY PROGRAM

FISCAL YEAR 1977 - 78

The 1976 Highway Safety Act in Michigan

Michigan has made the transition from the 1973 Highway Safety Act (HSA) to the 1976 HSA regarding the obligation of apportioned funds. We have retained 1973 HSA monies within various subprograms of the Categorical Safety Program to provide for active project overruns.

This year's Categorical Safety Program was more successful in every subprogram as far as obligating funds. During fiscal 1978, a total of \$37,895,697 was obligated with \$17,887,090 being TQ funds. The biggest increase percentage-wise occurred in the Rail-Highway Crossings program, \$3,411,800 in fiscal 1977 versus \$5,540,173 in fiscal 1978, a 62 percent increase. The Special Bridge Replacement Program showed the second largest increase at 47.7 percent, \$1,276,000 versus \$1,884,581. This increase would be larger if the program was given credit for the \$4 million of TQ funds obligated. The increases in the Safer Off-System and High Hazard Obstacle programs closely followed with 32.6 and 32 percent increases respectively.

Evaluations of completed Categorical Safety Program projects included in this report show a time of recovery (TOR) factor of 2.5 years. Evaluations of completed Michigan Safety (Ms) projects have a TOR of 5.2 years.

We completed a visual evaluation of the hot applied thermoplastic special pavement markings placed at at-grade railroad crossings on bituminous surfaced trunklines. Photographs were taken this spring and are included in this report.

Administrative responsibilities for the categorical safety subprograms included in the 1976 Highway Safety Act are assigned to the Michigan Department of State Highways and Transportation's Local Government and Traffic and Safety Divisions. The Local Government Division processes most requests that originate for off-trunkline projects. The Traffic and Safety Division processes all trunkline projects and those that are submitted through the division's Community Assistance Program for off-trunkline projects. The Office of Highway Safety Planning and the Michigan Department of State Police act as advisors due to a federally funded Section 402 grant for the Community Assistance Program.

The Transition Quarter (TQ) funds that Michigan received when the fiscal year was changed from a July 1 to June 30 period to an October 1 to September 30 period, has allowed Michigan to obligate an additional \$37 million towards safety related work items. A large part of the funds obligated have involved projects within the HHS/ROS and Special Bridge Replacement Programs. This has slowed the obligation of appropriated funds within the HHS/ROS program but has allowed Michigan greater flexibility for completing more projects within a shorter time frame.

Following is a more detailed discussion of each subprogram of the Categorical Safety Program and an evaluation of completed projects.

Rail Highway Crossings

This subprogram of the Categorical Safety Program contains two separate programs; Rail-Highway Crossing Protection (RRP), and Rail-Highway Crossing Safety (RRS).

The purpose of the RRP program is to eliminate hazards associated with rail-highway crossing through separation, reconstruction of existing structures, or the elimination of grade crossings by consolidating railways. Construction costs may qualify for 100 percent federal funds while right-of-way costs are limited to a maximum of 70 percent federal funds. The cost to the railroad cannot exceed 5 percent. Title 23 Section 104 requires that 10 percent or less of all funds apportioned to a state during any fiscal year may be used for this program.

The purpose of the RRS program is directed at reducing accident severity through the installation of standard signs, pavement markings, train-activated warning devices, crossing illumination, improvements of the crossing surface, and the consolidation or separation of crossings. All signing and pavement markings must conform to the MMUTCD. All improvements are to be determined from a priority listing in accordance with methodology in the Federal Aid Highway Program Manual. At least 50 percent of authorized funds are available for the above project types.

Administrative responsibilities for this section of the Categorical Safety Program are jointly shared by the department's Local Government Division and the Bureau of Highways' railroad contact engineer. Projects on the local roads system are administered by the Local Government Division while projects on the state trunkline system are administered by the railroad contact engineer. The safety of all rail-highway crossings within the state is shared with the department's Railroad Safety Unit, the railroads, and local highway authorities.

The Rail-Highway Crossing Improvement Program for fiscal year 1978 obligated \$5,540,173 of 1976 HSA monies. A total of 67 new projects (32 on trunkline, and 35 on the local system) have been programmed at an estimated cost of \$7,473,395. Since enactment of the 1973 HSA, the department has obligated a total of \$14.7 million.

The type and size of projects have varied considerably. The smallest project cost less than \$2,000 for signing an individual crossing to \$320,000 for upgrading a crossing which consisted of crossing and approach work, flashing signals with cantilevers, 1/2 gates, pavement markings, and advance warning signs.

The criteria used in the railroad priority determination sheet on page 1-11 does not consider accidents that may have occurred. However accident potential is considered in the charts, found on pages 1-12 through 1-14, for the various types of crossing protection. These charts provide an exposure factor for the crossing based on vehicular traffic versus the type of protection present with the resultant answer being expressed as probable vehicle-train accidents annually. Projects which consolidate several railway lines to a section of common railway provide the greatest cost benefit ratio when using these charts. We are computerizing the data contained in the

accident potential charts and the priority determination sheet plus actual accident data. Through the analysis capabilities of the computer program, when operational, a more meaningful priority assignment can be determined.

Evaluation

The three projects discussed in last year's Fourth Annual Report for thermoplastic pavement marking of at-grade railroad crossings on the state trunkline system indicate stricter controls are needed. Several of the RXR symbols did not last through the winter months. Photographs taken this spring in Michigan's lower peninsula, see pages 1-7 through 1-10, show excellent to poor condition of the symbols markings. It appears that the major fault is inadequate adhesion of the thermoplastic material to the pavement surface. In some instances the poor condition of the pavement surface initiates deterioration of the marking. In other instances it may be a combination of poor adhesion in conjunction with snowplowing. The specifications for these projects did not require that a primer be placed prior to applying the thermoplastic material.

We have made two changes in this year's special pavement marking program for school crossings and legends financed with PMS funds. It is mandatory that a primer be used and the temperature of the thermoplastic material at application was increased from 375° to 400° ± 10°. Monitoring of this project's wearability will again be completed by our district traffic and safety engineers.

Pavement Marking Demonstration Program

The purpose of this program is to show that vehicle and pedestrian safety can be increased through the standard application of pavement markings.

This program provides 100 percent federal funding for surveying no passing zones and the marking of any paved public highway except for interstate routes. Paved highways that had not been previously marked or had markings which were not in accordance with the MMUTCD were eligible. All costs for materials, labor, equipment rental or depreciation charges required to place markings initially and renew markings over a two-year period for evaluation purposes are funded. Higher type pavement markings such as hot applied thermoplastic materials are funded but require a complete cost-effectiveness analysis. Also eligible are costs incurred for data collection, analysis, and evaluation activities.

The department's Local Government Division has administrative responsibility for this program with the Traffic and Safety Division acting in an advisory capacity.

The department has for the first time used PMS funds on the state's trunkline system. Hot applied thermoplastic material was placed at designated school crossings on bituminous surfaced routes. The markings included "SCHOOL" legends, stop bars, and crosswalks designated as school crossings in accordance with the MMUTCD. This program included three separate projects which required that 3,527 lin. ft. of 12" stop lines, 36,960 lin. ft. of 6" crosswalk lines, and 1,462 single lane "SCHOOL" legends be painted statewide. The total cost as let for the three projects is \$320,368 without contingencies added.

This program did not place markings on all bituminous surface locations. A screening process hopefully eliminated areas that were to be resurfaced during the next two- to three-year period. However, resurfacing programs are subject to periodic changes of project scheduling which may call for resurfacing over recently painted markings.

The initial participation among Michigan's 83 counties was 95 percent. The requests for renewal paintings is currently 86 percent with 68 of 79 counties participating.

High priority was given to marking all unmarked two-lane rural highways and all no-passing zones on roads and streets under local (county) authority. Pavement marking standards in the Michigan Manual of Uniform Traffic Control Devices 1973 edition (MMUTCD) were followed in addition to the requirements found in Volume 6, Chapter 8, Section 3, Subsection 5, of the Federal Aid Highway Program Manual.

Federal standards required that centerline markings were to be applied on all paved roadways 16 feet wide or wider that carried an average of 250 or more vehicles per day. The MMUTCD adds to the pavement width requirement that a prevailing speed of greater than 35 mph must also exist. The federal standards for edgeline marking requiring a paved surface 20 feet or wider with an ADT of 250 or more vehicles, were compiled with all routes marked were chosen by the local authorities based on the above-mentioned criteria.

By June 30, 1978, a total of \$5,707,817 in Federal Aid Section 205 Safety funds had been obligated, \$1,751,817 during fiscal year 1978. The total amount expended leaves us with a total of less than \$1,000 of 1976 HSA monies. Letters from local agencies on pages 1-16 to 1-19 indicate their feelings regarding the value of the PMS Program.

High Hazard Obstacle/Roadside Obstacle

Sections 152 and 153 of Title 23 United States Code provide funding to reduce the hazards at locations on the federal aid system identified as high-accident locations and to eliminate or shield potentially hazardous roadside obstacles.

The project types eligible for Section 152 funding include, but is not limited to, intersection improvements, cross section modifications, skid resistance treatments, and alignment changes. It is intended that these projects be spot improvements, not major reconstruction at lengthy sections of roadway.

Project types eligible for funding under Section 153 include, but is not limited to, replacement of nonyielding supports, relocation of roadside obstacles such as utility poles and deep ditches; eliminate exposed bridge end posts, culvert ends, bridge abutments or piers, and guardrail endings; improve guardrails to current standards; and eliminate narrow bridges.

This department's Local Government Division has the administrative responsibility for locations that are off the state trunkline system with the Traffic and Safety Division acting in an advisory capacity. Locations on the state trunkline system are administered and engineered by the Traffic and Safety Division.

Local agencies, through the efforts of the department's Local Government Division and Community Assistance Program, are submitting locations which are more cost beneficial. Projects being submitted are showing 15 years or less of cost recovery time.

Project selection on all roadway systems is improving because of the availability of more computerized accident data. With the development of computerized correctable accident pattern data, we can be more selective in choosing various types of improvements. The average cost TOR (time of return) for projects on the trunkline system is approximately six years. See the completed evaluations of projects on pages 2-5 and 2-6. The reason for the low TOR can be attributed to a screening process which takes several factors into consideration as follows:

- A. Number and severity of accidents.
- B. Presence of "correctable patterns" and reoccurring patterns.
- C. Practicality - potential for improvement, size of project, consideration of potential right-of-way and/or drainage problems, and necessity of securing participation from municipalities.
- D. Operational considerations such as increased capacity, providing for left and right turns, roadside control, and removal of obvious "bottlenecks."
- E. Area factors - potential growth, traffic generators, and uniformity of treatment with a route.
- F. Consideration is given to expanding an intersection to its "ultimate cross section" in selecting appropriate treatment and project limits.
- G. Operational changes rather than reconstruction, such as signs, signals, or pavement markings.

The 1976 Highway Safety Act appropriations to Michigan were \$4,790,481 in Fiscal Year 77 and \$4,782,938 for Fiscal Year 78. As of June 30, 1978, a total of \$26,771,000 had been obligated since enactment of the 1973 HSA with \$2,751,361 being obligated during Fiscal Year 1978. If allowed to take credit for expended TQ funds, the totals would be HHS type projects \$3,087,000 and ROS type projects \$4,484,000 for a total fiscal expenditure of \$7,571,000.

Safer Off-Systems Program

Sections 101(e) 219 and 315 of Title 23 United States Code makes provisions which enable state and local road officials to construct and improve off-system roads and bridges. Projects which significantly contribute to the safety of the traveling public considered high priority.

Toll roads and roads under the jurisdiction of and maintained by a public authority or are not available for public travel are not eligible for project funding.

The selection of projects should be low cost corrections of high hazard locations, elimination of roadside obstacles, structure widening, or the installation and upgrading of traffic control devices. The highway agency distributes available funds throughout the state and cooperates with local road officials in the selection of projects to maximize the funds available.

The department's Local Government Division has the administrative responsibilities for this program. The Traffic and Safety Division provides traffic engineering consultation as needed.

A total of \$3,204,000 or 48.2 percent of the appropriated \$6,645,207 was distributed to Michigan's 83 counties and rural cities and villages under 5,000 population for fiscal 1978. The amounts ranged from a low of \$13,303 for Keweenaw County to a high of \$69,239 for Berrien County.

Cities and villages not included in either federally recognized urban or rural areas have \$435,000 available for their use. Special emphasis continues to be directed toward sign upgrading projects.

During fiscal 1978 \$5,811,000 of SOS funds were obligated. Additionally the Railroad Off-System Program (RRO) accounted for another \$2,533,000.

Special Bridge Replacement Program

Section 144 of Title 23 of the United States Code provides financial assistance to replace bridges over waterways or other topographical barriers that are considered significantly important and are unsafe because of structural deficiencies, physical deterioration or functional obsolescence. The program in Michigan is administered by the department's Local Government Division.

Bridges under local jurisdiction have been surveyed for structural adequacy and are ranked for priority of replacement in accordance with critical need based on the local agency's financial resources, importance of the bridge to the area, and the structural condition of the existing bridge. From 1972 through June 30, 1978, bridges representing \$15,173,231 in Federal Aid funds have been obligated. Four were obligated during Fiscal 1978 at a cost of \$1,207,000 which depletes the fiscal appropriation.

We currently have a backlog of approximately 346 structures to be improved. A typical improvement costs between \$200,000 and \$250,000 and occasionally exceeds \$1,000,000. Additional funds required to improve all currently listed deficient structures, if available, would be approximately \$55,000,000.

Transition Quarter Funds

Michigan extended the 1975-76 fiscal year from June 30, 1976, to September 30, 1976 to coincide with the October 1 to September 30 federal fiscal year. As a result of this extension, Michigan received a fifth quarter allotment (Transition Quarter TQ) of federal funds to be used as needed. During fiscal 1977 Michigan obligated 21,420,564 of TQ funds and an additional \$13,687,090 during fiscal 1978 for a two-year total of \$35,107,654. This money was mainly directed at HHS/ROS and Michigan Safety (Ms) type projects. Over \$4 million was obligated for bridge replacement projects.



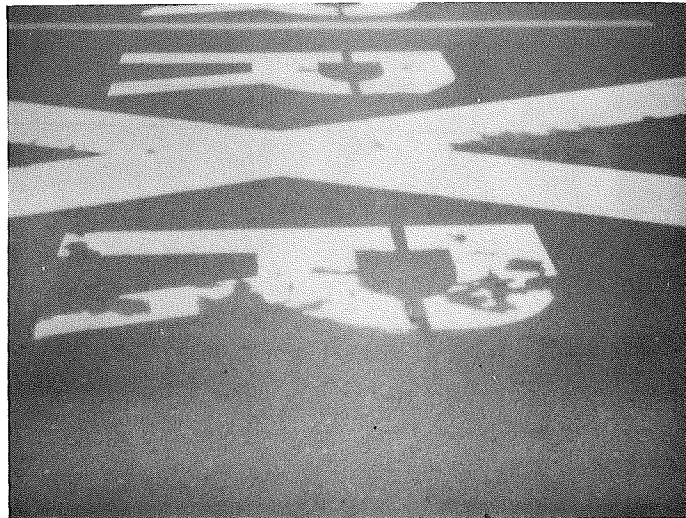
M-143 Michigan Ave. in Lansing
The thermoplastic pavement marking is
totally intact after one winter.



Close up of marking in photo above
Note the excellent condition of the pavement
surface



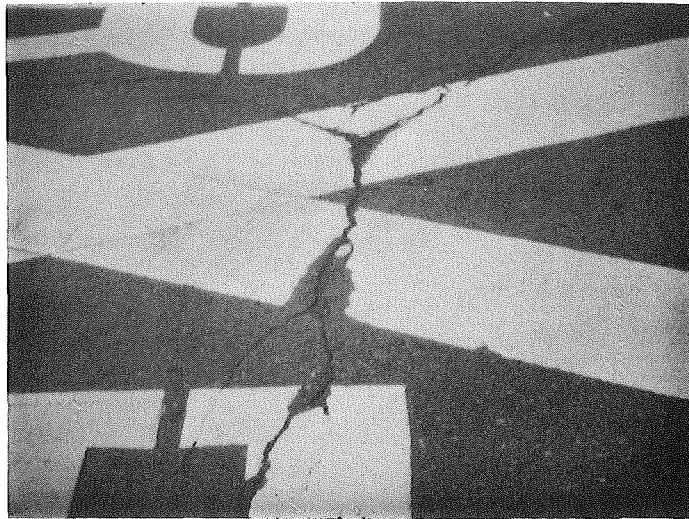
WB M-25 in Unionville, Tuscola Co.
Approximately 40% of the thermoplastic
marking has disappeared after one winter.
Note rough pavement surface.



