TENTH ANNUAL REPORT
OF
MICHIGAN'S OVERALL HIGHWAY
SAFETY IMPROVEMENT PROGRAM

July 1, 1982 - June 30, 1983

MICHIGAN
DEPARTMENT OF TRANSPORTATION

August 31, 1983

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INTRODUCTION

This is Michigan's Tenth Annual Report of our Highway Safety Improvement Program. During the period covered by this report, July 1, 1982 through June 30, 1983, over $106,000,000 was expended for safety in Michigan. This is $49,000,000 less than the $155,000,000 documented as spent the previous year.

There are several factors which contributed to the lower expenditures. Severe revenue problems in Michigan required that available funds be concentrated on maintenance type activities and used for matching federal funds. As a result, total state expenditures attributed to such activities as the bituminous resurfacing (Mb) and bituminous reconstruction (Mbr) programs and the Michigan Safety (Ms) program were only about $2,310,906. These three programs accounted for over $14,000,000 in last year's report.

Some of the critical resurfacing/reconstruction needs were addressed by using federal aid primary and secondary funds. This, however, left less money for specific safety projects and, as a result, safety related expenditures decreased substantially. Similarly, interstate funds were directed to basic improvements aimed at preserving that system. Also, completion of interstate "yellow book" work is reflected in lower identified safety obligations from the interstate fund. With the increased revenues afforded by new federal and state user fees this past year we expect an increased commitment of construction funds to safety improvements in Michigan in future years.

We have attempted to reduce the size of this report by eliminating unnecessary and/or redundant narrative and appendices. For example, detailed descriptions of the various programs are not included. The reader may consult previous reports if these detailed descriptions are desired and/or contact the Traffic and Safety Division for needed details.

We continue to emphasize evaluation of safety work. A highlight is our evaluation of the roadside safety program on the interstate system. The results show a strong correlation between roadside safety work and reduced deaths and serious injuries. Evaluation of projects funded by the HES program and similar state/local funded spot safety improvements continues to show that these programs are among the most cost-effective administered by this department from a safety point of view. Also included in this report are before-and-after accident data related to rail/highway safety projects as requested by the Federal Highway Administration. Although we believe that the statistically based study offered in last year's report of the rail/highway safety programs is vastly superior, the before-and-after data compiled therein will address FHWA requirements.

Several new programs, developments, and studies are also summarized in this report, as is custom. Also of special note is a status report of our TOPICS program, the traffic engineering element of the Transportation Systems Management (TSM) process, initiated last year. The new TOPICS program focuses on comprehensive reviews of traffic engineering deficiencies in larger cities on both state trunklines and the local systems (using Section 402 Community Assistance staff) and the development of low-cost operational type countermeasure to reduce accidents and improve capacity. Based on the success of this program, we are expanding it to include 17 smaller cities with populations greater than 10,000.

HIGHWAY SAFETY IN MICHIGAN - THE YEAR IN REVIEW

Highways in Michigan are becoming safer! The reduction of fatalities documented in last year's report continues the steady downward trend since 1978. During 1982 deaths numbered 1,417 with a death rate of 2.3 per 100 million vehicle miles, again one of the lowest in the nation. Only once since World War II have the number of highway deaths been less in Michigan (in 1958, 1,382 fatalities were reported with a death rate of 4.7/100 MVM). A total of 294,971 accidents were reported in Michigan during 1982, the lowest total since 1964. The 130,061 injuries were the fewest since 1963.

Many factors have contributed to the continuing accident and casualty reductions in addition to improved highways. Improved vehicle design, multi-media educational programs, and targeted selective enforcement efforts based on up-to-date computerized accident information also play their part. We believe that highway safety improvement programs have contributed substantially to reduced traffic crashes and casualties. In this and previous annual reports, we have documented the Michigan Department of Transportation's commitment to safety and, through evaulations, the success of those efforts.

Michigan is a recognized leader in the construction of highway safety improvements. The most recent status report of federal funds obligated by states for highway safety improvements ranks Michigan first in percent of overall safety funds obligated. In their transmittal letter, the FHWA division administrator notes that "as has become the custom, Michigan continues to rank near the top based on combined safety funds obligated."

The impact of intensive, comprehensive engineering upgrading improvement programs is well evidenced by close review of accident experience on the interstate system. That system, from its inception, was designed to the optimum standards of its day and the accident and casualty experience reflect that standard. However, concern over <u>roadside</u> crashes in the 1960's resulted in a targeted upgrading/retrofit program. That program focused more on the reduction of deaths and serious injuries than on actual accident reduction. The success of that program is documented in this report. Coupled with the notable success of other highway safety improvement efforts such as the federally funded HES and our own Ms safety programs, which are targeted at spot locations with documented accident concentrations, the substantial contribution of highway engineering to improved safety is unchallenged.

A broad-based coalition has emerged in Michigan which is serving as an effective advocate for highway safety issues. The coalition includes the usual traffic safety community as well as representatives from medical groups, insurance, auto and trucking industries, and various citizen special interest groups such as MADD (Mothers Against Drunk Drivers). The coalition has been particularly effective in achieving support for legislative initiatives involving safety.

As reported last year, the coalition's first success was passage of a child restraint law in Michigan. Preliminary accident data confirms the substantial positive impact of the new law. During the first eight months following the law's effective date 1,098 children, aged 3 or younger, died or were injured in traffic crashes. During an identical period preceding the bill's enactment, 1,586 child casualties were reported.

This past year the coalition witnessed passage of new tougher drunk driving legislation. The law has received widespread publicity and it is generally agreed that there is greatly increased awareness in Michigan of the drunk driver problem. More importantly, drivers perceive a greater likelihood that if they drink and drive they will be apprehended, convicted, and subjected to severe penalties.

The coalition's current efforts are now focused on mandatory seat belt legislation. Legislators are expected to act on this measure near the end of 1983.

Highway safety in Michigan is a cooperative effort. Our State Safety Commission leads in the initiation of legislative reforms and other safety activities. In addition to their role in child restraint, seat belt, and drunk driving issues, the commission actively supported regional safety groups, driver education maintenance and improvements, continuation of motorcycle helmet requirements, and prohibition of radar detection devices.

Enforcement agencies in Michigan, led by the Department of State Police, utilize some of the most sophisticated accident analysis techniques to direct their patrol/enforcement efforts. The holiday operation CARE program, initiated in Michigan, has been adopted by many other states. Recently the department was joined by the Michigan National Guard in a SKYGUARD surveillance and speed timing effort in certain areas of the state.