BL-96 N. Grand River Ave. in Lansing
The material has chipped off with a
good pavement surface.



EB M-81 in Reese, Tuscola Co.
Approximately 50% of the thermoplastic
marking has disappeared. The pavement
surface is good.



BL-96 N, Grand River Ave. in Lansing
The only chipping is adjacent to a
pavement surface crack which indicates
good adhesion.



WB M-142 in Pigeon, Huron Co.
Approximately 50% of the thermoplastic
material remains intact. The pavement
surface is not in good condition.



Considerable chipping has taken place with
a good pavement surface. This could be
the result of poor adhesion or snow
plowing.

HHS
 SECTIONS 203, 230
 RAILROAD PRIORITY
 DETERMINATION

DATE: _____

CROSSING - _____

Determination of Points

<u>CRITERIA</u>	<u>MAX. POINTS</u>	<u>RELATIVE INFORMATION</u>	<u>ACTUAL POINTS</u>	<u>REVISED POINTS</u>
MPSC - (Priority & Order)	40			
Speed	10			
Chart - ADT, No. Trains	20			
Alignment & Sight -	10			
No. Tracks - (Max. For 2)	5			
Condition of Approaches	5			
School Busses -	5			
No. Trains -	5			
TOTAL POINTS				
Other Criteria - Circumstances which affect priority, not included above. 10 Points.				
TOTAL POINTS				

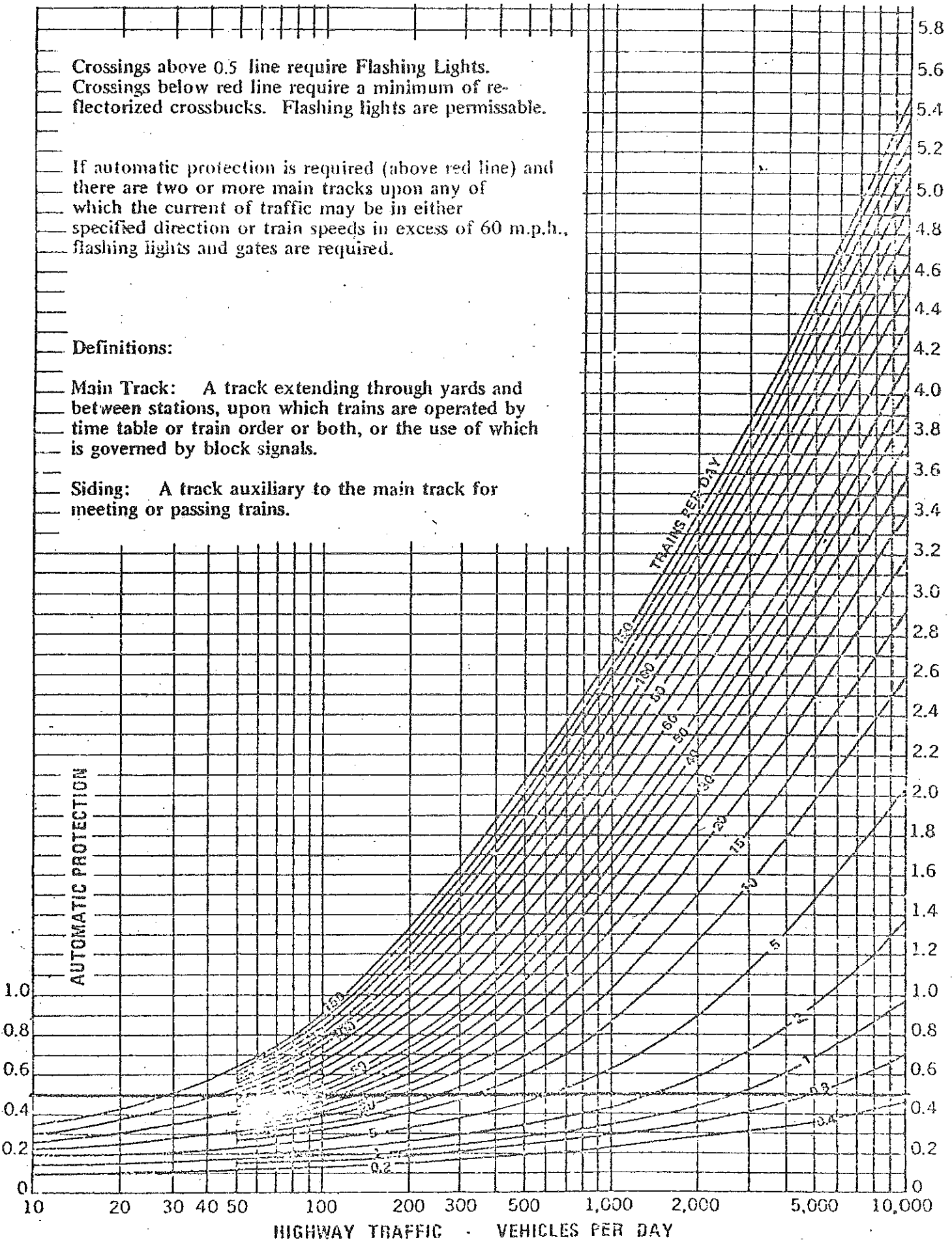
Crossings above 0.5 line require Flashing Lights.
 Crossings below red line require a minimum of reflectorized crossbucks. Flashing lights are permissible.

If automatic protection is required (above red line) and there are two or more main tracks upon any of which the current of traffic may be in either specified direction or train speeds in excess of 60 m.p.h., flashing lights and gates are required.

Definitions:

Main Track: A track extending through yards and between stations, upon which trains are operated by time table or train order or both, or the use of which is governed by block signals.

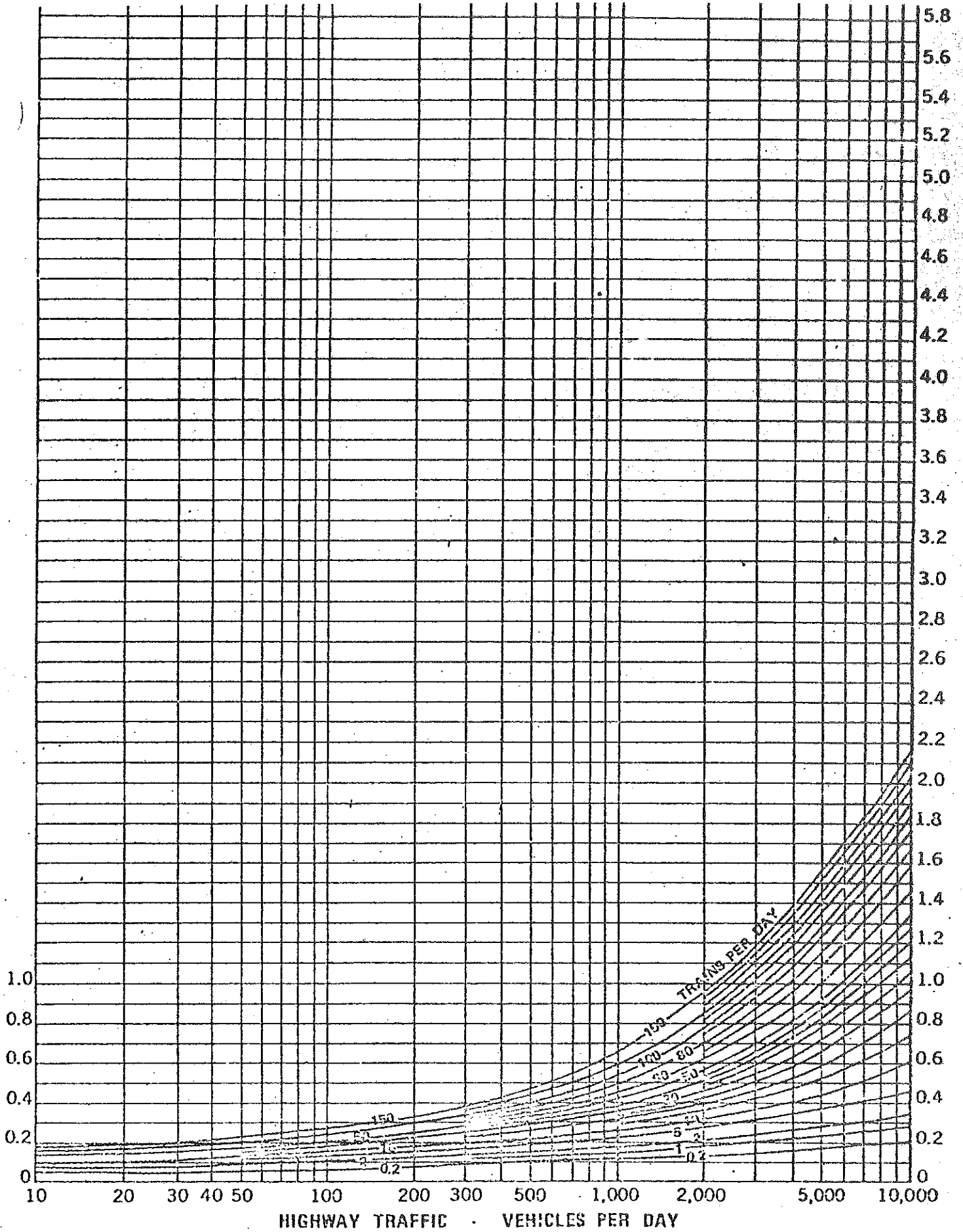
Siding: A track auxiliary to the main track for meeting or passing trains.



PROBABLE ANNUAL NUMBER OF VEHICLE - TRAIN ACCIDENTS

PROBABLE ANNUAL NUMBER OF VEHICLE - TRAIN ACCIDENTS

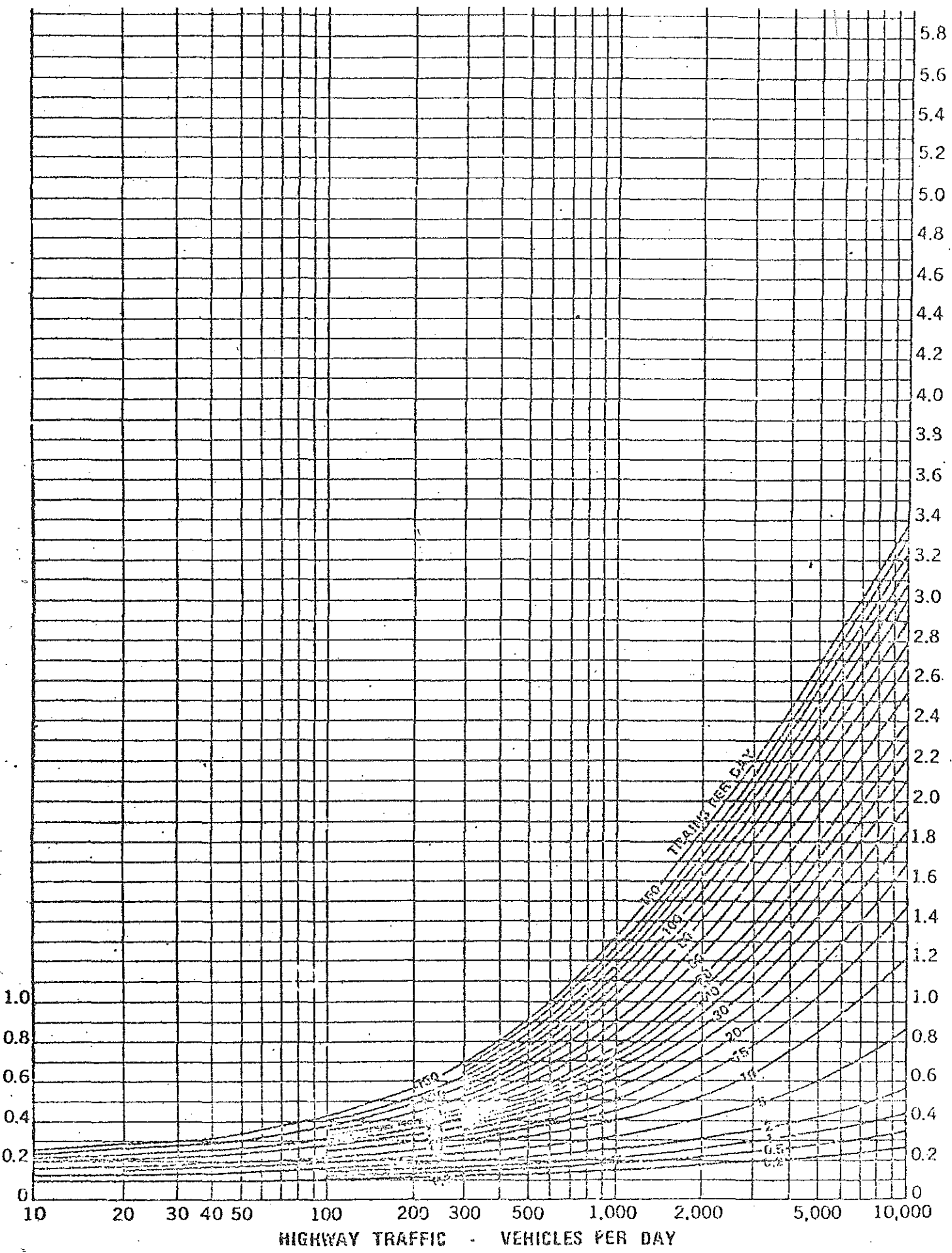
AT GRADE CROSSINGS PROTECTED BY SIGNS ONLY



PROBABLE ANNUAL NUMBER OF VEHICLE - TRAIN ACCIDENTS

PROBABLE ANNUAL NUMBER OF VEHICLE - TRAIN ACCIDENTS

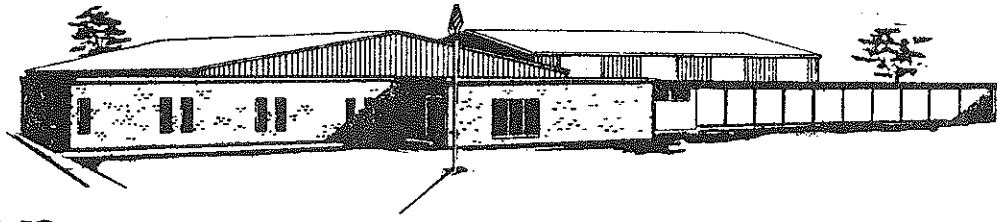
GRADE CROSSINGS PROTECTED BY AUTOMATIC GATES



PROBABLE ANNUAL NUMBER OF VEHICLE - TRAIN ACCIDENTS

PROBABLE ANNUAL NUMBER OF VEHICLE - TRAIN ACCIDENTS
 AT GRADE CROSSINGS PROTECTED BY FLASHING LIGHTS
 1-14

Clare County Road Commission



3900 E. Mannsiding Rd., Route 3, Harrison, Michigan 48625 • Area Code (517) 539-2151

March 17, 1977

Mr. John J. Michels, P. E.
Federal Aid Safety Engineer
State Highway Building
425 West Ottawa, P. O. Box 30050
Lansing, Michigan 48909

Re; Pavement Marking

Dear Sir:

I don't know that the Federal Pavement Marking Program has greatly decreased accidents but it has been a great help in reducing the number of complaints of near misses from irate citizens.

Pavement marking gives the traveling public a greater feeling of safety to have markings on the road to follow. Pavement edge marking is also a great help in areas where edge ruts are a problem; narrow bridge approaches can be defined more clearly with edge markings.

Sincerely,

John W. Burnett
Acting Superintendent

BOARD OF COUNTY ROAD COMMISSIONERS • COUNTY OF VAN BUREN • LAWRENCE, MICHIGAN 49064

Commissioners • Bill Burnette, Robert R. Pearson, Harry J. Sarno

County Highway Engineer • Paul J. Kaiser P.E.

Secretary • Mrs. Almeda Hartman

Telephone 616-674-8011

December 28, 1976

Mr. John Bergh, P.E.
Engineer of Local Government
Michigan Department of State Highways & Transportation
PO Drawer K
Lansing, Michigan 48914

Attention: Dave Myer

Dear Mr. Myer:

Re: Pavement Marking Demonstration Project

The Van Buren County Road Commission has participated in the federally funded Sight Distance Survey and Pavement Marking Projects.

Pavement Markings were completed the summer of 1976.

We feel it is in order to comment upon the practicality of the program and upon the good public relations which have resulted.

The Marking Project is a very practical and excellent use of federal funds. A very minimum amount of administrative work is involved. Waiver of extensive testing for materials helped to reduce overall cost and resulted in more competitive bids. The Pavement Marking Demonstration Project has required minimum inspection and field supervision. Previously demonstrated professional competence of specialty companies has resulted in excellent results.

Public comment on the markings has been excellent. Most persons are not aware that federal funds were used and expressed appreciation and approval of the work after being informed of the project. The markings are noticed by all travelers and certainly have added to safety on our highways.

Of all the Federal Programs available in the past and to the present date, we feel the Pavement Marking Demonstration Project is a most excellent and efficient way to spread maximum benefit to the public with the use of tax dollars.

Strong consideration should be given to continue the Marking Programs on a regular maintenance basis. The Demonstration phase of the project has proven itself very well.

	BERGH	LOTT
	DEC 28 1976	RECEIVED
	LOCAL GOVERNMENT	REWARDS
	FEDERAL AID SECTION	COPIES
		MICHELIS

December 28, 1976

One small difficulty we had involved marking of pavements through villages and small cities. In previous years we were able to maintain these markings through separate agreements. The Federal Program was of course restricted to our system of roads, therefore the villages/cities were required to negotiate separate contracts for relatively unfamiliar sections of markings. Perhaps guidelines for application of the markings could be changed to permit marking through street systems only--5,000 population and under--excluding urban areas--etc. Further study might limit it to some specific average through distance such as 2.00 miles maximum per identity etc.

The Van Buren County Road Commission has received maximum benefit from a well conceived and executed program.

Sincerely,

VAN BUREN COUNTY ROAD COMMISSION



William G. Camburn, P.E.
Highway Engineer

WGC:cl

BARRY COUNTY FARM BUREAU

234 E. STATE STREET
HASTINGS, MICHIGAN 49058

Farm Bureau - Guardian of Farm and Home

PHONE: 945-3733

March 18, 1977

Mr. Richard C. Mastin
Engineer of Local Government
Michigan Department of State
Highways and Transportation
P. O. Box 30050
Lansing, Michigan 48909

Dear Mr. Mastin:

One of the policies adopted by the Board of Delegates at the Michigan Farm Bureau 57th Annual Meeting held in Grand Rapids in December of 1976 reads as follows:

"Highway accidents take many lives each year; many people are injured, and much property damage occurs. To help reduce auto accidents, we recommend that: . . . Hard top roads should be marked with centerlines and side lines as an aid to safer nighttime driving..."

By this letter the Barry County Farm Bureau is urging the continuation of one of the best received Federal Programs to come out of Washington in some time: the Pavement Marking Demonstration Program, Section 205 of the Federal Highway Safety Act of 1973. This program provided for the marking of some 355 miles of centerlines and 44 miles of edgelines in Barry County. If the program is discontinued Barry County will not be financially capable of maintaining these miles in serviceable condition.

We ask that everything possible be done to provide for the continuation of this program.

Thank you for your cooperation.

Sincerely,

BARRY COUNTY FARM BUREAU



Rodney Pennock,
President

jb

STATE _____

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 FIPS CODE
(Alpha)

PAVEMENT MARKING DEMONSTRATION PROGRAM

ANNUAL REPORT 1978

TABLE 3

MILES AND COST OF MARKINGS PLACED

Type of Markings Placed	MILES AND COST (\$1,000) OF MARKINGS PLACED, *JULY 1, 1977 TO JUNE 30, 1978										Total Miles and Cost of Markings Placed July 1, 1977 To June 30, 1978		Cumulative Total Miles and Cost of Markings Placed to June 30, 1978	
	FEDERAL-AID SYSTEM					OFF THE FEDERAL-AID SYSTEM								
	Urban		Primary		Secondary		State Jurisdiction		Local Jurisdiction		Miles	Cost	Miles	Cost
	Miles	Cost	Miles	Cost	Miles	Cost	Miles	Cost	Miles	Cost				
Centerlines Only					3941	457,786			2387	277,274	6328	735,060	23,404	3,329,160
Edgelines Only					5945	475,600			1911	152,880	7856	628,480	22,911	1,663,680
Both Center lines and Edgelines													2,693	326,200
TOTAL			"SCHOOL"	320,368	9886	933,386			4298	430,154	14,184	1,363,540	49,008	5,707,817

*If reporting period is other than July 1, 1977 to June 30, 1978 indicate dates:

What percent of pavement marking demonstration funds were used for other than painted edge and center lines (raised pavement markings, cross walks, school zones, etc.)? 22% - 388,277

What percent of the miles shown in Table 3 were marked for the first time during the year ending *June 30, 1978? FAU _____, FAP _____,

FAS 3%, State _____, Local 9%

TABLE 4

TOTAL MILES REMAINING TO BE MARKED

Type of Markings to be Placed	MILES BY SYSTEM					TOTAL
	FEDERAL-AID SYSTEM			OFF THE FEDERAL-AID SYSTEM		
	Urban	Primary	Secondary	State	Local	
Centerlines Only						
Edgelines Only						
Both Centerlines and Edgelines						
TOTAL						

TABLE 1

STATE _____

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 FIPS CODE
(Alpha)

 HIGHWAY SAFETY IMPROVEMENT PROGRAM
 ANNUAL REPORT 1978
 PROCEDURAL AND STATUS INFORMATION

Line	Highway System	HIGHWAY LOCATION REFERENCE SYSTEM		TRAFFIC RECORDS SYSTEM		HAZARDOUS LOCATIONS	
		Miles Covered (Percent) (1)	Expected Completion (Year) (2)	Volume Data (Percent) (3)	Highway Data Correlation (Y,N,U) (4)	Location Criteria *(5)	Project Priority Selection *(6)
101	Interstate	100		100	U	A E R S Z	C E I P R
102	State - F.A.	100		100	Y	A E R S Z	C E I P R
103	State - Non-F.A.	100		100	Y	A E R S Z	C E I P R
104	Local - F.A.	48	1979	0	U	A L Z	C E I P R
105	Local - Non-F.A.	48	1979	0	U	A L Z	C E I P R

Line	Highway System	ROADSIDE OBSTACLES Project Priority Selection *(7)	SKID IMPROVEMENT Project Selection *(8)	NARROW BRIDGES Project Selection *(9)	RAILROAD-GRADE CROSSINGS					
					Inventory Update *(10)	Project Priority Selection *(11)	Compliance With MUTCD			
							Crossings Upgraded 7/1/73-6/30/78 (12)	Not Complying Number (13)	Compliance Target Date (14)	Compliance Target Date (15)
201	Interstate	A E H V	A-G-H-I-P-S-V- W-Y	A R V						
202	State - F.A.	A E H V	A-G-H-I-P-S-V- W-Y	A R V	None	C-I-P-T-V-W	111	None	0	None
203	State - Non-F.A.	A E H V	A-G-H-I-P-S-V- W-Y	A R V	None	C-I-P-T-V-W-Z	None	None	0	None
204	Local - F.A.	-----	A-G-H-I-P-S-V- W-Y	A R V	None	A-C-E-H-I-P T-V-W	108	None	0	None
205	Local - Non-F.A.	-----	A-G-H-I-P-S-V- W-Y	A R V	None	A-C-E-H-I P-T-V-W	148	None	0	None

F.A. = Federal-Aid

*If more than one code applies, show all appropriate codes.

Describe "Y" Codes on separate sheet and attach to this table.

SECTION 1

PART 2

EVALUATION DATA SUBMITTED FOR THE
CATEGORICAL SAFETY PROGRAM

Evaluation data for ten projects completed during 1976 is shown on the following page. These projects were funded by the HHS or ROS sub-programs with 1973 HSA monies.

By applying current accident costs \$125,000/fatal accident; \$4700/injury accident; and \$670/property damage accident, the before period accident cost is \$872,100. The after period accident cost becomes \$354,280 which shows a net savings of \$517,820 through a reduction of accidents and accident severity. The total cost of all ten projects is \$1,014,000. The TOR in this instance is 2.5 years.

TABLE 2

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND
PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1978
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

STATE _____

FIPS CODE
(Alpha)

Line	Safety Improvement Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements (\$1000) (3)	Quantity of Improvements (4)	Units (5)	NUMBER OF ACCIDENTS										Evaluation Status (16)	Exposure (Millions)			Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
						Before					After						Before (17)	After (18)	Units (19)			
						Mos. (6)	Fat. (7)	Inj. (8)	PDO (9)	Tot. (10)	Mos. (11)	Fat. (12)	Inj. (13)	PDO (14)	Tot. (15)							
01	HH	39	12	1	.1	12	0	3	8	11	12	0	0	1	1	F	11,800	11,800	V	U	4	D
02	HH	24	256	1	.1	12	1	17	45	63	12	0	17	35	52	F	7,870	7,870	V	U	4	U
03	HH	25	144	1	.1	12	0	6	15	21	12	0	7	24	31	F	8,050	8,050	V	U	2	U
04	RO	13	208	1	.1	12	0	5	10	15	12	0	3	11	14	F	15,180	15,180	V	U	4	U
05	HH	24	256	1	.1	12	0	2	1	3	12	0	0	0	0	F	5,200	5,200	V	U	2	U
06	HH	11	13.5	1		12	1	1	6	8	12	0	0	3	3	F	8,180	8,180	V	R	4	U
07	HH	11	15	1		18	0	17	17	34	18	0	5	18	23	F	38,870	38,870	V	U	4	U
08	HH	11	9	1		24	0	13	20	33	24	0	1	22	23	F	52,670	52,670	V	U	4	U
09	HH	11	8.5	1		12	0	0	31	31	12	0	0	14	14	F	21,430	21,430	V	U	4	U
10	HH	24	92	1	.4	24	0	37	67	104	24	0	19	36	55	F	44,000	44,000	V	R	5	U
11																						
12			1,014				2	101	220	323		0	52	164	216							
13																						
14								872,100					354,280									
15																						

1-22

SECTION 2

THE 1977-78

MICHIGAN SAFETY (Ms) PROGRAM

Michigan Safety (Ms) Program

Through the Michigan Safety (Ms) Program, the Michigan Department of State Highways and Transportation annually conducts a statewide review of the trunkline and interstate highway systems. This review is made to identify and implement safety improvements at locations experiencing correctable accident patterns. The Safety Programs Unit, located within the Traffic and Safety Division, is responsible for the development, implementation, and evaluation of this program which is funded with \$6 million of 100 percent state funds.

One of the principal program objectives is to minimize the frequency and severity of those types of accidents for which known corrective treatments are available. A computerized statewide accident location system (MALI) is used as the basis for the accident data generation. The identification process is accomplished through the acquisition of computer-generated printout listings which are categorized by roadway types exhibiting specific geometric, environment, and/or traffic characteristics. The Michigan Dimensional Accident Surveillance (MIDAS) model is used to obtain this information. For a given set of conditions, an accident data "package" is available which outputs a histogram for the following 20 possible accident codes: total accidents; right-angle; rear-end; left-turn; right-turn; head-on; ran-off-road; ran-off-road hit object (guardrail, sign, pole, culvert or ditch, abutment, tree); parking; pedestrian; dry surface; wet surface; icy surface; light and nonlight.

The histogram is a graphical representation of the accident frequency distribution which indicates the number of locations where collisions were reported, if any, as well as the magnitude of the accident frequency. Also listed is an English description of those locations exceeding a given upper confidence limit which includes the highway control section number, mileage point, number of accidents, route, cross road, local governmental agency, and county. The histogram also provides a ranking of locations with similar characteristics exhibiting disproportionate accident frequencies which are measured by the number of standard deviations from the mean. The procedure permits the identification of outliers by statistical significance and is most useful in the analysis process.

Using this data, it is possible to examine sets of geometric, environmental and traffic conditions and analyze specific accident patterns. For instance, roadways with two-, four-, or six-lane two-way cross sections can be studied for left-turn related accidents in order to determine the need for exclusive turn lanes. Other cross sections such as three-, five- or seven-lane two-way roadways can be reviewed for the need of special phasing of signalized locations with head-on left-turn accident patterns. From the identification of accident patterns, computer-generated collision diagrams are utilized to define actual correctable accidents, on-site field inspections are conducted, and alternate corrective treatments are analyzed to develop recommendations for operational modifications and/or appropriate minor and major safety improvement projects.

Evaluation studies are conducted annually to determine the effectiveness of the corrective measures in terms of accident reduction and injury avoidance. The goal is to select those projects with the greatest potential

for accident reduction and highest benefit/cost ratio. The department continues to forecast accident reductions based on previous before-and-after accident studies. The National Safety Council values for property damage, injury and fatal accidents are used in conjunction with the forecasted reductions to estimate anticipated safety benefits. The expected project amortization or time-of-return is attained by dividing the estimated construction cost by the anticipated yearly benefit. Currently, potential projects are being programmed with an expected return in safety benefits ranging from five to eight years.

Candidate projects usually consist of intersectional improvements such as the addition of protected right- or left-turn lanes, median left-turn lanes on divided roadways, increased curb radii, improved roadside control and skidproofing sections of highways exhibiting a disproportionate number of wet surface collisions along with low coefficients of wet sliding friction (WSF). Other projects have included the installation of protective guardrail and median barriers as well as limited highway improvements in newly developing commercial, industrial, or educational centers to accommodate increased traffic activity.

The department is continuing efforts to improve the effectiveness of the Safety (Ms) Program by further developing the MIDAS model. With Stage I of the model now in operation, the completion of Stages II and III are being advanced. At the present time, an application for a federal grant (402 funding) is being prepared in order to accomplish this. A complete discussion of the status of the MIDAS model can be found on pages 4-2 and 4-3.

Narrow Bridge Program

This year the Traffic and Safety Division initiated a five-year accident review (1971-75) of narrow bridge locations on the free access state trunk-line system. The review included a verification of the bridge sites with the associated control section milepoints in order to ensure reliable matching of accident data to bridge location. The base accident data information was derived from MIDAS data files and only included fatal or injury-related collisions.

A computer-generated ranking of high accident bridge locations was reviewed. This ranking indicated such factors as the total number and type of injury/fatal accidents reported, as well as the control section and mileage point of the site, the posted speed limit, roadway approach width, bridge width, and the ratio of bridge width to approach roadway width (BW/AW). An uppermost threshold ratio of 1.3 was selected since the comparison of accident frequency to ratio becomes rather constant with increasing ratios beyond this point.

A review of this ranking revealed there were several locations having a ratio of less than one where further investigation should be conducted to determine the need of supplemental signing or other appropriate operational modifications. The implementation of any changes are considered as interim improvements to any warranted geometric modification. A systematic study of these narrow bridge sites (based on high accident ranking) is also being conducted and is focused on locations with 20 or more injury/fatal accidents reported during the five-year study period. The review will include an

analysis of computer-generated collision diagrams, on-site field inspections, and the determination of alternate corrective treatments. This process will be used to "prioritize" recommendations for bridge reconstruction projects.

Evaluation data for 48 Ms projects completed during 1974 is shown on the following page. This format is not a true evaluation but merely a submission of accident numbers. Changes in an identifiable correctable accident pattern and the number of fatalities and injuries is not reflected. The format has been simplified so that all states are submitting like data for computerization purposes.

By applying current accident costs \$125,000/fatal accident, \$4700/injury accident, and \$670/property damage accident the before period accident cost is \$8,554,000. The after period accident cost becomes \$7,251,000. The total costs for the 48 projects is \$4,203,000. The after period costs indicate a net savings of \$1,303,000.