Michigan's Office of Highway Safety Planning (OHSP) coordinates many safety related activities in Michigan. This past year they sponsored several slide presentations and produced public information material in support of child seat belt use. They also developed and produced slide presentations designed to encourage law enforcement officers to enforce the child restraint law and distributed to police agencies warning notes which could be given in lieu of citations for violations of the law.

One matter of some concern in Michigan is that average speeds on the state's 55 mph roadways continue to increase. Last year, Michigan reported that 48.8 percent of all vehicles were exceeding the 55 mph speed limit. Preliminary data for the first three quarters of this year indicates that Michigan may exceed the federal criteria of 50 percent for the year ending September 30, 1983. This raises the potential of withholding of some federal highway funds if compliance is not achieved or a plan to achieve compliance is not developed. We would note, however, that the speed increases have not resulted in negative safety impacts. This indicates that the issue of the appropriateness of the 55 mph limit on all roads for failure to achieve compliance should be reevaluated. In the interim, the state will take all reasonable steps to ensure maximum compliance with the 55 mph speed limit.

Enactment of new federal and state highway user taxes in 1983 will have a significant positive effect on all highway programs, including those involving safety. These new revenue sources should ensure that safety gains of the past years will not be lost and that future improvments should provide more reductions in accident and casualty rates.

HIGHWAY SAFETY PROGRAM SUMMARY
Fiscal Year 1982-83 (July 1 - June 30)

<u>Categorical</u>

Rail Highway			$ 4,134,275
Pavement Marking			-0-
Hazard Elimination			8,162,871
Safer-Off-System			508,498
Special Bridge	Local System		12,904,147
	State System		4,234,407
		TOTAL	$29,944,198

<u>Other Federal Funds</u>

Interstate Safety		$ 4,896,245
Interstate 3R		14,040,577
Urban		29,200,237
FA Primary		17,213,147
FA Secondary		8,422,622
	TOTAL	$73,772,868

<u>State Funds</u>

TOTAL	$ 2,310,906
Total Safety Expenditures	$106,027,962

FEDERAL FUNDING OF HIGHWAY SAFETY IMPROVEMENTS IN MICHIGAN

As of June 30, 1983, Michigan had obligated $104,260,029.39 or 94 percent of its $110,837,631.96 Fiscal Years 1974 through 1983 apportionment of total combined federal aid safety construction funds. Michigan ranks number one in the nation in percent of those funds obligated.

From July 1, 1982, to June 30, 1983, $29,944,198 was obligated from the various categorical funds (including $17,138,554 for special bridge replacement on the state and local systems). Hazard Elimination obligations total $8,162,871, Rail/Highway obligations $4,134,275, and Safer-Off System program obligations, $508,498. No pavement marking program funds were obligated during this past fiscal year. However, the department allocated $3.2 million to maintenance of pavement markings on our state trunkline system.

The Pavement Marking and Rail/Highway Crossing programs were evaluated in some detail in the two previous reports. In response to Federal Highway Administration concerns, additional "before" and "after" project data for rail/highway safety projects is included in this report. Evaluation of the Hazard Elimination program is also once again included. In addition, a detailed evaluation of the roadside safety program on the Interstate system is in this Tenth Annual Report.

Following is "Table 1", Procedural and States Information and "Tables 3 and 4" pertinent to the Pavement Marking Demonstration program. As noted, no PMS funds were obligated during the reporting period.

TABLE 1

STATE Michigan

M	I

FIPS CODE (Alpha)

HIGHWAY SAFETY IMPROVEMENT PROGRAM
ANNUAL REPORT 1983
PROCEDURAL AND STATUS INFORMATION

Line	Highway System	HIGHWAY LOCATION REFERENCE SYSTEMS			TRAFFIC RECORDS SYSTEM		
		Miles Covered (Percent) (1)	Expected Completion (Year) (2)	Type of Location Reference Method (3)	Types of Data Collected and Maintained (4)	Automated Correlation of Accident and Highway Data (Percent) (5)	Automated Correlation of Accident and Volume Data (Percent) (6)
101	Interstate	100	N/A	M	AHT	100	0
102	State - F.A.	100	N/A	D-II	AHT	100	100
103	State - Non-F.A.	100	N/A	D-II	AHT	100	100
104	Local - F.A.	100	N/A	D-II	AT	100	0
105	Local - Non-F.A.	100	N/A	D-II	AT	100	0

Line	Highway System	HAZARD ELIMINATIONS		RAILROAD-HIGHWAY GRADE CROSSINGS					
						Compliance With MUTCD			
							Not Complying		
		Criteria for Identifying Hazardous Locations, Sections and Elements *(7)	Criteria for Setting Project Priorities *(8)	Inventory Update *(9)	Project Priority Selection *(10)	Crossings Upgraded **7/1/73-6/30/82 (11)	Number (12)	% (13)	Compliance Target Date (14)
201	Interstate	AEHLRS	CEIPTV						
202	State - F.A.	AEHRS	CEIPTV	B	AHIMPTVW	N/A	0	0	N/A
203	State - Non-F.A.	AEHRS	CEIPTV	B	AHIMPTVW	N/A	0	0	N/A
204	Local - F.A.	AEHRS	CHIPTV	B	AHIMPTVW	N/A	0	0	N/A
205	Local - Non-F.A.	AEHRS	CHIPTV	B	AHIMPTVW	N/A	0	0	N/A

F.A. = Federal-Aid
* = If more than one code applies, show all appropriate codes.
** = See instructions.
Describe "Y" Codes on separate sheet and attach to this table.

Indicate reporting period:
7/1/73-6/30/83____
7/1/81-6/30/83____

TABLE 3

Michigan — | M | I |

FIPS CODE (Alpha)

PAVEMENT MARKING DEMONSTRATION PROGRAM

ANNUAL REPORT 1983

QUANTITIES AND COST OF MARKINGS PLACED

TYPE OF MARKINGS PLACED	QUANTITIES AND COST ($1,000) OF MARKINGS PLACED, *JULY 1, 1982 TO JUNE 30, 1983										Total Quantities and Cost of Markings Placed July 1, 1982 To June 30, 1983		Cumulative Total Miles and Cost of Markings Placed To June 30, 1983	
	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													51,266	6,705.5
Edgelines Only													41,451	3,883.8
Both Center-lines and Edgelines													17,375	2,852.6
Sub-Total	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	110,092	13,441.9
	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost		
Railroad-highway Grade Crossings														
Pedestrian Crossings 1/														
Other (Describe)														
GRAND TOTAL														

*If reporting period is other than July 1, 1982 to June 30, 1983 indicate dates: ____________________

1/ Show number of intersections in "Quantity" column.