TABLE 2

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND
PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1978
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

STATE _____

FIPS CODE
(Alpha)

Line	Safety Improvement Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements (\$1000) (3)	Quantity of Improvements (4)	Units (5)	NUMBER OF ACCIDENTS										Evaluation Status (16)	Exposure (Millions)			Rural or Urban (20)	Number of Lanes (21)	Type of Road (22)
						Before					After						Before (17)	After (18)	Units (19)			
						Mos. (6)	Fat. (7)	Inj. (8)	PDO (9)	Tot. (10)	Mos. (11)	Fat. (12)	Inj. (13)	PDO (14)	Tot. (15)							
01	SL	24	671	6	1.8	24	1	92	168	261	24	1	84	132	217	F	108,000	107,900	V	U	4	U
02	SL	24	438	7	3.1	24	2	254	450	706	24	2	198	428	628	F	169,000	161,300	V	U	5	U
03	SL	24	584	1	.7	24	0	48	146	194	24	2	48	148	198	F	23,000	28,200	V	U	3	U
04	SL	24	229	1	.8	24	0	56	123	179	24	0	32	104	136	F	22,500	20,400	V	U	6	U
05	SL	24	757	4	3.4	24	2	232	338	572	24	3	111	200	314	F	164,100	157,900	V	U	6	D
06	SL	24	587	6	3.4	24	1	45	90	136	24	0	39	66	105	F	45,100	48,800	V	R	2	U
07	SL	24	31	3	.6	24	0	34	87	121	24	0	25	62	87	F	90,200	90,400	V	R	4	D
08	SL	24	21	1	.2	12	0	1	0	1	12	0	0	1	1	F	14,000	14,000	V	U	4	U
09	SL	24	434	3	2.3	12	3	72	136	211	12	2	50	106	158	F	59,300	59,100	V	U	6	D
10	SL	24	81	2	.5	12	0	2	2	4	12	0	1	1	2	F	13,200	13,000	V	R	2	U
11	SL	19	8	5	.2	24	2	15	31	48	24	0	15	32	47	F	29,000	25,600	V	U	2	U
12	SL	19	8	1	.2	24	0	0	1	1	24	0	0	4	4	F	8,300	10,100	V	R	2	U
13	SL	22	179	1	1.4	24	1	37	15	53	24	0	22	20	42	F	27,600	25,900	V	U	4	D
14	SL	20	19	2	.2	24	0	19	120	139	24	0	19	68	87	F	6,000	6,700	V	R	2	U
15	SL	39	24	1	.6	24	0	9	32	41	24	0	13	39	52	F	36,000	36,100	V	U	4	D

TABLE 2

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND
PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1978
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

STATE

PIPS CODE
(Alpha)

Line	Safety Improvement Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements (\$1000) (3)	Quantity of Improvements (4)	Units (5)	NUMBER OF ACCIDENTS										Evaluation Status (16)	Exposure (Millions)			Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
						Before					After						Before (17)	After (18)	Units (19)			
						Mos. (6)	Fat. (7)	Inj. (8)	PDO (9)	Tot. (10)	Mos. (11)	Fat. (12)	Inj. (13)	PDO (14)	Tot. (15)							
01	SL	39	23	1	.2	24	0	6	18	24	24	0	16	21	37	F	172,100	179,200	V	U	8	D
02	SL	39	95	2	2.3	24	2	209	412	623	24	3	241	451	695	F	36,100	34,000	V	U	6	D
03	SL	27	14	1	.2	24	0	3	31	34	24	0	9	39	48	F	6,500	10,000	V	U	4	U
04																						
05			4,203	48			14	1134	2200	3348		13	923	1922	2358							
06							\$1,750	\$5,330	\$1,474	\$8,554		\$1,625	\$4,338	\$1,288	\$7,251							
07																						
08																						
09																						
10																						
11																						
12																						
13																						
14																						
15																						

2-6

SECTION 3

OTHER SAFETY-RELATED PROJECTS

FISCAL YEAR 1977-78

Introduction

Michigan programs several other types of projects that are safety-related. Projects falling within this category include federal aid urban, federal aid primary, federal aid secondary, federal aid off-system projects, and 100 percent state and local funded projects.

Typical safety-related work items accomplished through these projects are: intersectional geometric improvements, signal modernizations, rail-highway crossing and signal improvements, roadside control, guardrail modernization, obstacle removal, resurfacing for skidproofing, median barrier construction, side slope improvement, and shoulder improvements.

Federal Aid Urban Program

This program provides the impetus to improve roads that service the centers of urbanized areas. Any construction project that qualifies for funding on any federal aid system is considered an eligible activity. Project selection is based on a predetermined planning process outlined in Title 23 Section 134.

Projects within this program provide the flexibility needed to maximize efficiency of existing roadways in the urban network. Project types include upgrading of traffic signal systems; bus lanes, loading areas, and facilities; pedestrian overpasses, and grade separations for highways and railroads.

Flexibility for highway/transit is also provided with urban system funds. Bus shelters, fixed rail facilities, and the purchase of rail rolling stock are eligible for funding, and they do not have to be on the urban system.

Projects such as intersection improvements, elimination of unnecessary guardrail through slope grading, modification of crossovers, elimination of sight restrictions, guardrail installations when obstacle could not be relocated, widening to improve capacity, and resurfacing can be considered as safety oriented in part or totally.

During fiscal 1978 a total of \$26,759,817 was obligated with \$18,900,000 being safety related.

Federal Aid Primary

Projects within this program are on state trunklines and rural arterial routes that extend into or through urban areas considered to be part of a system of main connecting roads important to statewide and regional travel that service the interstate system.

The types of projects funded by this program include, but are not limited to, the construction of bus passenger loading areas and facilities, exclusive bus lanes, traffic control devices, bridge railing and bridge deck replacement.

During fiscal 1978 \$4,690,894 was obligated that is safety related.

Federal Aid Secondary Program

This program provides the state and local governments with monetary assistance for improvement of rural FAS routes. Projects have to be selected by the department and local officials on a cooperative basis. Fifty percent or more of the apportioned amount is first made available to local road officials for use only on secondary roads.

Michigan's 1978 fiscal appropriation was \$11,655,553 for secondary road improvements. Local rural officials receive 55 percent \$6,410,554 with \$2,331,111 being distributed to cities and \$4,079,443 going to counties. The remaining \$5,244,999 was for use on the trunkline system. We obligated a total of \$12,610,464 during fiscal year 1978 for over 100 projects. An analysis of those projects indicate that \$6,935,755 was attributable toward the state's overall safety efforts.

Federal Aid Off-System Program

Project selection is a cooperative effort by the state and local road officials. This project selection considers several factors which are: provide employment for minorities and other disadvantaged persons; enhancement of opportunities for minority business enterprises; and the creation of employment in high unemployment areas.

The types of work include, but are not limited to, replacement, strengthening, or widening of functionally obsolete bridges; improving high hazard locations; elimination of roadside obstacles; placement of warranted traffic control devices; eliminating or improving rail-highway crossings; improving roads that serve school buses, mail routes, agricultural areas, and roads which have been removed from the federal aid secondary system.

Projects in this program cannot be funded if they are on: toll roads, cities and urban areas with over 5,000 population; roads not open to public travel; roads that are maintained and under the jurisdiction of other than a public authority; roads funded by a trust fund as per Title 23 within Indian reservations; and the federal aid system.

During fiscal 1978 \$1,072,685 were obligated for 16 projects. Of this amount \$375,540 was considered to be expended for the safety of the traveling public.

Michigan Funded Projects

In addition to the Safety (Ms) Program, there are several other state funded programs within which safety-related work is performed.

The determination of which project types are safety related is relatively simple, but time consuming. For instance, resurfacing projects are checked against skidtest data within the project limits. Those areas, where the skid number was low, are considered as safety expenditures. The same criteria was used in determining which bridge deck would be credited as a safety item.

Projects which replaced bridge railings, improved traffic signals, eliminated guardrail through grading, extended culverts, upgraded guardrail type, installed flared guardrail endings, etc., were evaluated similar to projects submitted for federal aid funding. If the project would have qualified for federal funds, 100 percent of the cost was considered safety. The percentage of safety items on other projects varied considerably.

Pedestrian and bicycle construction projects were considered 100 percent safety related if total segregation from the automobile conflict was established. Shoulder improvements were also considered 100 percent safety related because of the large percentage of right side, ran-off-roadway accidents and published research confirming the value of stabilized shoulders.

Mb Bituminous Resurfacing - This program is primarily aimed at the driving surface of highways. During fiscal 1978 there were 46 such projects let to contract. Resurfacing of highways that exhibit low coefficients of wet sliding friction, a high percentage of wet surface accidents, or have uneven surfaces are of primary concern. Correction of superelevation has also been accomplished through this program. The cost of these projects totaled \$11,413,561; \$3,081,661 for safety.

Mbr Bituminous Reconstruction - This program focuses on the surface and base of highways. Projects may include minor widening and roadside control with curb and gutter and enclosed drainage. During fiscal 1978, 34 projects were let to contract at a cost of \$7,404,103 of which \$3,109,000 was identified as safety related.

M Miscellaneous Construction - During fiscal 1978, there were 26 projects costing \$3,784,000 let to contract. One project was for revision of ramps at \$169,967 and one project was for joint repair and shoulder paving at a cost of \$312,786. The bridge railing and cable guardrail were replaced on another project at a cost of \$183,746. One bridge deck resurfacing project was done for \$62,590. The total that could be attributed toward safety was \$887,586.

Mbd - Bridge Deck - Projects in this program correct bridge decks that have exhibited spalling to the point where rebars are exposed, the bridge deck leaks, or the bridge deck is slippery when wet. In most cases the deck is waterproofed after completing any required minor deck repair and a latex modified mortar, concrete, or bituminous surface is applied. During fiscal 1978, eight projects were let to contract at a cost of \$477,540 of which \$119,385 is safety related.

Mnm Nonmotorized Vehicle Facility - This program funds facilities for exclusive pedestrian and bicycle usage. The conflict between vehicles, bicycles, and pedestrians has been the subject of concern for several years. Three projects let to contract during fiscal 1978 cost a total of \$294,802. One of the projects was on the interstate system and cost \$112,427. The projects provided paved shoulders or separate pathways for nonmotorized vehicles.

Msh Shoulder Edge Treatment - This program provides a minimum three-foot bituminous edge strip along the right-hand side of state highways. It is aimed at preventing the formation of an edge drop between the pavement and adjacent shoulder material. An edgeline is provided to delineate the driving lanes and prevent regular usage of the added width. During fiscal 1978, there were 19 projects involving 185.7 miles at a cost of \$1,728,004 or \$10,000 per mile.

High Accident Skid Test Program

As part of the annual surveillance process, a review of a statewide accident listing (by 0.2 mile sections) is conducted to determine the percentage of wet accidents occurring above a predetermined threshold level. The district average wet percentage is used as the norm to isolate locations warranting further investigation. Skid tests are then obtained at those locations which have a wet surface accident experience above the norm. Those locations displaying correctable accident patterns (rear-end or side-swipe type) in conjunction with low wet sliding friction (WSF) coefficients are recommended for treatment.

Recently, the department's Testing and Research developed an accident surface friction model which has the ability to prioritize candidate locations (intersections only) based on the predicted accident reduction using skid number, weather, and traffic volume data. It is anticipated that this model can become the basis to develop a comprehensive anti-skid/accident reduction program, especially when considered along with those locations not suitable for analysis by the model (nonintersection or freeway sections). At the present time, however, the actual implementation of the skid-accident model is still being investigated.

Yellow Book Program

The Michigan Department of State Highways and Transportation is currently engaged in a program of implementing safety improvements to reduce hazards in the roadside environment. Typically this program consists of culvert extensions, modernization of guardrails, resloping to eliminate guardrails, replacing or retrofitting inadequate bridge rails, concrete median barriers and glare screen installations, impact attenuation, installing traffic signs on breakaway supports or bridge mounts, and freeway lighting alterations.

Plans preparation for yellow book upgrading have been based on the 1967 and 1974 editions of the AASHTO publications of Highway Design and Operational Practices Related to Highway Safety commonly referred to as the Yellow Book. More recently, AASHTO's 1977 Guide for Selecting, Locating and Designing Traffic Barriers has also been used as a guideline for designing roadside safety improvements.

Progress in actual completion of yellow book interstate safety improvements has been slow until the past three years. Initially, work authorizations were issued starting in 1971 to have the work performed by contract counties and state forces as their schedules permitted. The work at that time consisted mainly of guardrail improvements, culvert extensions, and minor grading.

As time went on, however, only a small amount of work was completed. The contract counties and state forces did not have enough time or manpower requirements (with a few exceptions) to complete the work as initially anticipated.

In 1975 we began to let yellow book interstate safety projects to private contract. The conversion to private contract allowed the scope of the work to be expanded to include bridge railing replacements, crash cushion installations, concrete median barrier and glare screens, and freeway lighting upgrading.

Yellow Book projects are blanket-type projects which include complete roadside safety improvements for longer segments of highway such as an entire control section. Yellow Book safety improvements are often classified as interstate safety projects but are separated for this report.

Interstate safety projects may also include superelevation corrections, modification of interchange ramp termini to avert wrong-way maneuvers, widening lanes or structures to separate turning movements, or provide for left-turns and freeway on- and off-ramp roadway alignment signalization, and other types of spot improvements to improve safety.

Interstate Freeways - Yellow Book Status

Yellow book upgrading continues on the 1,100 miles of interstate routes open to traffic with 935 miles of upgrading approved by the FHWA. The remaining 165 miles are in accordance with present day standards with the exception of a limited number of buried end section guardrails and a few minor items which will ultimately be brought up to current standards.

Of the 935 miles:

1. 65 percent (603 miles) has been completed or are presently under contract.
2. 32 percent (299 miles) are programmed and in the design stage.
3. 3 percent (28 miles) are either unprogrammed or not in the design stage.

In 1977-78 Michigan obligated yellow book projects that total \$5,432,000 and encompassed 59 miles of freeways.

Michigan has recognized that it will be necessary to review each yellow book project that has been completed since standards and guidelines for safety improvements have changed over the years. For instance, freeway mainline improvements were the main issue for some of the earlier projects. Some interchange and crossroad work, including guardrail modernizations and bridge railing replacements for structures over freeways was not accomplished. Also, it was quite common to retain Type A guardrail (12'6" post spacing and not blocked out) for some of the older projects if it was structurally sound, of appropriate height, and did not show evidence of being struck. Current practice includes complete roadside upgrading, including ramps and crossroads, replacement of all obsolete bridge rails for freeway mainline or crossroad structures over freeways.

Interstate safety projects are similar to those categorized as yellow book safety improvements and include installation and/or removal of traffic barriers and endings; installation of impact attenuators; lengthening culverts and modifying end sections; minor grading of slopes; installation, modification, and/or relocation of signs and markings; overpass screening; and glare screening. Generally, interstate safety projects are spot improvements.

Noninterstate Freeways - Yellow Book Status

Of the 560 miles of noninterstate freeways open to traffic, it will be necessary to perform yellow book safety upgrading on 500 miles. The remaining 60 miles is up to current safety standards.

Of the 500 miles:

1. 38 percent (188 miles) has been completed or are presently under contract.
2. Programmed or in design - 6 percent (34 miles).
3. The remaining 278 miles have been prioritized based upon accident rates over a five-year period.

During 1977-78 Michigan obligated yellow book projects on the noninterstate freeway system using Transition Quarter (TQ) funds.

Free Access State Trunklines - Yellow Book Status

Realizing that complete yellow book upgrading on the free access state trunkline system will require several hundred million dollars to complete. Michigan has elected to complete this work in three stages defined as Task 1, Task 2, and Task 3.

Task 1 includes the installation of buffered end sections to eliminate straight guardrail endings and the potential hazard of penetration into passenger compartments. This work began on a limited basis and three counties were completed during the winter of 1974-75 and was financed with 100 percent state funds. In the fall of 1976 the remaining work was authorized in the amount of \$1,455,000 and financed with Transitional Quarter funds as a Roadside Obstacle Safety (ROS) project with the FHWA participating in 90 percent of the total cost.

During fiscal 1977-78 \$630,594 was expended and the project is estimated 63 percent complete.

Task 2 includes upgrading guardrails proximate to bridges and replacing or retrofitting guardrails to the existing railing system. This type of work is currently being included with road and bridge reconstruction or resurfacing projects as available manpower and funding allows. Most of this work is being financed with 100 percent state funds.

The costs for this Task 2 work are included in the category of Other State Funded Projects on page 3-3.

Task 3 includes complete improvement of the roadside to current yellow book standards. Due to lack of funds, specific Task 3 programs have not been initiated. However, guardrail modernization work is currently being included with road and bridge reconstruction or resurfacing projects as resources allow. The costs for this Task 3 work are included in the category of Other State Funded Projects on page 3-3.

Impact Attenuators

The Michigan Department of State Highways and Transportation has 168 existing impact attenuators installed on the state highway system. Ninety-seven are Hi-Dro Cell attenuators, 28 are "GREAT" (Guardrail Energy Absorption Terminal) attenuators, 26 are sand barrel attenuators, one Hi-Dri Cell attenuator, and the remaining six are Cell Cluster attenuators. We also have an additional 57 attenuators in one of the design stages. The total estimated installation cost for these attenuators is \$1,474,875.

Personnel from the Traffic and Safety Division conducted a field inspection of all of the existing attenuators on our trunkline system. An inventory of the attenuator locations has been forwarded to the Maintenance Division for their use.

Traffic Engineering Services

The Michigan Department of State Highways and Transportation continues to provide, through the Community Assistance Program and the Operational Inventories Unit, traffic engineering services to local governmental agencies. These services are generally limited to those agencies who do not have qualified traffic personnel and/or sufficient resources to plan, design, and develop appropriate countermeasures to alleviate traffic engineering and traffic safety problems.

The Community Assistance Program provides the capability of identifying, analyzing, and correcting problem accident locations. Recommendations generated through this program outlines operational and geometric improvements which, when implemented, will reduce the number of accidents and their severity. The Operational Inventories Unit provides assistance to local governmental agencies for the inventory of the traffic control devices on the local road system. As part of the inventory process, recommendations are made for the erection, replacement, relocation, and removal of traffic control devices to meet the requirements of the 1973 Michigan Manual of Uniform Traffic Control Devices. Department personnel conduct inventories for the smaller agencies and train local personnel to conduct their own inventories in larger agencies.

Participation in both services is initiated through a request by the local agency to the department's Local Government or Traffic and Safety Divisions. Both programs are federally funded through a grant from the Office of Highway Safety Planning using Section 402 funds enabling local agencies to receive these services free.

Request for both community assistance and inventories of traffic control devices has increased to the extent that we are considering the use of private traffic engineering consultants to aid us in providing traffic engineering services to local governmental agencies.

Upon the completion of MALI in the spring of 1979, Michigan will have the capability of locating accidents to all streets and roads, thereby providing accident analysis information to state and local users. With this ability to identify hazardous locations on all streets and roads, we anticipate that future requests by local communities for traffic engineering services will increase substantially. Therefore we plan a pilot program, utilizing private consultants, that will be designed to have them review and analyze these potentially hazardous locations and develop methods for their improvement.

During fiscal 1977-78, the Community Assistance Program has reviewed and analyzed 92 spot locations in 30 different local jurisdictions. Recommendations resulting from these analyses involve traffic signal installations, traffic signal modernizations, and intersection reconstruction. \$1,849,000 in Federal Highway Safety funds was programmed to assist local agencies in implementing safety improvement projects.

Statewide, traffic control device inventories have been completed on 17,577 miles of county primary roads in 55 counties, 14,770 miles of county local roads in 18 counties, and 8,633 miles of major and local streets in 199 cities and villages. This accounts for approximately 38 percent of the total statewide nontrunkline mileage of 106,908 miles. The accomplishments by fiscal year from 1969 to present are:

MANUAL INVENTORIES

Fiscal Year	County		Local		Cities or Villages		Cumulative	
	Primary/FAS No.	Miles	No.	Miles	No.	Miles	No.	Miles
69-70	1	277.26	-	-	-	-	1	277.26
70-71	7	2,670.96	-	-	-	-	7	2,670.96
71-72	24	6,198.30	-	-	-	-	24	6,198.30
72-73	6	2,345.97	-	-	-	-	6	2,345.97
73-74	3	1,140.53	-	-	1	18.80	4	1,159.33
74-75	1	357.00	1	746.61	10	148.93	12	1,252.54
75-76	2	765.22	5	4,470.17	19	469.57	26	5,688.17
Trans. Quarter	5	1,370.20	2	1,616.59	13	197.37	20	3,184.16
76-77	1	254.33	3	2,099.60	55	677.23	59	3,031.16
77-78								
(6-30-78)	3	1,061.40	3	1,756.51	39	503.85	45	3,326.76
Sub Total	53	16,441.17	14	10,659.48	137	2,020.75	204	29,151.40

In addition to Michigan Department of State Highways and Transportation inventory activities, three counties and 62 local agencies have been inventoried by consultants using the photolog procedure resulting in computerized printout inventories involving 11,829 miles of nontrunkline roadways.

Departmental personnel continue to provide technical assistance to the local governmental agencies by preparing the necessary documents required to obtain federal funds for project implementation. During fiscal 77-78, 86

sign upgrading project contracts were initiated involving approximately \$2.5 million of various federal program funds. Seventy-three additional projects involving \$1.7 million of federal funds are anticipated to be readied for contract within a few months.

Michigan Accident Location Index (MALI)

The Michigan Department of State Highways and Transportation and the Michigan Department of State Police, in cooperation with the Michigan Office of Highway Safety Planning, have developed a computerized accident location reference and analysis system referred to as the Michigan Accident Location Index (MALI). The MALI system is designed to generate a computerized description of traffic accident locations directly from the information reported by the police officer. The computer system generates and maintains the accident location information on the MALI street index for later retrieval and analysis. The MALI street index is a map of the street network stored in the computer. The street index is composed of distances between intersections, alternate street names, and accurate city and township boundaries.

The primary functions of the MALI system are to expand the state's accident locating capability to all roads and streets, eliminate the manual locating of accidents, and provide accident analysis information to state and local users. The MALI system will enable the user to identify hazardous locations on all roads and streets, forming the basis for establishing priorities for safety improvement projects, selective enforcement areas, and other activities that have an impact on the state's accident experience.

The MALI project is currently operational on the state trunkline system in all 83 counties and on the local road system in 34 counties. The MALI street index for the local road system in the 49 remaining counties will be completed by a consultant through an agreement with the Michigan Department of State Highways and Transportation. The consultant anticipates satisfying the terms of the contract by the end of January, 1979, instead of the original projection of August, 1979. An amendment to the contract was signed on June 10 to provide for the addition of all public railroad crossings to the master index for all roads in the state. This addition will allow the referencing of crashes to both at-grade and grade-separated crossings and, more importantly, the subsequent identification and classification of accidents occurring.

The completed indexes on the MALI system are presently locating 60 percent of the total accidents in the state of Michigan. The remaining accidents are being located to pseudo locations by road type and political subdivision rather than specific locations. The percent of accidents located will increase as the remaining trunkline routes and local routes are added to the master index.

SECTION 4

NEW DEVELOPMENTS IN

HIGHWAY SAFETY

New Developments in Highway Safety

Some rather unique developments have again taken place during the past year relative to Michigan's highway safety program. The second phase of the interchange priority study was completed and approved by the FHWA. The MIDAS model had its initial year of actual operation. A Positive Guidance Demonstration Project was granted to Michigan by the FHWA. The SCANDI project was let to contract. Project BEAR will be operational this fall. Finally, plans for a waterwall crash barrier were initiated.

Interchange Priority Study Phase 2

The interchange priority study was undertaken to comply with federal guidelines concerning justification for safety improvement projects. Phase 1 of the study established a criticality ranking of those statewide interchanges exhibiting an abnormally high number of injury accidents. Phase 2 of the study outlines the procedures to be followed in the analyzation/prioritization process. The report addresses alternate solutions, estimated costs and benefits, and cost effectiveness.

The various steps in the prioritization process can be outlined as follows:

1. Perform interchange data analysis
2. Determine alternate countermeasures or solutions
3. Obtain cost estimates and calculate benefits
4. Determine cost effectiveness of each alternative
5. Implement and evaluate

Currently, we are at Step 1 in the prioritization process. This involves the manual preparation of collision diagrams and the analysis of traffic volumes for the topmost ranking interchanges.

In addition, we are having aerial photographs taken of all three interchanges. The photographs will supplement the collision diagrams to depict roadway geometrics, recent development that has occurred near ramp terminals, and other physical features that may be helpful in the analysis.

In conjunction with the interchange priority study that we have developed, the department is now involved with Midwest Research Institute in the development of an interchange prioritization procedure for possible use on a nationwide basis. The department will cooperate closely with Midwest Research Institute on certain aspects of this federally funded research grant.

In a closely related aspect of the interchange priority study, the department is developing a program to modify tight diamond interchange ramp terminals. It is felt that this program will help to improve both the safety and the operational features of these outdated interchanges.

MIDAS - Michigan Dimensional Accident Surveillance

The department is currently developing a highly sophisticated crash surveillance and analysis system known as the Michigan Dimensional Accident Surveillance Model (MIDAS). The system has been designed to provide a statistical analysis of abnormal crash patterns and an analysis of all feasible corrective treatments, which includes costs and expected crash reductions. Furthermore, the system will include an optimization process whereby the most cost-effective alternatives are selected which maximize the expected casualty reduction within the constraints of a fixed budget.

The goal of this department is to further develop and implement the MIDAS model which, in conjunction with the MALI index, will provide Michigan with a total traffic record system. In order to accomplish this objective, the MIDAS project was divided into three component areas as follows:

The Completion of the MIDAS Model - The first component of the total project involves the completion and implementation of the MIDAS model. The total MIDAS model is composed of three stages. The first stage involves a computerized data bank containing information such as laneage, alignment, lane and shoulder widths, auxiliary lanes, traffic controls, and lane usage. It is possible to classify the information into as many as one-half-million discreet units, with each unit containing accident data for sites with identical characteristics. The numerous variables are explained by the four basic dimensions; geometry, environment, cross section, and accident characteristics. We are also investigating traffic volume (more specifically congestion) at the time of the accident which will be more definitive than the presently used accident rates based on average daily traffic. It will be possible to explore the relationship of variables to one another and search for variables and combination of variables which explain the accident phenomena. At the present time this stage of the model is operational within the constraints of existing accident data and program limitations.

The second stage of the computer model will calculate the cost effectiveness of each potential accident countermeasure. For every site identified as having a significant accident concentration, every feasible corrective treatment (left-turn lanes, traffic signals, all-red phases, etc.) will be cost estimated using historical cost data input into the computer. The expected reduction in accidents will be estimated by a complex statistical analysis relying on the first stage data base. The projected cost divided by the anticipated reduction in accidents relatively describes the cost effectiveness of each proposal.

The third stage will involve objective optimization using one of a number of available mathematical optimizing processes. The computer will select the abnormal accident site and identify countermeasures which maximize the expected reduction in accidents and personal injuries within the constraints of available safety funds.

The development and implementation of the final two stages of the MIDAS model is not expected to be difficult. Through the use of federal dollars completion of the model is expected in the near future.

Automated Roadway Features Recording Vehicle - The second component of the MIDAS project involves the collection and computerization of the necessary roadway geometry and other physical data for the trunkline road system and the local road system. This step will involve the operation of an automated surveying vehicle which will contain computer and navigational systems from other disciplines, combined with the latest photolog equipment. The successful completion of this project will provide additional roadway data for the trunkline system and also enable the MIDAS model to be implemented on the local road system.

Expansion of the MIDAS Model Data Base - The third component of the MIDAS project consists of the integration of parallel data sources, such as the Secretary of State driver and vehicle records, weather bureau information, and environmental data with the existing data base for the MIDAS model. These types of data will allow the MIDAS model to relate the driver, the vehicle, and the roadway to available crash characteristics.

The significance of the MIDAS project to our common overall goal of reducing crashes and providing increased safety and convenience to the motoring public cannot be underestimated. We believe the MIDAS project, together with the MALI system, will provide Michigan with a total record system relating the driver, the vehicle, and the roadway. These types of programs will enable Michigan to continue as a leader in the crash location and analysis field.

Positive Guidance Demonstration Project

Michigan was one of three states recently awarded a FHWA contract to participate in a Positive Guidance Demonstration Project. The project, 100 percent federally funded, employs the Positive Guidance methodology to improve the safety and operational features of an inefficient location. The project site selected for Michigan was the eastbound I-96 freeway split at M-37 (Alpine Avenue) near the city of Grand Rapids.

The Positive Guidance approach integrates the traffic engineering and human factor technologies to produce an information system matched to driver performance capabilities under varying traffic operational facilities and conditions. It is a process designed to provide high-payoff, short-range solutions to safety and operational problems at relatively low cost. Positive Guidance is based on the premise that a driver can be given sufficient information to avoid accidents at hazardous and inefficient locations.

Highway system failures range from simple delays through traffic conflicts to actual accidents. Many of these are the result of failures by drivers to select appropriate speeds and paths. Positive Guidance helps eliminate these system failures by providing information which will increase the probability that drivers will select the proper speed and path for the operating conditions of the highway.

The step-by-step Positive Guidance methodology consists of the following six functions:

- Data Collection at Problem Locations
- Specification of Problems
- Definition of Driver Performance Factors
- Definition of Information Requirements
- Determination of Positive Guidance Information
- Evaluation

As of this writing, the field data has been collected and reduced. At present, the evaluation of driver expectancies is being conducted. The results of this study should be available for the next annual report.

SCANDI - Surveillance, Control and Driver Information

The SCANDI system is a project of the Michigan Department of State Highways and Transportation whose objective is to improve the safety, capacity, and driver comfort on Detroit area freeways by applying advance technology and positive research findings in an operational system supervised by a real time Data Acquisition and Control System.

The major objective of the program will be to monitor conditions on the freeways, respond in real time to changes in the traffic stream, alert Control Center personnel to capacity reducing incidents, implement corrective action by controlling access to the freeway, and to provide positive information to the motorist.

The surveillance aspect of the system will be provided by vehicle detectors placed in the roadway, and in some instances will be supplemented by closed circuit television and motorist-aid call boxes. The control aspect will begin with ramp metering at selected locations and may eventually include other devices that may in time be proven effective. Driver information will initially take the form of advisories to the motorist via commercial radio, as is presently being performed by Traffic Central, which is a cooperative effort by the Detroit police, the Detroit Traffic Safety Association, and the Detroit area commercial radio stations. Other devices, such as driver information signs and other forms of information may be added in the future. The SCANDI system is proposed for all 65 miles of freeway within the city limits of Detroit, and an eventual expansion into the suburban areas surrounding Detroit, thus encompassing a total of up to 187 miles, is highly probable.

The first stage of the SCANDI Project was let to contract during the past year. The \$10.3 million contract involves the installation of the SCANDI on 32.5 miles of Detroit freeways.

When the system is first put on line, response to capacity reducing incidents will be provided by the service agencies (police, fire, maintenance, etc.) who presently perform on the freeways. Their response time will be decreased through the early and reliable detection provided by SCANDI. In time, a more sophisticated incident management team will be developed, probably quite similar to that used in California, using a team consisting of traffic, maintenance, and police supervisory personnel and

utilizing "preplanned" incident management strategies which will serve to further improve the response capabilities of these service agencies.

It is anticipated that the total program inside the city of Detroit would take approximately five years. Expansion into the suburbs, if approved, would extend into the mid-1980's with constraints being the availability of funds for construction and timing to coordinate with new freeways that will be under construction until about that time.

BEAR - Broad Emergency Assistance Radio

The Department of State Highways and Transportation, in cooperation with the Michigan Department of State Police, will soon begin operation of a Citizens Band Radio Motorist-Aid System along Interstate 96 from Grand Rapids to Detroit. The project is being funded through the Federal Highway Administration, using 90 percent federal funds.

This system, known as Project BEAR (Broad Emergency Assistance Radio) will utilize 10 evenly spaced, remotely controlled CB base stations along the I-96 corridor to relay motorists' assistance requests on CB Channel 9 directly to State Police Headquarters in East Lansing. Full-time police dispatchers will then send aid to stranded motorists by communication over police radio to one of three state police posts.

The basic objectives of this project are threefold:

1. To determine the feasibility and measure the effectiveness of an in-vehicle, two-way, motorist-aid communications device which provides direct communication with emergency services personnel.
2. To measure the impact that the state police monitoring of Channel 9 (the CB emergency frequency) will have on highway safety services to stranded motorists along a rural highway.
3. To formulate recommendations for future CB motorist-aid systems.

The value of a Citizens Band Radio System in reporting emergency situations and providing motorist assistance has been documented by current Michigan State Police and other private volunteer monitoring programs across the nation. The nationwide increase in licensed CB stations from 7.5 million in 1976 to 11.5 million in 1977 illustrates the potential that CB radios have in providing public and traffic safety benefits.

Those motorists with vehicles not equipped with CB radios are expected to equally benefit from the system. The special informational type signing to be installed as part of this project, coupled with the helpful nature of most CBers, will result in the reporting of stranded motorists whose vehicles are not equipped with CBs.

The attractiveness of this type of motorist-aid system over similar systems lies in its relatively low cost. The installation of a roadside call-box system costs approximately \$15,000 per mile, whereas Project BEAR will cost only

\$700 per mile. Another advantage is providing in-vehicle communications, thus eliminating pedestrian activities in reaching a call box along the freeway.

The system should be operational by late summer and will complement the state police Operation CARE (Combined Accident Reduction Effort) on holiday weekends. A system evaluation will be conducted to determine if the basic objectives of the project are met. If Project BEAR is successful, it may be expanded to other freeways in the state.

It is believed this system will prove to be an effective, economical, and reliable means of increasing safety on Michigan freeways.

Waterwall Project

A waterwall installation is being planned as part of a yellow book contract along a sharp deflecting curve on I-375 within the city of Detroit. The purpose of the wall is to lessen the severity of impact and to redirect vehicles interacting with fixed objects. It is used primarily in road sections with sharp degree of curvatures and where run-off-the-road frequencies are high.