Table 4

PAVEMENT MARKING DEMONSTRATION PROGRAM

ANNUAL REPORT 1983

TOTAL MARKINGS REMAINING TO BE PLACED

State Michigan

M	I

FIPS CODE (Alpha)

TYPE OF MARKINGS TO BE PLACED	QUANTITY BY SYSTEM							GRAND TOTAL
	FEDERAL-AID SYSTEM				OFF THE FEDERAL-AID SYSTEM			
	Urban	Primary	Secondary	Total	State Jurisdiction	Local Jurisdiction	Total	
Centerline Miles Only								
Edgeline Miles Only								
Miles of Both Center and Edge lines								
TOTAL MILES	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Railroad-Highway Grade Crossings								
Pedestrian Crossings (Number of Intersections)								
Other (Describe)								

NOTE: Michigan obligated no PMS funds during the July 1, 1982 to June 30, 1983 period.

SAFETY PROGRAM EVALUATION DATA

Federal (HES, HHS, and ROS) and State/Local Safety Programs

Eighteen federally funded and 35 state/local funded spot safety improvement construction projects were evaluated for this year's annual safety report. The projects included intersection flares, additional lanes (in some cases in conjunction with new traffic signals), pavement friction improvements, and various roadside safety improvements.

Accident data was collected for three years before-and-after each project and is summarized on the following tables. The eighteen federally funded projects (HES, HHS, ROS) experienced a cumulative total of 1673 accidents in the "before" period, 509 resulting in injuries and 14 in fatalities. In the "after" period, the project locations experienced 1,246 crashes, including 361 involving injuries and six involving fatalities. The total cost of the 18 projects was $4.7 million. An annual accident savings of $950,000 resulted in a project time-of-return (TOR) of 4.96 years. This is comparable with the TOR of projects evaluated in previous annual reports.

The 33 state/local projects were similar, in type of work, to the federal funded group. They were generally at intersections and were selected based on correctable accident concentrations. The 33 locations experienced 2,249 accidents in the three "before" years; 626 involved injuries and four fatalities. In the "after" period, total accidents decreased to 1,638 with injury accidents declining to 457 and fatal crashes to two. Total project costs were $2.70 million, with an annual safety benefit of $680,000 and a project TOR of 3.99 years.

Federal Funded Safety Project Accident Data, Costs and TOR

Before				After			
Fatal	Injury	PD	Total	Fatal	Injury	PD	Total
14	509	1150	1673	6	361	879	1246

Before accident costs $7,497,800 After accident costs $4,635,780
Savings $2,862,020
Annual Savings $954,007
Project Costs $4,735,600
TOR 4.96 years

State/Local Funded Safety Project Accident Data, Costs, and TOR

Before				After			
Fatal	Injury	PD	Total	Fatal	Injury	PD	Total
4	626	1619	2249	2	457	1189	1638

Before accident costs $6,918,580 After accident costs $4,883,180
Savings $2,035,400
Annual Savings $678,467
Project Costs $2,708,700
TOR 3.99 years

The "time-of-return" method of analyzing project cost/benefit, while simple and easily understood, does not account for changes in accident experience over time resulting from other factors. As a result, several statistical evaluation techniques were reviewed to further assess the data. Procedures endorsed by the FHWA in Evaluation of Highway Safety Projects (January 1979), were chosen. Specifically, the Poisson technique, 95 percent level of confidence was used. Three years of "before" accident data was compared with three years of "after" data through the use of appropriate controls. The expected "after" period accident frequency (E_f) was calculated using the following formula:

$$E_f = \frac{B_{pf}\ (\text{After Project ADT})\ (A_{cf})\ (\text{Before Control ADT})}{(\text{Before Project ADT})\ (B_{cf})\ (\text{After Control ADT})}$$

Where B_{pf} = before period accident frequency
A_{cf} = after control accident frequency
B_{cf} = before control accident frequency

Evaluation of "all" federal and "all" state/local projects utilized statewide accident data as the control. Since control ADT was unavailable except for statewide trends that showed about a one percent change between the two three-year periods, this term was deleted. The expected accident frequency (E_f) was then used to compute the percent reduction and the statistical significance was determined by using the Poisson curve at the 95 percent confidence level. Both the federal and state/local programs showed significant reductions in accidents. The federal program yielded a 12.3 percent reduction and the state/local projects 15.4 percent beyond that "expected." Those reductions were slightly less than one-half of the actual reductions.

In addition, certain project types were evaluated where a sufficient sample size was available. The types evaluated, individually and in combination, included additional lanes, intersection flaring (widening without adding lanes) skid treatment, new and modernized traffic signals and roadside safety improvements. Project type codes indicated on the following tables are those developed by the FHWA. The statistical evaluation of the specific project types utilized, as controls, the accident data for state trunkline signalized intersections, nonsignalized intersections, or nonintersection segments.

Although instructions for completing the table indicate that only one project type code should be used, we do not believe that the noted multiple projects can be evaluated independently. For instance, construction of a left-turn lane in conjunction with installation of a new traffic signal or construction of a shoulder along a freeway in conjunction with the removal of roadside obstacles cannot (or should not) be evaluated as individual projects since the change in accident experience is a function of both.

As indicated on the statistical evaluation table, all of the project types evidenced statistically significant accident reductions except two - widening projects (no lanes added) and signal upgrading in conjunction with widening.