While the waterwall has not been used in Michigan to date, there are a few locations along the trunkline system where it may have some merit. This project should allow the department to evaluate the effectiveness of the waterwall.

Network Simulation Model (NETSIM)

The department has recently obtained the latest version of a Network Simulation Model, commonly referred to as NETSIM. The original development and testing of the model was supported by the Federal Highway Administration as part of the Urban Traffic Control System in Washington, D.C. The computer software has been converted to be compatible with our computer system and is presently operational.

The model is designed for testing network traffic signal timing strategies under peak traffic conditions. The model is based on a simulation of individual vehicles as they move through a street network and has the capacity to analyze all geometric designs and traffic control devices. It will also determine the effectiveness of conventional traffic engineering measures (e.g., parking and turn controls, channelization, one-way street systems, geometric designs), bus priority systems, and a full range of signal control strategies.

The outputs of the model include, vehicular miles, moving time, delay time, average delay per vehicle, number of stops per vehicle, average speeds, vehicular emissions, fuel consumptions, length of queues by lane, and several statistical analyses of the network operation.

One practical application of this model involves determining the effects of a parking lot or shopping center development on the surrounding area in advance of actual construction. Potential problems can be discovered and solutions implemented as a part of the development.

Another application involves determining the effect of a traffic signal installation on the operation of existing signals within the network of a particular city. The proper signal timing coordination with other signals and turning restrictions can all be determined before the signal is actually installed.

During the next fiscal year we expect expanded use of the NETSIM model in conjunction with our MALI and MIDAS programs to increase safety and convenience to the motoring public.

Utility Pole Placement and Highway Safety

A review of fixed-object accidents indicates a relatively high incidence of pole-related collisions. In an effort to minimize the potential of such collisions, a Highway Safety Steering Subcommittee concerning utility pole placement adjacent to traveled ways has been formed to prepare guidelines to:

1. Relocate existing or place new pole installations at the extreme limits of the highway right-of-way.
2. Relocate existing or place new pole installations "outside" of the highway right-of-way limits.
3. Utilize poles with "breakaway" features.
4. Encourage the use of underground systems.

Guidelines are to include both the upgrading of existing highways and the construction of new roadway systems.

The latest AASHTO safety practices are included to the degree that it is feasible and practicable. High accident locations are being studied with regard to the type, frequency, and lateral distance to fixed objects. The intent is to relate roadside density of fixed objects to pole accident rate and roadway geometrics for rural, fringe, and urban areas.

SECTION 5

SPECIAL STUDIES

Special Studies

The Safety Programs Unit initiated two special studies pertaining to the field of highway safety during the past year. One of the studies examined fatal train-vehicle accident characteristics. The other study compared accident trends among various types of fixed objects.

Fatal Train-Vehicle Accident Study

This study examined the characteristics prevalent among fatal train-vehicle accidents and defined the problems that are associated with them. Two types of rail-highway grade crossings were examined, namely, those protected by active systems (signals or flashers) and those protected by passive systems (signs only).

The study concludes that "even if 100 percent of the grade crossings were to be signalized, the train-vehicle accident pattern would still not be eliminated... The fact that drivers become impatient and disobey flashing signals may indicate that track activation circuitry should be improved."

The study also revealed the following informational facts concerning fatal railroad crossing accidents in Michigan: See tables on pages 5-4 and 5-5.

- 91.2 percent of the fatal crossing accidents occurred on nontrunklines.
- Nonautomobile vehicle types (trucks, buses, etc.) were involved in 31.2 percent of the accidents.
- The driver had been drinking in at least 31.2 percent of the cases (in 7.5 percent of the cases it was unknown if the driver had been drinking according to police reports).
- Male drivers were involved in 76.2 percent of all accidents.
- 51.3 percent of the drivers were below the age of 30.
- Over 75 percent (6,007 of 7,957) of the nontrunkline crossings and over 72 percent (6,122 of 8,480) of all crossings are equipped with passive crossing protection only.
- 46.2 percent of all fatal train-vehicle accidents occur at actively protected crossings.

Fixed-Object Accident Study

This report focuses on the declining fatal accident trends among various types of fixed objects. The report attempts to illustrate the kind of benefit that is resulting from the application of yellow book contracts.

The report shows that the greatest reduction in fixed-object accidents has occurred in the guardrail category. Also showing significant reductions were the categories of highway signs, bridge piers, and bridge rails.

Each of the Highway Safety Acts since 1966 have specifically designated certain portions of the highway trust fund to be used for highway safety improvements. A major target of the earmarked funds has been fixed-object accidents.

Total trunkline accidents and total fixed-object accidents remained relatively stable between the six-year period of 1971 through 1976. During this period fatal fixed-object accidents dropped from 288 to 161, or 44 percent. Total fatal trunkline accidents fluctuated from 850 in 1971 to a high of 915 in 1973 to a low of 665 in 1976. This represents a net reduction of 22 percent over the six-year period. See tables on pages 5-6 to 5-11 for accident trends.

Analysis shows that while total guardrail accidents remained about the same during the 1971-1976 period, fatal accidents dropped from a high of 83 in 1971 to a low of 25 in 1976. This 70 percent reduction is felt to be partially attributable to the extensive guardrail upgrading that has occurred on the trunkline system.

The category of highway signs also showed a reduction in fatal accidents. While total highway sign accidents stayed relatively the same, fatal accidents were reduced from 20 in 1974 to 10 in 1976 for a 50 percent reduction. It is felt that the installation of breakaway sign supports has had much to do with this reduction.

The bridge pier category has the highest severity ratio of all fixed-object categories. During the six-year period, one fatal accident occurred for every 11 contacts with a pier. This compares with one out of every 77 for all fixed-object accidents as a group. However, bridge pier fatal accidents have reduced from a high of 35 in 1973 to a low of 14 in 1976, or a 60 percent reduction. It is felt that a good proportion of this reduction can be explained by the heavy emphasis that has been placed on impact attenuators and guardrail revisions at bridge locations.

The bridge rail category has gone from a high of eight fatal accidents in 1972 to a low of two for the years 1975 and 1976. Again, this 75 percent reduction can be partially explained by our bridge rail upgrading program.

This study concludes that "lives are being saved as a result of providing a forgiving roadside. The downward trend in fatal fixed-object accidents is even more significant when it is considered that Michigan motorists traveled more vehicle miles in 1976 than in any of the previous years. Clearly then, much progress has been made in the roadside safety program."

Evaluation Procedures Study

Through cooperation with the Federal Highway Administration, detailed evaluations are being conducted on five recently completed safety improvement projects.

Representatives from 24 state transportation agencies, as well as representatives from the FHWA, attended a seminar on Highway Improvement Evaluation in September of 1977. The principle purpose for this seminar was to

encourage a common procedure for performing evaluations of safety projects. Each agency will study five projects following the format presented at the seminar.

The final report will include comparison of three years "before and after" accident data as well as turning movement counts and delay studies. Economic and statistical analysis will also be performed.

A workshop is scheduled for the spring of 1979 to review progress in this matter.

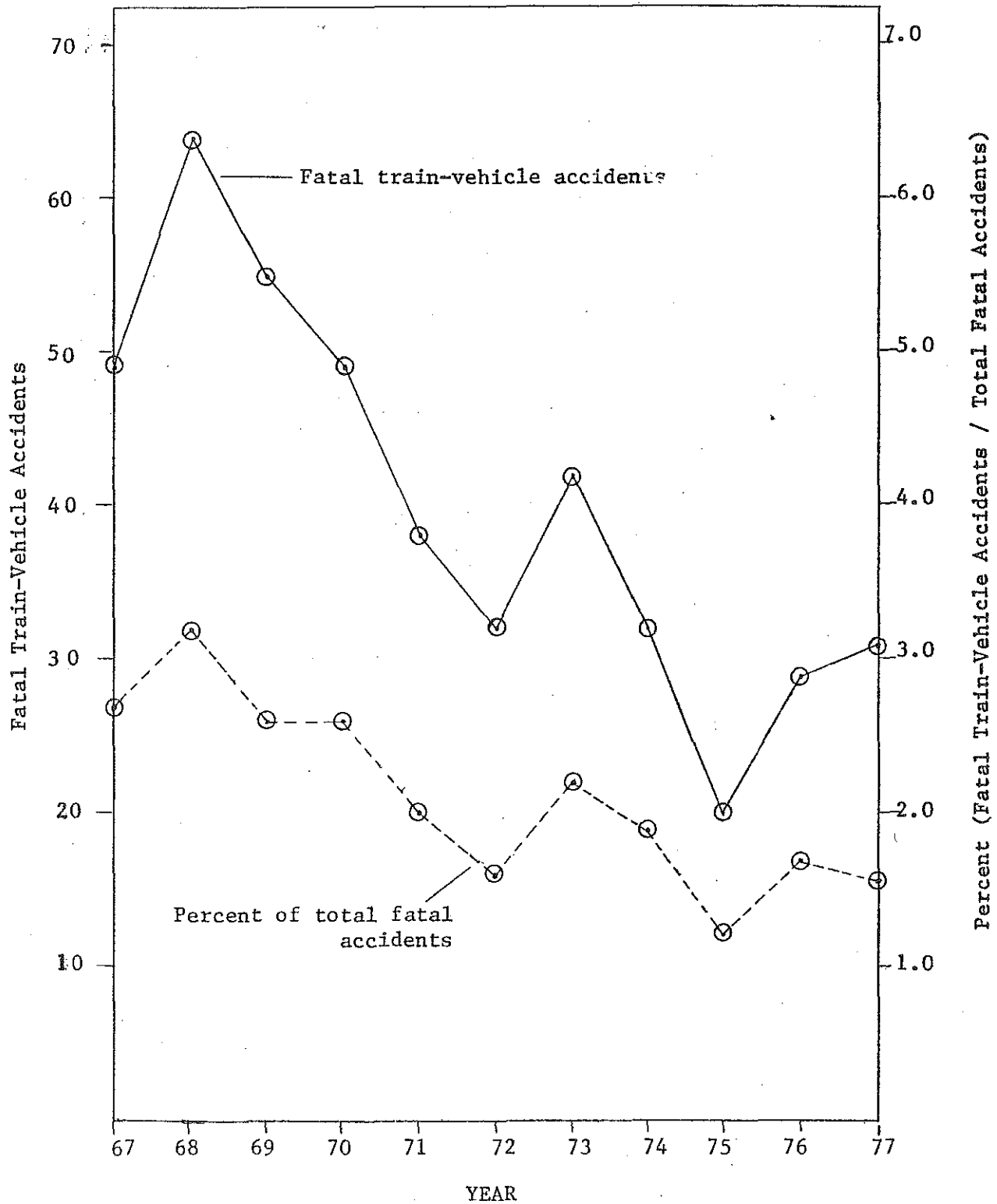


Figure 1. Trends in Fatal Train-Vehicle Accidents and Percentage of Total Fatal Accidents (1967-1977).

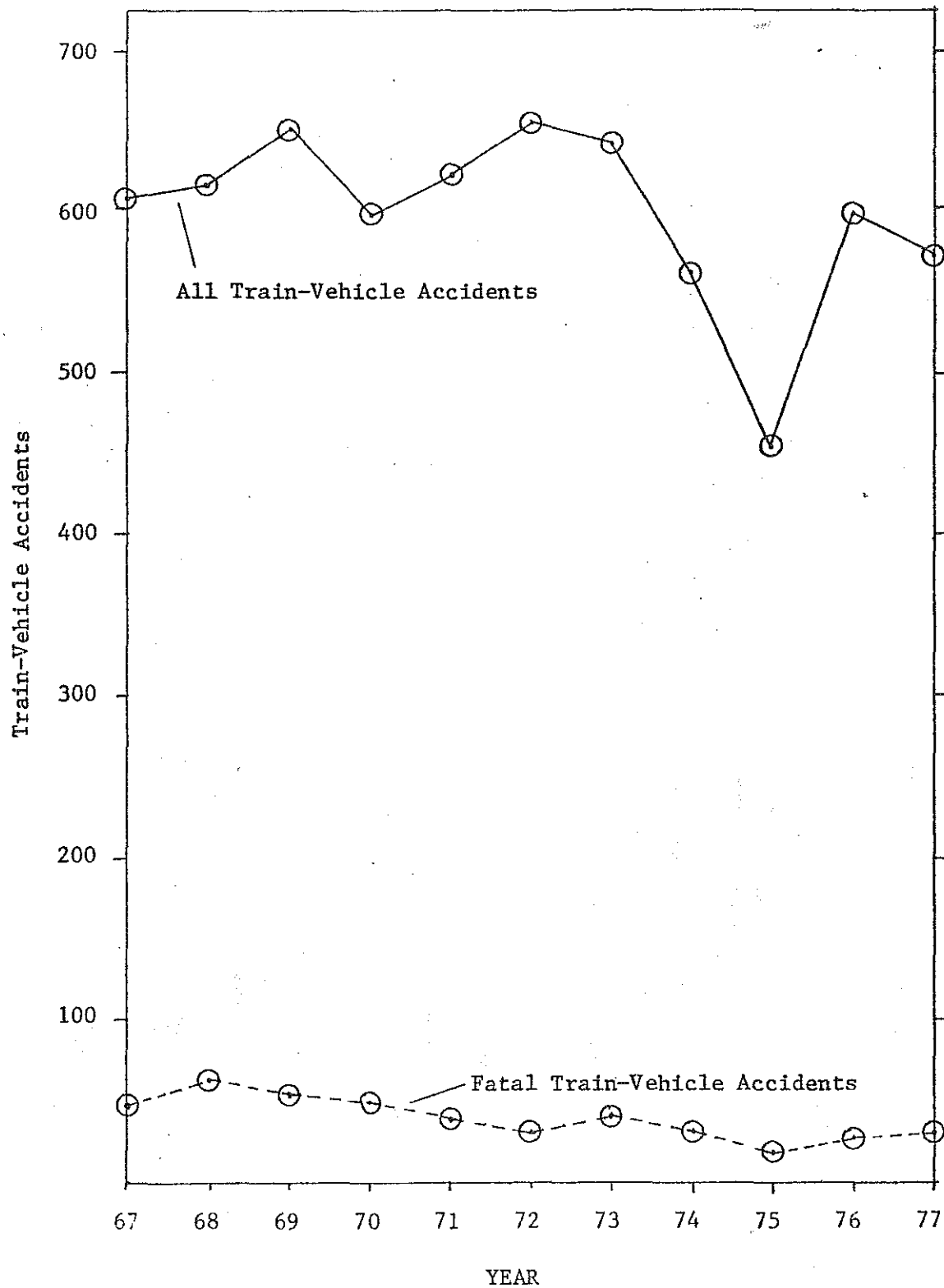
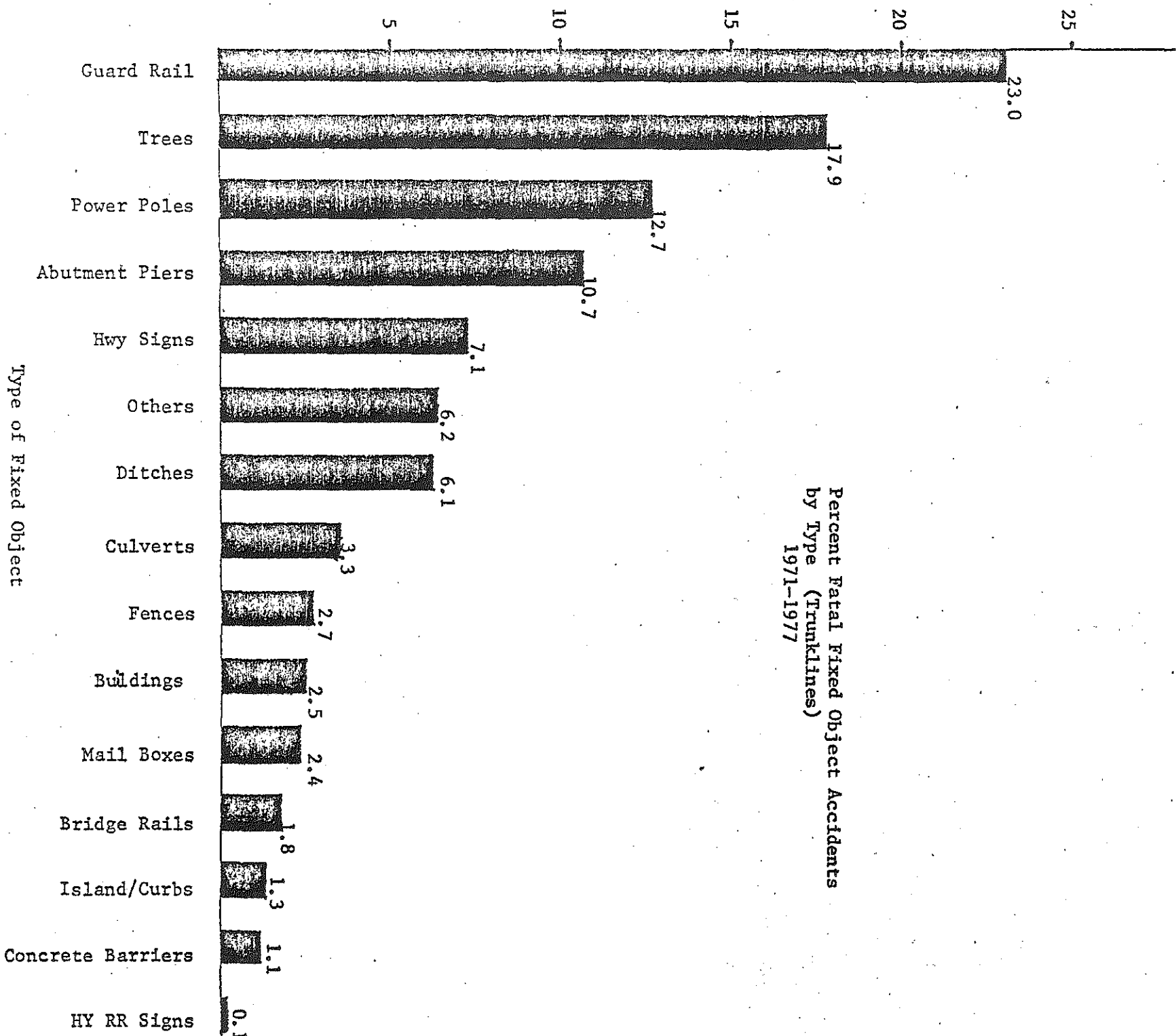


Figure 2. Relationship between Fatal Train-Vehicle Accidents and All Train-Vehicle Accidents.