Statistical Evaluation of
Federal and State/Local
Funded Safety Projects

Project Type	B_{pf}	A_{pf}	A_{cf}/B_{cf}	A_{padt}/B_{padt}	E_f	% Reduc.	Significant?
All Federal Funded (18 Proj.)	1,673	1,246	.789	1.077	1,421	12.3	Yes
1A, 1G 1G,3B (New Signal, Lane Widening - 3 proj.)	183	96	.910	1.104	184	47.7	Yes
1A 3B (Lane widening- 5 projects)	250	172	.789	1.098	216	20.4	Yes
3D,3N,3R (Shoulder Imp., Impact Att., Obstacle Removal - 2 projects)	120	83	.789	1.064	100	17.0	Yes
All State/Local Funded (33 proj)	2,249	1,638	.789	1.091	1,936	15.4	Yes
3B (Lane Widening - 16 Projects)	754	532	.789	1.073	638	16.6	Yes
3F (Skid Treatment - 10 Projects)	691	455	.789	1.078	588	22.6	Yes
3A (Widening-No Additional Lanes - 10 Projects)	61	47	.856	1.112	58	18.9	No
1A, 1F 1F,3B (Upgrade Signals, Lane Widening- 3 Projects)	559	471	.805	1.072	482	2.3	No

B_{pf} = Before Period Accident Frequency

A_{pf} = After Period Accident Frequency

A_{cf}/B_{cf} = After Control Accident Frequency/Before Control Accident Frequency

A_{padt}/B_{padt} = After Period ADT/Before Period ADT

E_f = After Expected Accident Frequency

TABLE 2

Michigan | M | I |
FIPS CODE (Alpha)

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND PAVEMENT MARKING DEMONSTRATION PROGRAM ANNUAL REPORT 1983 EVALUATION DATA FOR COMPLETED IMPROVEMENTS

Safety Improvement Program	Safety Classification Code	Total Cost of Evaluated Improvements ($1000)	Quantity of Improvements	Units	NUMBER OF ACCIDENTS										Evaluation Status	Exposure Information			Rural or Urban	Number of Lanes	Divided or Undivided
					Before					After											
					Mos.	Fat.	Inj.	PDO*	Tot.	Mos.	Fat.	Inj.	PDO*	Tot.		Before AADT	After AADT				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
HH	1G	19.5	1	X	36	0	16	36	52	36	0	8	28	36	F	19,710	24,090		R	2	U
HE	1A1G	85.5	1	X	36	0	15	66	81	36	0	10	30	40	F	11,498	13,468		U	2	U
HH	1A1G	33.2	1	X	36	0	21	59	80	36	0	14	31	45	F	18,615	19,491		U	2	U
HH	1A1G	38.3	1	X	24	0	8	14	22	24	0	5	6	11	F	10,950	12,373		R	2	U
TOTALS	1G3B	157.0		3		0	44	139	183		0	29	67	96							
HE	1F3F	165.5	1	X	36	0	51	60	111	36	0	37	52	89	F	21,900	23,762		U	5	U
RO	2D	46.5	0.1	M	36	1	7	17	25	36	0	11	11	22	F	25,185	27,703		R	4	U
RO	2E3K3R	2,844.4		X	36	8	154	386	548	36	5	99	342	446	F	19,601	22,776		R	4	D
HE	1A	457.3	0.6	X	36	0	11	11	22	36	0	8	20	28	F	3,832	4,599		U	2	U
HE	1A	45.0	1	X	36	0	26	56	82	36	0	18	46	64	F	18,396	19,163		U	2	U
HE	1A	22.1	1	X	36	0	15	53	68	36	0	14	40	54	F	20,805	24,090		U	2	U
HE	1A	360.7	1	X	36	0	10	8	18	36	0	6	5	11	F	4,380	4,708		R	2	U

*Threshold for reporting PDO accidents that are included in this Table (i.e., minimum dollar value, towaway, etc.) $200

TABLE 2

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND
PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1983
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

Michigan | M | I |
FIPS CODE (Alpha)

Safety [illegible] Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements ($1000) (3)	Quantity of Improvements (4)	Units (5)	Number of Accidents – Before: Mos. (6)	Fat. (7)	Inj. (8)	PDO* (9)	Tot. (10)	Number of Accidents – After: Mos. (11)	Fat. (12)	Inj. (13)	PDO* (14)	Tot. (15)	Evaluation Status (16)	Exposure Information: Before AADT (17)	After AADT (18)	(19)	Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
HE	1A	276.2	1	X	36	4	25	31	60	36	0	5	10	15	F	8,432	8,760		R	4	U
Totals	1A	1,161.3	5			4	87	159	250		0	51	121	172							
RO	3D3N3R	96.3	0.2	M	36	0	23	89	112	36	0	26	51	77	F	14,235	15,089		R	4	D
RO	3D3N3R	56.5	0.1	M	36	0	5	3	8	36	0	2	4	6	F	7,665	8,202		R	4	D
Totals	3D3N3R	152.8	2			0	28	92	120		0	28	55	83							
HH	3F	37.6	0.2	M	36	0	2	1	3	36	0	0	1	1	F	976	1,088		R	2	U
RO	3K3M	58.0	0.2	M	36	1	98	178	277	36	1	68	127	196	F	120,334	123,568		U	6	D
HE	3K3R	57.3	0.6	M	36	0	6	40	46	36	0	10	44	54	F	876	946		R	2	U
HH	3N	35.7	1	X	36	0	16	42	58	36	0	20	31	51	F	114,975	122,448		U	5	U
TOTAL	ALL –	4,735.6				14	509	1,150	1,673		6	361	879	1,246							

*[illegible] reporting PDO accidents that are included in this Table (i.e., minimum dollar value, towaway, etc.)

TABLE 2

Michigan — M I — FIPS CODE (Alpha)

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND PAVEMENT MARKING DEMONSTRATION PROGRAM ANNUAL REPORT 1983
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

Safety [illegible] Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements ($1000) (3)	Quantity of Improvements (4)	Units (5)	NUMBER OF ACCIDENTS — Before — Mos. (6)	Before — Fat. (7)	Before — Inj. (8)	Before — PDO* (9)	Before — Tot. (10)	After — Mos. (11)	After — Fat. (12)	After — Inj. (13)	After — PDO* (14)	After — Tot. (15)	Evaluation Status (16)	Exposure Information — Before AADT (17)	Exposure Information — After AADT (18)	(19)	Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
SL	1A1F	91.9	1	X	36	0	53	116	169	36	1	22	107	130	F	32,850	34,821		U	4	U
SL	1A1F	67.5	1	X	36	0	27	23	50	36	0	19	25	44	F	29,565	32,078		U	5	U
SL	1A1F	201.7	1	X	36	0	67	273	340	36	0	63	234	297	F	12,264	13,122		U	4	U
Totals	1A1F	361.1	3			0	147	412	559		1	104	366	471							
SL	1A1G	145.4	1	X	36	0	7	32	39	36	0	9	23	32	F	7,665	8,355		R	2	U
SL	1A1G	368.6	1	X	36	0	29	75	104	36	0	24	39	63	F	19,710	21,484		U	4	U
SL	1G	76.2	1	X	36	1	15	25	41	36	0	15	23	38	F	16,973	19,009		R	4	D
SL	3A	21.5	.05	M	36	0	4	19	23	36	0	4	18	22	F	15,877	17,147		U	2	U
SL	3A	17.8	.05	M	36	0	2	7	9	36	0	0	3	3	F	6,241	6,554		U	2	U
SL	3A	12.4	.05	M	36	0	0	8	8	36	0	2	2	4	F	6,241	6,554		U	2	U
SL	3A	13.4	.05	M	36	0	0	0	0	36	0	1	1	2	F	1,643	1,861		R	2	U
SL	3A	10.0	.05	M	36	0	4	3	7	36	0	1	3	4		2,190	3,504		R	2	U

*Threshold for reporting PDO accidents that are included in this Table (i.e., minimum dollar value, towaway, etc.) $200.

TABLE 2

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND
PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1983
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

Michigan — FIPS CODE (Alpha): M I

Safety [illegible] Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements ($1000) (3)	Quantity of Improvements (4)	Units (5)	Number of Accidents – Before – Mos. (6)	Before – Fat. (7)	Before – Inj. (8)	Before – PDO* (9)	Before – Tot. (10)	After – Mos. (11)	After – Fat. (12)	After – Inj. (13)	After – PDO* (14)	After – Tot. (15)	Evaluation Status (16)	Exposure Information – Before AADT (17)	Exposure Information – After AADT (18)	(19)	Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
SL	3A	9.0	.03	M	36	0	2	1	3	36	0	1	3	4	F	2,190	2,518		R	2	U
SL	3A	9.4	.03	M	36	0	1	4	5	36	0	2	2	4	F	2,190	2,515		R	2	U
SL	3A	9.2	.03	M	36	0	0	1	1	36	0	0	0	0	F	2,135	2,409		R	2	U
SL	3A	9.0	.03	M	36	0	0	2	2	36	0	0	1	1	F	2,135	2,299		R	2	U
SL	3A	9.3	.03	M	36	0	2	1	3	36	0	0	3	3	F	1,314	1,533		R	2	U
Totals	3A	121.0	10			0	15	46	61		0	11	36	47	F						
SL	3B	38.5	1	X	36	0	4	6	10	36	0	5	2	7	F	13,140	14,191		R	2	U
SL	3B	36.9	1	X	36	0	14	21	35	36	0	6	6	12	F	15,658	16,598		R	2	U
SL	3B	64.8	1	X	36	0	12	14	26	36	0	4	5	9	F	15,330	16,230		R	2	U
SL	3B	11.7	1	X	36	1	3	6	10	36	0	1	8	9	F	10,950	11,710		R	2	U
SL	3B	119.6	1	X	36	0	18	13	31	36	0	8	16	24	F	8,213	8,787		R	2	U
SL	3B	146.1	1	X	36	0	7	11	18	36	0	4	4	8	F	13,906	17,629		U	2	U
SL	3B	127.4	1	X	30	0	2	3	5	36	0	5	5	10	F	17,739	21,024		R	4	D

*[illegible] reporting PDO accidents that are included in this Table (i.e., minimum dollar value, towaway, etc.)

TABLE 2

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND
PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1983
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

Michigan | M I | FIPS CODE (Alpha)

Safety Improvement Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements ($1000) (3)	Quantity of Improvements (4)	Units (5)	NUMBER OF ACCIDENTS Before Mos. (6)	Fat. (7)	Inj. (8)	PDO* (9)	Tot. (10)	After Mos. (11)	Fat. (12)	Inj. (13)	PDO* (14)	Tot. (15)	Evaluation Status (16)	Exposure Information Before AADT (17)	After AADT (18)	(19)	Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
SL	3B	77.3		X	36	0	23	26	49	36	0	20	22	44	F	12,045	12,264		R	2	4
SL	3B	138.5		X	36	1	97	344	442	36	0	70	250	320	F	18,615	20,641		U	4	U
SL	3B	44.2		X	36	0	0	6	6	36	0	5	1	6	F	4,270	4,612		R	2	U
SL	3B	138.5		X	36	0	7	15	22	36	0	2	1	3	F	9,308	10,052		U	4	U
SL	3B	21.6		X	36	1	6	4	11	36	0	1	5	6	F	6,022	6,263		U	4	U
SL	3B	32.6		X	36	0	4	3	7	36	0	6	7	13	F	17,410	18,455		R	4	U
SL	3B	146.7		X	36	0	16	44	60	36	0	13	31	44	F	3,833	4,292		R	2	U
SL	3B	20.5		X	36	0	3	1	4	36	0	3	1	4	F	9,855	10,742		R	2	U
	3B	75.1		X	36	0	8	10	18	36	0	5	10	15	F	4,052	4,295		R	2	U
Totals	3B	1,240.0	16			3	224	527	754		0	158	374	532							

*Threshold for reporting PDO accidents that are included in this Table (i.e., minimum dollar value, towaway, etc.)

TABLE 2

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND
PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1983
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

Michigan | M | I |
FIPS CODE (Alpha)

Safety [illegible] Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements ($1000) (3)	Quantity of Improvements (4)	Units (5)	NUMBER OF ACCIDENTS — Before: Mos. (6)	Fat. (7)	Inj. (8)	PDO* (9)	Tot. (10)	After: Mos. (11)	Fat. (12)	Inj. (13)	PDO* (14)	Tot. (15)	Evaluation Status (16)	Exposure Information: Before AADT (17)	After AADT (18)	(19)	Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
SL	3F	171.4	1.40	M	36	0	91	235	326	36	0	82	176	258	F	27,703	29,920		U	4	U
SL	3F	59.2	0.2	M	36	0	30	112	142	36	0	15	62	77	F	29,236	31,575		U	4	U
SL	3F	66.1	0.9	M	36	0	42	82	124	36	0	19	37	46	F	10,950	11,717		U	2	U
SL	3F	99.9	0.96	M	36	0	26	73	99	36	1	20	53	74	F	6,460	6,913		R	2	U
Totals	3F	396.4	4			0	189	502	691		1	136	328	455							
TOTAL	ALL	2,708.7				4	626	1,619	2,249		2	457	1,189	1,638							

*[illegible] for reporting PDO accidents that are included in this Table (i.e., minimum dollar value, towaway, etc.)