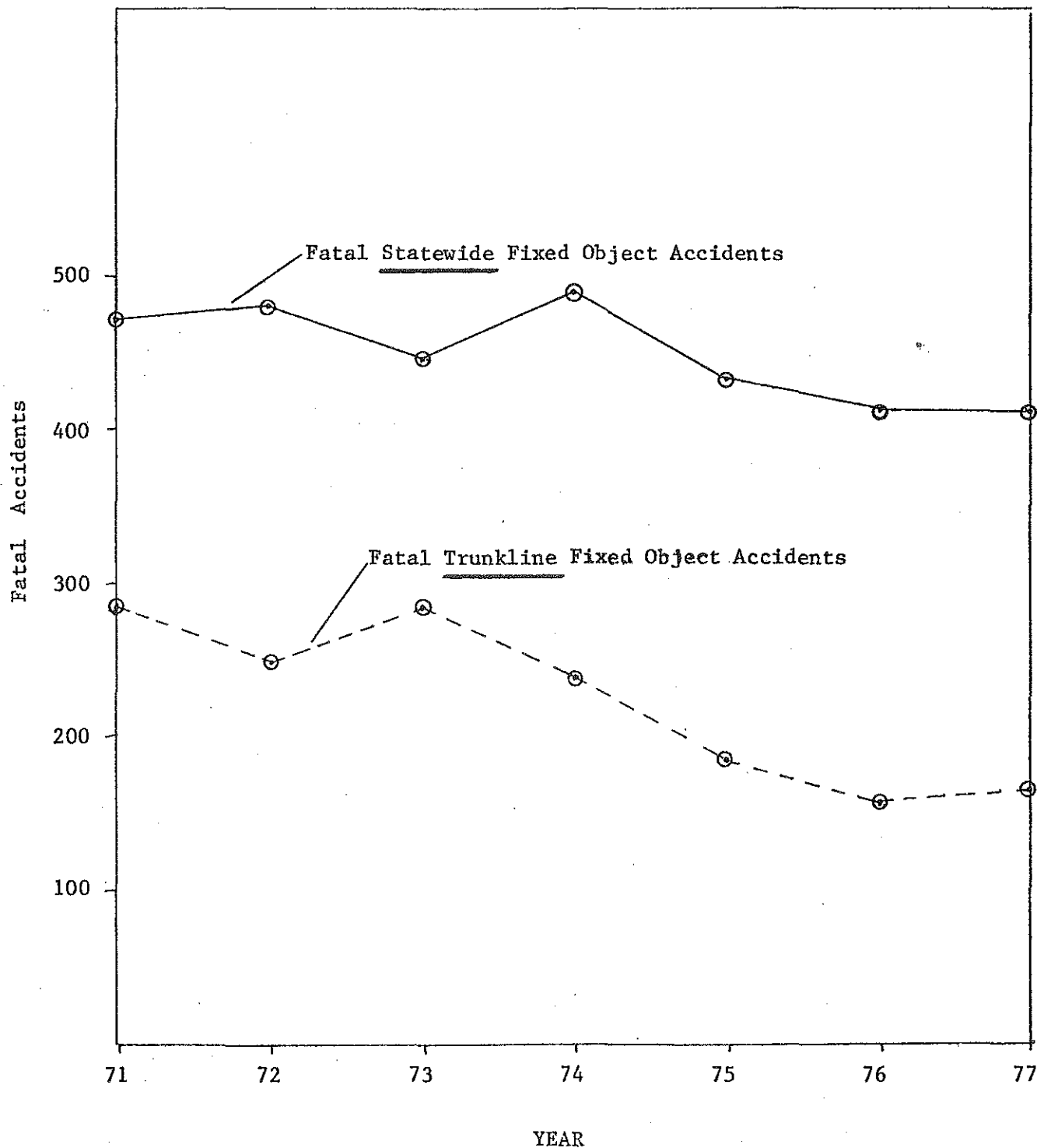
Percent of Fatal Fixed Object Accidents



Percent Fatal Fixed Object Accidents
by Type (Trunklines)
1971-1977

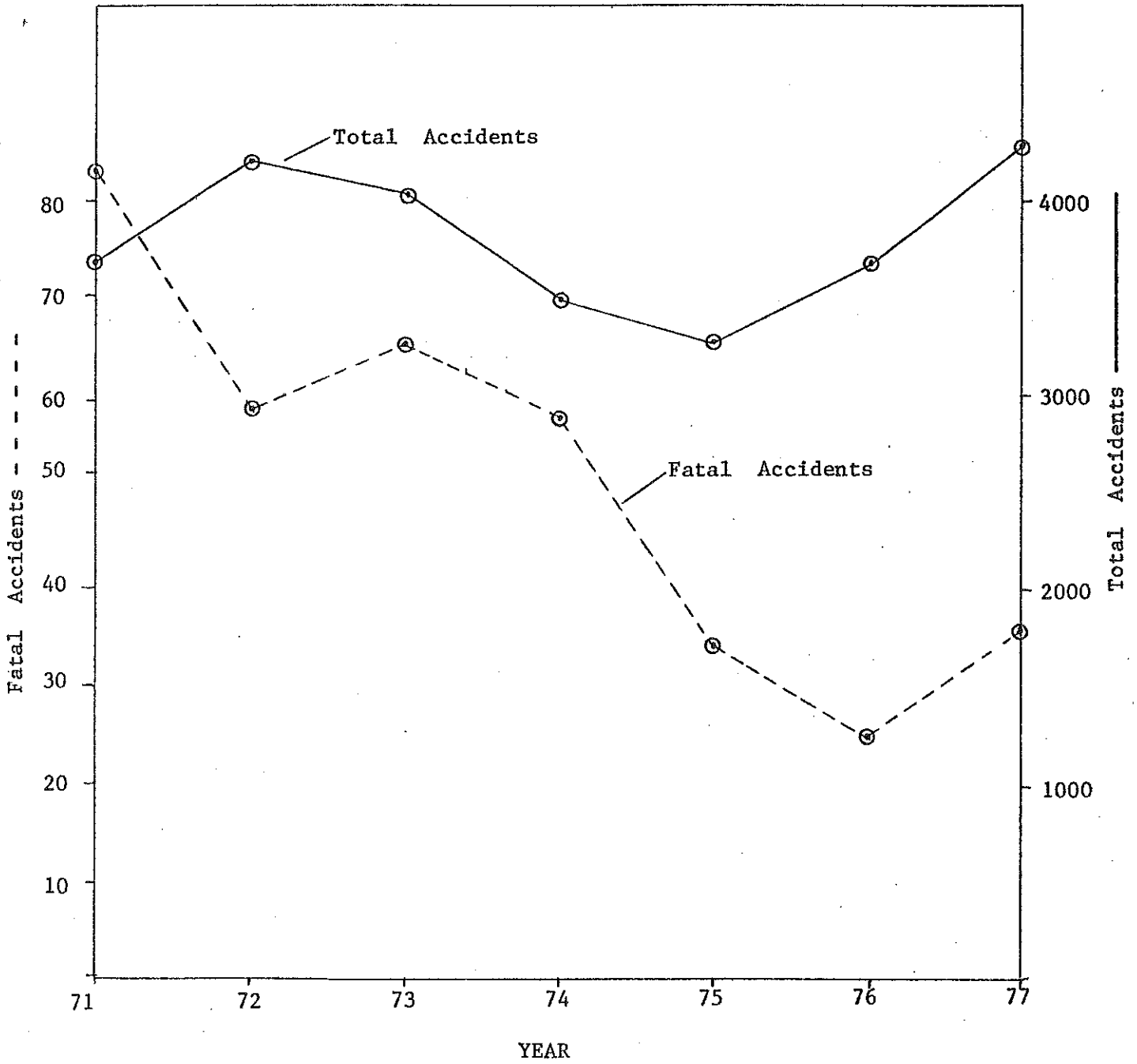
Figure 1

Figure 2



Fatal Fixed Objects Accident Trends.

Figure 3



GUARD RAIL (Trunkline)

Figure 4

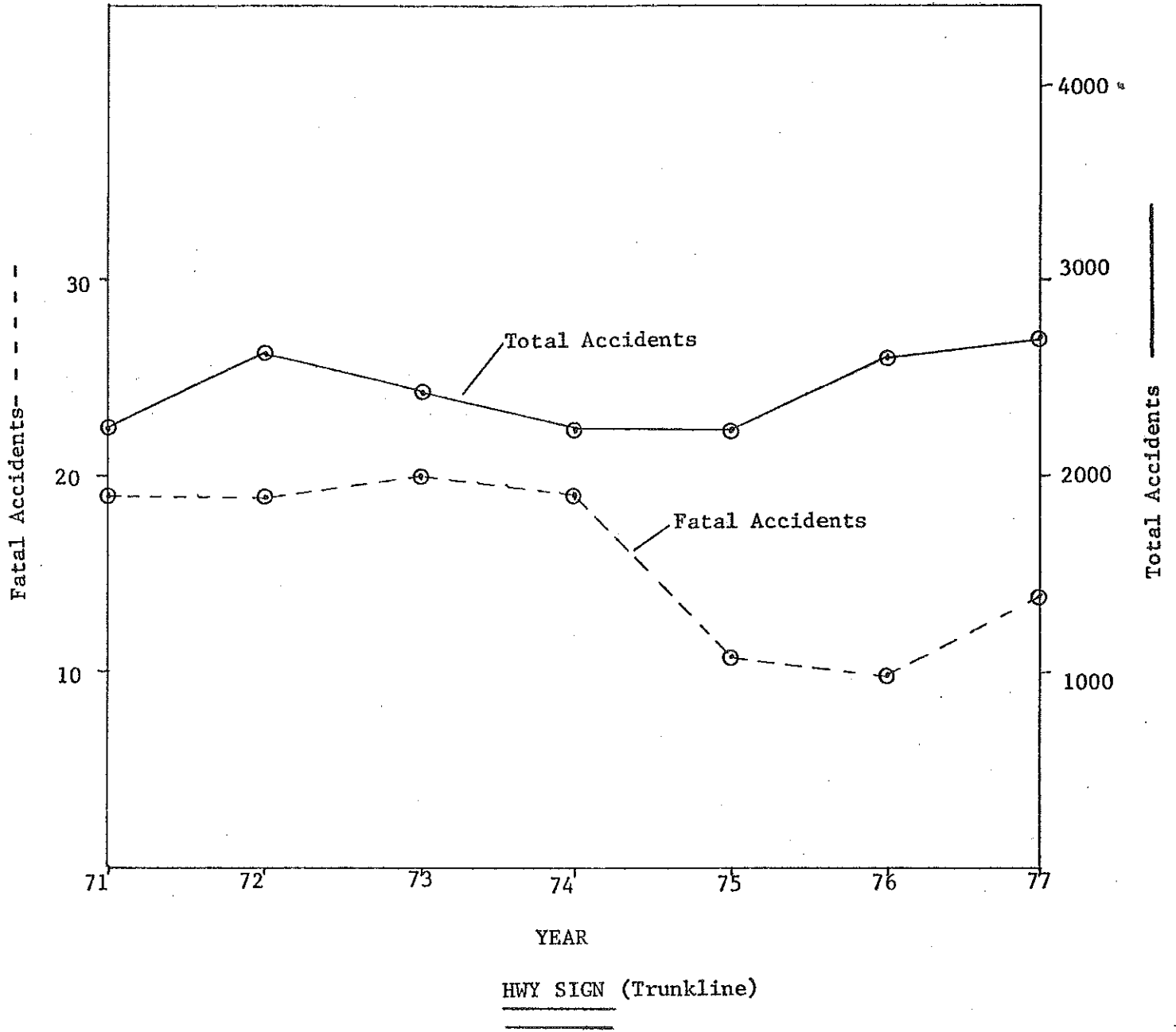
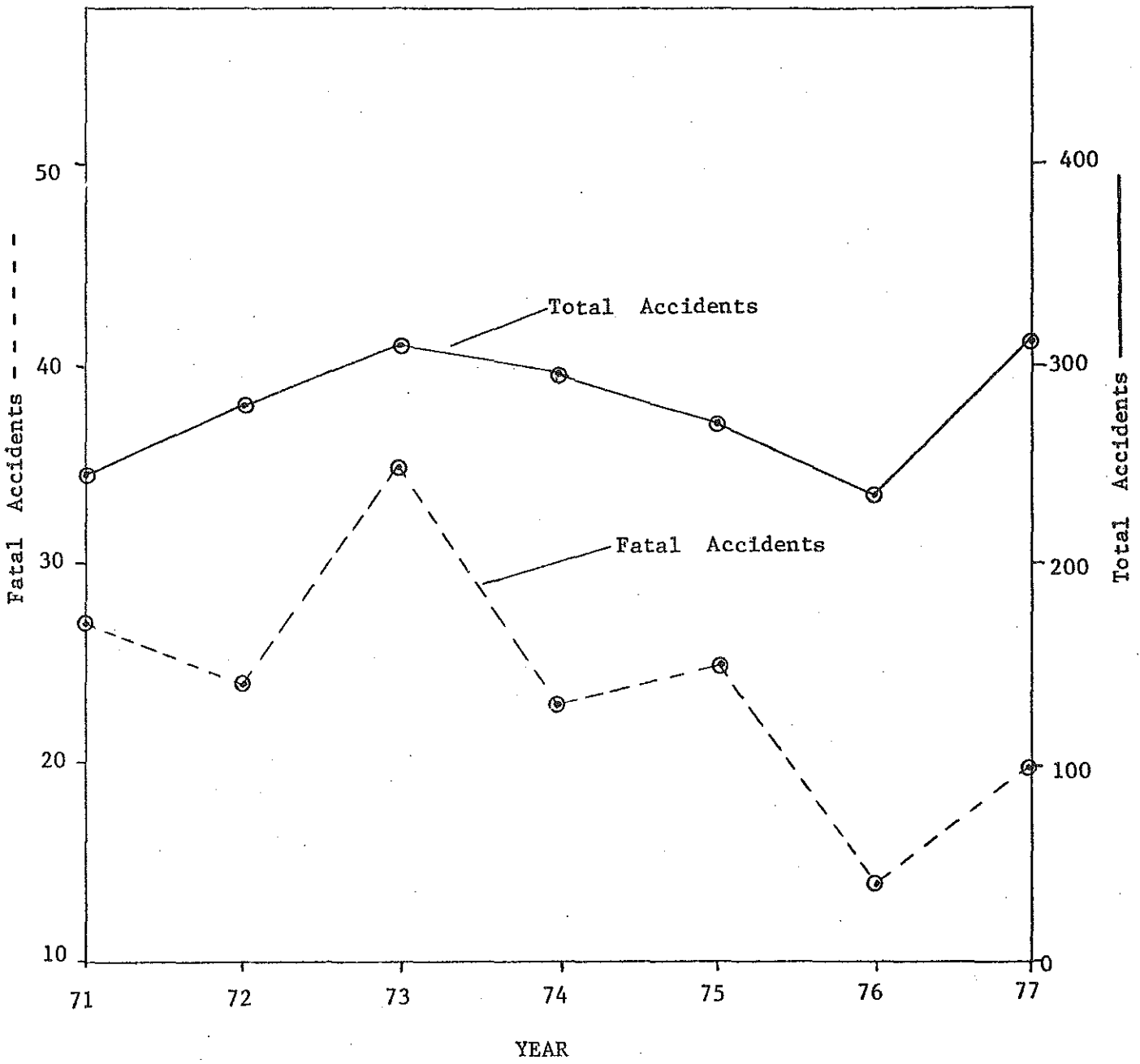
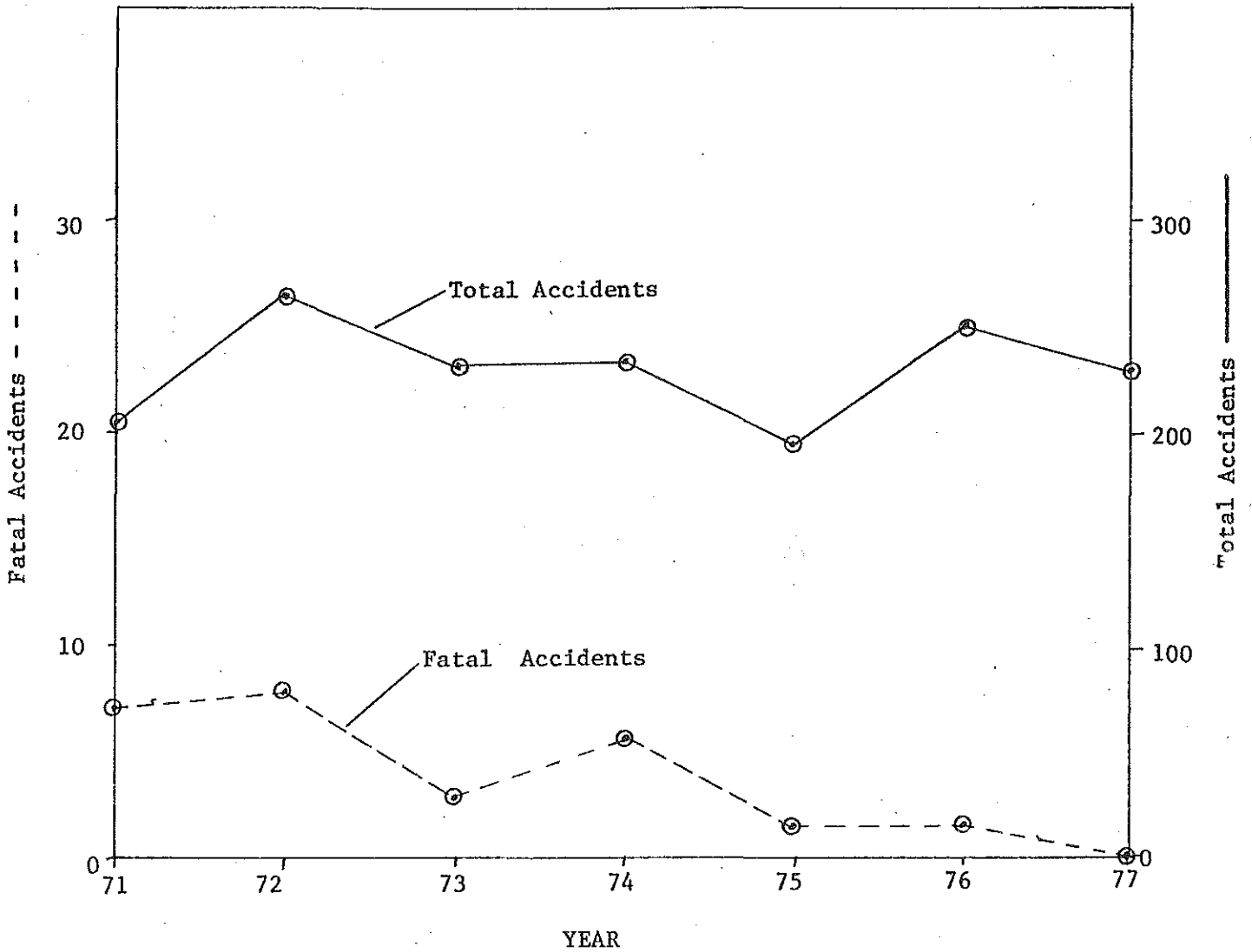