Interstate Roadside Safety Program

The first sections of interstate freeway in Michigan were constructed in 1958. By 1970 there were 951 miles completed. Total interstate mileage had increased to 1,065 by 1975 and 1,124 by 1980. As of 1983, there were 1,130 miles of interstate freeway in Michigan with only 51 miles remaining to be completed on our authorized system.

In the mid 1960's growing public concern for highway safety focused attention on casualties resulting from off-road crashes with fixed-objects adjacent to the highway. Many of these crashes were with highway-related appurtenances such as guardrails, signs, culverts, bridge piers, and light standards. In response to these concerns, the American Association of State Highway and Transportation Officials (AASHTO) developed guidelines relative to the roadside environment in a 1967 publication entitled "Highway Design and Operational Practices Related to Highway Safety." This publication, more commonly called the "Yellow Book", was the basis for early programs focusing on improving the safety of roadsides.

In Michigan, initial implementation of roadside safety improvements began in 1969. Standards for new construction were modified to incorporate the clear or "forgiving" roadside called for by the "yellow book". Since most new roadway construction in the 1970's involved freeways, those roads, particularly new interstate freeways, benefited most from the higher roadside safety standards.

Concurrently, in the late 60's and early 70's action was taken to upgrade the roadside environment of existing freeways to the new standards. Bridge-mounted signs, steel column breakaway supports, breakaway wood posts, and relocation of signs back to 30 feet from the pavement edge had evolved by 1970. In general, roadside safety work associated with signs was well underway by 1970.

Full width, paved shoulders were being provided on interstate freeways by 1970. Concrete median barrier was being constructed along the high volume Detroit freeways in the early to mid 1970's and, as guardrail standards evolved, new or replacement guardrail reflecting the more up-to-date standards was being installed. Frangible or breakaway light standards were developed in the mid to late 1970's and use of impact attenuators was common by 1980.

In addition to the wide range of improvements cataloged above, a systematic prioritized roadside safety upgrading program on our freeway system was initiated in 1971. First priority was the interstate system. Initially, projects were authorized by maintenance force account procedures using either department or contract county forces. Work was also prioritized by type. Guardrail improvements were to be done first, such as removal, upgrading, or extension of the rail and upgrading of end sections. Subsequent priorities were slope flattening, filling of gore areas, and modifying culvert end sections. Signs and light standards not already upgraded were also targeted for correction.

By 1975 it was decided to let much of the remaining work to competitive bid contract to expedite completion of the roadside safety work. Forty-two percent of the interstate system at that time was up to, or nearly up to, AASHTO roadside safety standards. Improvements on an additional 40 percent of the system were being designed. By 1982, essentially all of the interstate system had been upgraded to the more forgiving roadside safety standards, although authorization of further improvements reflecting the continual evolution and refinement of those standards continues.

Analysis of the impact of roadside safety improvement projects on safety is difficult for several reasons. As outlined above, much of the work was accomplished in stages over several years, and some of the work was included within projects not specifically classified as roadside safety. Analysis is further complicated by lack of adequate accident sample sizes, particularly when attempts are made to segregate ran-off-road accidents involving fixed-objects or rollovers and correlate them to specific improvements. Another problem, until recently not clearly recognized, was defining exactly what the safety impacts of roadside safety projects were; that is, did they reduce total accidents or did they affect injuries and fatalities?

Our initial premise was that these projects would not have a dramatic impact on total accidents. We believed that their focus was minimizing the consequences of an errant vehicle crash rather than minimizing the number of such incidents. Logically, we believed that the primary benefit of such projects would be reflected in reduced casualties (fatalities and injuries). This proved to be true, but of special interest is the fact that more detailed analysis of the injury data disclosed that deaths and the most serious injury (Type A) decreased at a much faster rate than did the less serious (B and C Type) injuries.

The tables and graphs document accident/casualty experience on the interstate system from 1968 to 1982. Basically, the data in the early years reflects a "before" condition, and the later years the "after" condition.

Total accidents on the interstate system averaged about 15,000 from 1968 through 1975. Accidents increased to over 19,000 by 1978 and dropped back to slightly over 15,000 in 1980, 1981, and 1982. As the interstate system mileage grew and miles driven increased, the accident rate decreased about 3.3 percent a year. During this same period the injury rate decreased 5.1 percent per year. Of more significance, however, was that the fatality and serious injury (Type A) rate decreased substantially faster. The death rate has dropped, more or less consistently, from 3.73/MVM in 1968 to 0.91/MVM in 1982. When coupled with the most serious Type A injury, that casualty rate has decreased at a rate of 10.1 percent per year. By comparison, on all state highways between 1968 and 1982, the total accident rate decreased by 1.6 percent annually, injuries by 2.9 percent, and serious casualties by 7.7 percent per year. Prior to 1971, fatalities and Type "A" injuries constituted an average of 35 percent of all casualties on the interstate system. This rate decreased to 21 percent in 1971 and continued to decrease at about 0.4 percentage points a year.

Since the interstate roadside safety program specifically addresses ran-off-road, fixed-object accidents, the trend of fatalities and serious injuries resulting from that type of crash was also assessed. Injury severity data are available for fixed-object accidents only since 1971. The data shows that the ratio of fatalities and serious injuries to total casualties has decreased from 26 percent in 1971 to 20 percent by 1982, a reduction rate of two percent per year. For multiple vehicle accidents, which make up most of the remaining crashes, injury severity data was available only for the years 1976 to 1982.

In that seven-year period, the severe accident ratio remained constant. Since 1976, fixed-object related deaths decreased from 67 to 33 (51 percent). Multiple vehicle deaths dropped from 76 to 53 (30 percent). Corresponding Type A fixed-object injuries decreased from 514 in 1976 to 361 in 1982 (28 percent). Multivehicle Type A injuries decreased from 828 to 693 (16 percent). This lends further credibility to the theory that significant serious casualty reductions on the interstate system are to a large degree attributable to the roadside safety improvement program. A statistical analysis of the data was also conducted. Several regression lines were generated and the growth rate ($S = P(1+i)^n$) was selected as being the clearest explanation of the trends. All trend lines shown are statistically significant at a 95 percent confidence level and all equations given explain at least 82 percent of the variations in the data.