Figure 5



BRIDGE PIER (Trunkline)

Figure 6



BRIDGE RAIL (Trunkline)

APPENDIX I

Instructions and Codes
Table 1
Procedural and Status Information
HIGHWAY SAFETY IMPROVEMENT PROGRAM
ANNUAL REPORT 1978

Highway Location Reference System

Column (1) - Percent of miles covered by location reference system.

- " (2) - If column (1) is less than 100%, show date it is expected 100% of highway mileage will be covered by reference method.
(Year)

Traffic Records System

Column (3) - Percent of entered accidents for which accident data is correlated with volume data.

- " (4) - Is it currently possible to correlate accident data with highway inventory data through automated data processing?
(Y-Yes, N-No, U-Under development)

For columns (5), (6), (7), (8), (9), and (11) use the specified codes to list in order of their importance the major factors taken into account in developing projects for the various types of improvements.

Hazardous Locations

Column (5) - Criteria used to identify high hazard locations for further study.

CODES (more than one may apply)

- A Number of accidents
- E Economic loss/accident cost
- L A specific number of locations (e.g. top 100)
- R Accident rate, including rate-quality control
- S Accident severity
- Y Other (Describe on separate sheet)
- Z Under development

Column (6) - Factors taken into account in establishing hazardous location project priorities.

CODES (more than one may apply)

- C Criteria indicated in column (5)
- E Cost-benefit analysis
- I On-site investigation
- P Project cost
- R Accident and/or severity reduction expected from improvement
- Y Other (describe on separate sheet)
- Z Under development

Elimination of Roadside Obstacles

Column (7) - Factors analyzed in establishing project priorities for correction of roadside obstacle hazards.

CODES (more than one may apply)

- A Accident data
- E Cost-benefit analysis
- H Highway system or type
- I Type of obstacle/type of improvement
- O Obstacle survey data
- S Traffic speed or speed limit
- V ADT
- Y Other (describe on separate sheet)
- Z Under development

Skid Improvement Projects

Column (8) - Factors analyzed in determining priorities for correcting hazardous skid prone location.

CODES (more than one may apply)

- A Total accidents
- G Roadway geometrics
- H Included in hazardous locations
- I On-site investigation besides skid testing
- P Pavement texture or other pavement characteristics besides skid number
- S Skid number
- V ADT
- W Wet pavement accidents
- Y Other (describe on separate sheet)
- Z Under development

Narrow Bridges

Column (9) - Factors analyzed to determine priorities for correcting hazardous conditions associated with narrow bridges.

CODES (more than one may apply)

- A Accident history
- B Bridge width
- E Cost-benefit analysis
- G Condition of approach guardrail
- R Bridge width in relation to approach width
- S Posted speed limit
- V ADT
- X None
- Y Other (describe on separate sheet)
- Z Under development

Rail-Highway Grade Crossings

Column (10) - Method of updating crossing inventory

CODES (more than one may apply)

- N National Railroad-Highway Crossing Inventory Update Manual
- S State inventory
- Y Other (describe on separate sheet)

Column (11) - Factors taken into account in establishing project priorities

CODES (more than one may apply)

- A Accident history
- C Physical characteristics of the crossing
- E Cost/benefit analysis
- H Hazard rating index (show formula on separate sheet and define all terms)
- I On-site investigation
- P People factor (buses, passenger trains, etc.)
- T Characteristics of train traffic
- V Characteristics of highway traffic
- W Existing warning devices
- Y Other (describe on separate sheet)
- Z Under development

- Column (12) - Number of crossings at which crossbucks, advance warning signs, and/or pavement markings were upgraded during the period July 1, 1973, to June 30, 1978 without regard to funding source. This information has not previously been available from PR 37 data.
- Column (13) - Number of public crossings that do not comply with minimum MUTCD standards as of June 30, 1978.
- Column (14) - Percentage of public crossings that do not comply with minimum MUTCD standards as of June 30, 1978.
- Column (15) - Target date for full compliance with MUTCD (Year).

APPENDIX II

Instructions

Table 2

EVALUATION DATA FOR COMPLETED IMPROVEMENTS HIGHWAY SAFETY IMPROVEMENT PROGRAM AND PAVEMENT MARKING DEMONSTRATION PROGRAM ANNUAL REPORT 1978

General

- Provide information only for improvements with at least 1 year "before" and 1 year "after" accident data.
- Improvements (projects) may be grouped as long as the source of funds (column 1), safety classification code (column 2), before and after periods (columns 6 and 11), and evaluation status (column 16) are the same. Otherwise, data for each project should be shown separately.
- Information for columns (1) through (16) is required.
- Information for columns (17) through (22) is optional.

Column (1) - Indicate source of funds for the safety improvement.

Code:

HH - High Hazard Location Projects

RO - Elimination of Roadside Obstacles

SR - Safer Roads Demonstration

PM - Pavement Marking Demonstration Program

RR - Rail-Highway Crossings

SO - Safer Off-System Roads Program

IS - Interstate Safety Improvements

FA - Other Safety Improvements Made with Federal-Aid Funds

SL - Safety Improvements Funded with State and Local Funds Only

Column (2) - Indicate the type of safety improvement as classified by Safety Classification Codes in FHPM 6-8-2-1.

Column (3) - For the improvement(s) included on each line enter the total cost(s) in thousands of dollars to one decimal place.

Column (4) - Based on classification code used in column (2); enter the total quantity of improvements included on each line according to the codes below:

For Safety Codes	Quantity of Improvements	Units Code
10-19	Number of intersections	X
20-29, 67	Number of miles (0.1)	M
30-39, 66	Number of structures	S
50-59	Number of crossings	R
64	Number of miles (0.1)	*C,E,or B
68	Number of locations	L
Other codes	Not necessary	N

*If safety classification code is "64" use the following units codes:

- C - highway miles if centerline only is marked
- E - highway miles if edgeline only was marked
- B - highway miles if both centerline and edgeline were marked

Column (5) - Indicate the appropriate units code for quantity shown in column (4). If quantity of improvements is not available use "N" in column (5).

Columns (6) and (11) - Indicate the number of months included in the "before" and "after" time periods, respectively.

Columns (7) and (12) - Enter the number of fatal accidents that occurred in the "before" and "after" time periods, respectively.

Columns (8) and (13) - Nonfatal injury accidents.

Columns (9) and (14) - Property damage only accidents.

Columns (10) and (15) - Total accidents

Column (16) - For each line of data in the table:

- Enter "P" if this is preliminary data and the final evaluation data will be submitted on the improvement(s) at a later date.
- Enter "F" if this is the final evaluation data that will be submitted on the improvement(s).

Columns (17) and (18) - For each line entry, based on the classification codes used in column (2), enter the appropriate exposure data for the "before" and "after" periods in million vehicles or million vehicle-miles to two decimal places.

$$\text{Million vehicles} = \frac{(\text{ADT} \times 30 \times \text{number of months})}{(10)^6}$$

$$\text{Million vehicle miles} = \frac{(\text{ADT} \times 30 \times \text{number of months} \times \text{number of miles})}{(10)^6}$$

For Safety Codes	Exposure	Units Code
10-19	Million vehicles	V
30-39		
50-59		
66, 68	Million vehicle miles	M
20-29, 64, 67		
All Others	Either of the above as appropriate	V or M

Column (19) - Indicate the appropriate units code for the exposure data shown in columns (17) and (18).

Column (20) - Enter "R" if projects are in a rural area.

Enter "U" if projects are in an urban area.

Column (21) - Enter number of lanes. For divided highways indicate the total number of lanes in both directions. For intersection projects enter the number of lanes on the major street.

Column (22) - Enter "U" if roadway is undivided.

Enter "D" if roadway is divided.

For intersection projects indicate if the major street is divided or undivided.

SAFETY CLASSIFICATION CODES

The following Classification Codes shall be used when reporting highway safety improvements:

1. Intersection Projects

- 10 - Channelization, including left turn bays
- 11 - Traffic signals, installed or improved
- 12 - Combination of 10 and 11
- 13 - Sight distances improved
- 19 - Other intersection work (except structures, Codes 30-39)

2. Cross Section Projects

- 20 - Pavement widening, no lanes added
- 21 - Lanes added, without new median
- 22 - Highway divided, new median added
- 23 - Shoulder widening or improvement
- 24 - Combination of 20, 21, 22 and 23
- 25 - Skid Treatment/Grooving
- 26 - Skid Treatment/Overlay
- 27 - Flattening and/or clearing of side slopes
- 29 - Other cross section work or combinations of above categories

3. Structures

- 30 - Widening existing bridge or other major structure
- 31 - Replacement of bridge or other major structure
- 32 - Construction of new bridge or major structure
(except to eliminate a railroad grade crossing or one for pedestrians only)
- 33 - Construction or improvement of minor structure
- 34 - Construction of pedestrian over- or under-crossing
- 39 - Other structure work

4. Alignment Projects

- 40 - Horizontal alignment changes (except to eliminate highway grade crossing, Code 52)
- 41 - Vertical alignment changes
- 42 - Combination of 40 and 41
- 49 - Other alignment work

5. Railroad Grade Crossing Projects

- 50 - Flashing lights replacing signs only
- 51 - Elimination by new or reconstructed grade separation

- 52 - Elimination by relocation of highway or railroad
- 53 - Illumination
- 54 - Flashing lights replacing active devices
- 55 - Automatic gates replacing signs only
- 56 - Automatic gates replacing active devices
- 57 - Signing and/or marking
- 58 - Crossing surface improvement
- 59 - Other railroad grade crossing improvement

6. Roadside Appurtenances

- 60 - Installation or upgrading of traffic signs
- 61 - Breakaway sign or lighting supports
- 62 - Installation or improvement of road edge guardrail
- 63 - Installation or improvement of median barrier
- 64 - Installation of striping and/or delineators
- 65 - Roadway lighting installation
- 66 - Improvement of drainage structures
- 67 - Installation of fencing
- 68 - Impact attenuators
- 69 - Other roadside appurtenances

7. Other Safety Improvements

- 90 - Safety provisions for roadside features and appurtenances
- 99 - All projects not otherwise classifiable

PROJECT ANALYSIS WORKSHEET

By _____

Date _____

Location _____

City/Twp. _____ County _____

Control Section _____ SII # _____

Type of Improvement _____

PERIOD	ACCIDENT TYPES									
	pc		pd		pd		pd		pd	
	Injd		Injd		Injd		Injd		Injd	
TOTALS										

Estimated Accident Reduction	% Red.		% Red.		% Red.		% Red.		% Red.	

Remarks

Estimated Project Cost _____

Anticipated Annual Benefit _____

Project Amortization (T.O.R.) _____

COMPUTED BENEFITS DERIVED THROUGH ACCIDENT REDUCTION

Location _____ City/Twp. _____ County _____

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 IM21-3-67.

In the following analysis the costs provided by the National Safety Council are: 1976 values

Death - \$125,000

Nonfatal Injury - \$4,700

Property Damage Accident - \$670

$$B = \frac{ADT_a}{ADT_b} \times (Q R_1 + 670 R_2)$$

where

B = benefit in dollars

ADT_a = Average traffic volume after the improvement _____

ADT_b = Average traffic volume before the improvement _____

R₁ = Reduction in fatalities and injuries combined _____

R₂ = Reduction in property damage accidents _____

Q = 4700 if no fatal accidents occurred, and

$$Q = \frac{125,000 + (I/F \times 4,700)}{1 + I/F} = 6,128 \text{ if at least 1 fatality occurred.}$$

where

I/F = Ratio of injuries to fatalities that occurred statewide during the year 1976

$$= \frac{162,894}{1,955} = 83.3$$

Time of Return (T.O.R.) based on _____ years of data.

_____ yrs. B= _____ [(4700 or 6128) _____ + (670) _____]

_____ yrs. B= _____ [(_____) + (_____)] = _____

Annual B= _____ dollars

C= Total cost of project

$$T.O.R. = \frac{C}{B} = \frac{\text{_____}}{\text{_____}} = \text{_____ years}$$