A significant event which occurred during the study period which could have influenced total accident experience and accident severity, was enactment of the 55 mph speed limit in 1974, the oil embargo and the subsequent dramatic gasoline price increases. Comparison of the ratio of serious casualties to total casualties for both off-road fixed-object crashes and on-road multivehicle crashes seems to confirm however that the severity of fixed-object crashes decreased at a more significant rate. This indicates that something other than generally reduced speeds was impacting the severity of those accidents.

In summary, this study evaluated the impact on safety associated with an improved safe roadside environment. The interstate system in Michigan was selected because it reflected good "before" and "after" condition and because a large sample of accident data was available.

Results of this evaluation lead us to conclude that the roadside safety program on Michigan's interstate system has had a significant, positive impact on reducing deaths and serious injuries. We believe that the study confirms the benefits of roadside safety improvement programs and warrants continuation of those efforts on other freeways and on the free access highway system.

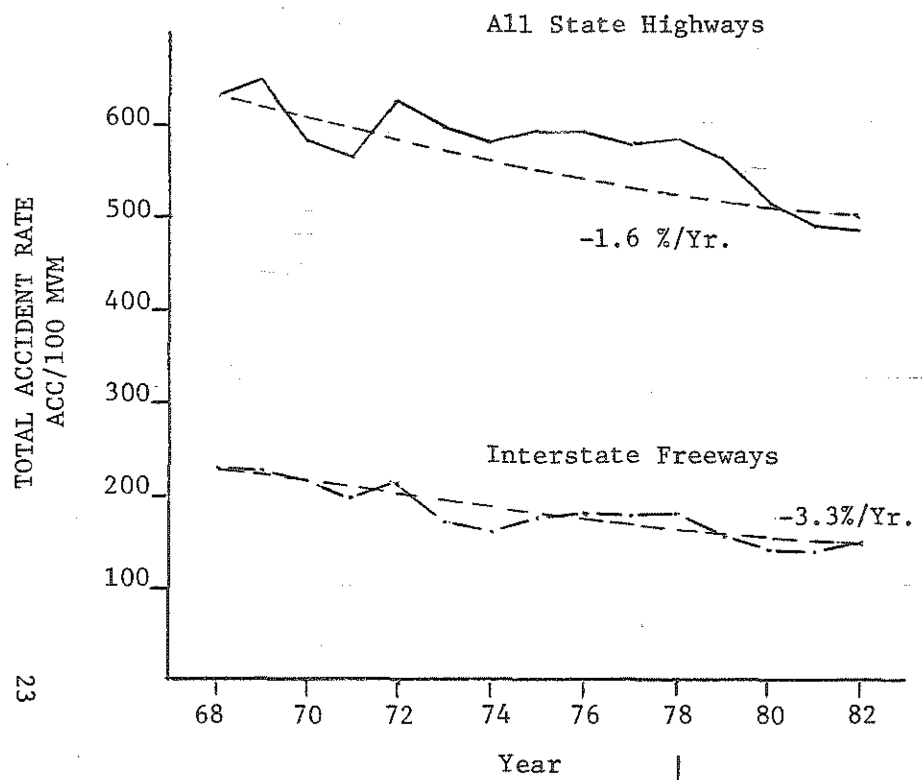
MICHIGAN INTERSTATE ACCIDENT DATA

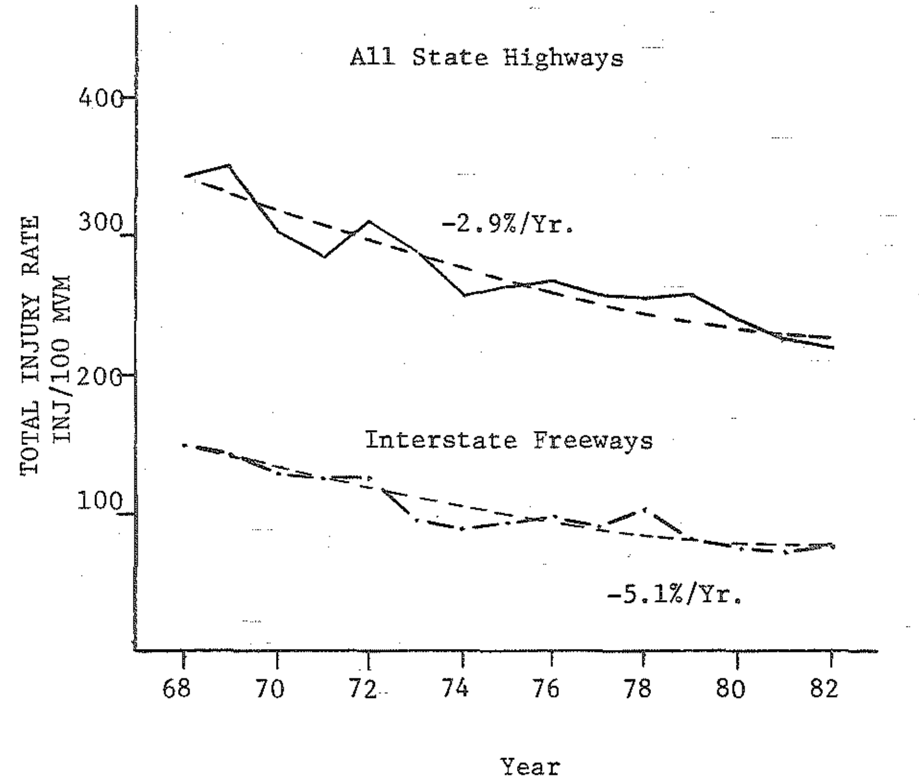
Year	VMT (Billions)	Total Accidents	Total Injuries	A Injuries	B Injuries	C Injuries	Total Killed	Acc. Rate Per 100 MVM	Casualty Rate K&I/100 MVM	Serious Cas. Rate $K\&I_A$/100 MVM	Death Rate K/100 MVM
1968	5.93	13777	8595	2845	2042	3707	221	232.327	148.7	51.7	3.73
1969	6.74	15252	9249	3111	2117	4021	248	226.3	140.9	49.8	3.68
1970	7.27	15388	8847	2827	2064	3956	199	211.7	124.4	41.6	2.74
1971*	7.69	15069	9237	1751	2495	4991	208	195.9	122.8	25.5	2.70
1972*	8.48	17737	10509	1728	2840	5764	177	209.2	126.0	22.5	2.09
1973*	9.11	15491	8331	1666	2499	4165	196	170.0	93.6	20.4	2.15
1974*	8.85	13949	7402	1133	2032	4092	145	157.6	85.3	14.4	1.69
1975*	8.82	14910	7719	1214	2082	4282	141	169.1	89.1	15.4	1.60
1976	9.82	17246	8801	1391	2412	4998	147	175.6	91.1	15.6	1.50
1977	10.30	18075	8919	1335	2730	4854	122	175.5	87.8	14.1	1.18
1978	10.97	19421	9649	1416	3001	5232	178	177.0	98.9	14.5	1.62
1979	11.81	18410	9299	1368	2881	5050	120	155.9	79.8	12.6	1.02
1980	10.66	15003	7625	1196	2463	3966	137	140.7	72.8	12.5	1.29
1981	10.99	15038	7494	1239	2245	4010	121	136.8	69.3	12.4	1.10
1982	10.40**	15271	7387	1083	2202	4102	95	146.8	71.9	11.3	0.91

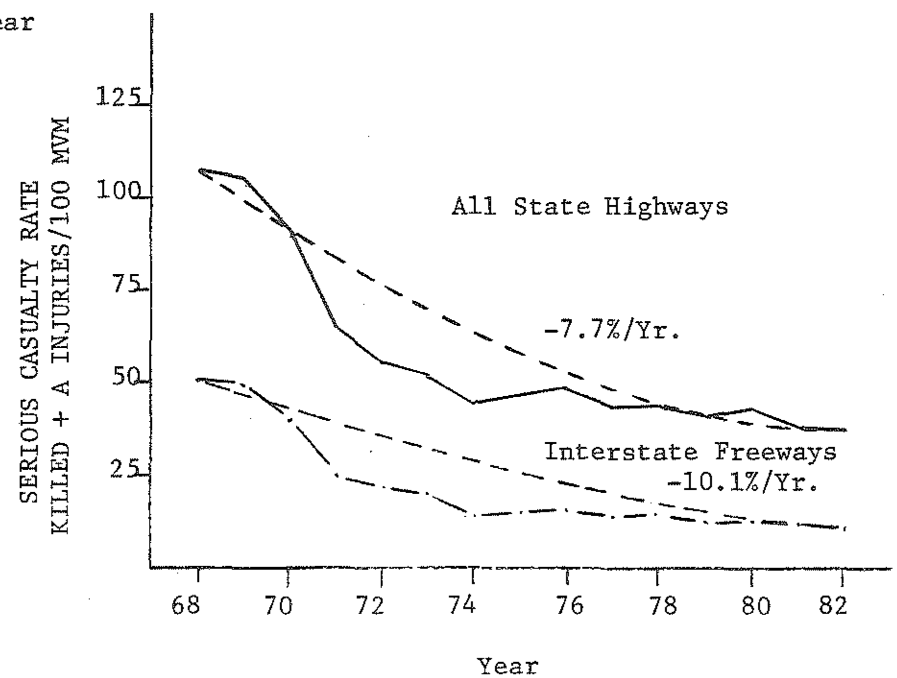
* Includes estimated Detroit data
** Est./Transp. Planning Services Division

MICHIGAN
INTERSTATE RELATED ACCIDENT SEVERITY SUMMARIES

	Fixed-Object				Multi-Vehicle			
Year	A Inj.	B Inj.	C Inj.	Killed	A Inj.	B Inj.	C Inj.	Killed
1976	514	800	1,056	67	828	1,515	3,785	76
%	21.1	32.8	43.3	2.8	13.4	24.4	61.0	1.2
1977	441	872	1,010	48	841	1,790	3,735	71
%	18.6	36.8	42.6	2.0	13.1	27.8	58.0	1.1
1978	471	920	1,024	59	886	1,941	4,017	111
%	19.0	37.2	41.4	2.4	12.7	27.9	57.8	1.6
1979	440	869	960	40	872	1,901	3,893	76
%	19.1	37.6	41.6	1.7	12.9	28.2	57.8	1.1
1980	443	951	930	56	696	1,413	1,903	72
%	18.6	40.0	39.1	2.3	13.7	27.8	57.1	1.4
1981	481	834	934	52	735	1,343	2,946	66
%	20.9	36.2	40.6	2.3	14.4	26.4	57.9	1.3
1982	361	702	892	33	693	1,435	3,126	53
%	18.2	35.3	44.9	1.6	13.1	27.0	58.9	1.0







Comparison of accident and casualty trends.
All state highways and interstate freeways

Rail/Highway Crossing Safety Program

Michigan's Ninth Annual Report included an evaluation of the rail-highway grade crossing safety program. This study confirmed the generally recognized decreasing trend in rail-crossing fatalities; evaluating that trend in the context of changes in train-vehicle exposure. A multiple regression analysis was performed with rail-crossing accidents as the dependent variable and statewide accidents, railway road miles, and automobile vehicle miles travelled as the independent variables. These variables accounted for 72 percent of the variance in rail-crossing accidents with railway road miles accounting for 65 percent. This indicated that the majority of the decrease in rail-highway crossing accidents was due to the decrease in rail-highway crossing exposure.

Railway road miles were used to reflect rail-highway crossing exposure because data were available from 1971 to present. Other measures of railroad exposure were only available for the past few years. Two of those, the change in the number of public rail-highway crossings and the change in the number of trains per day passing rail-highway crossings were found to have changes of the same magnitude as railway road miles for the past several years.

Based on this analysis, we concluded that it was difficult to attribute much of the credit for the reduction of rail-crossing accidents in Michigan to the rail-highway crossing improvement program.

However, Federal Highway Administration memoranda issued since publication of that report cites Michigan for not providing specific project before-and-after accident data. Since accident experience was not, in many cases, the major consideration in rail-crossing improvement project selection, and other programs such as Operation Lifesaver impacted rail/highway safety, the in-depth, statewide evaluation of rail-highway crossing safety was considered more appropriate. That report was responding to FHWA encouragement of better, statistically based evaluations of safety programs. However, in order to address recent FHWA requests, this year's annual report includes before-and-after project data compiled in the tables which follow.

Forty state trunkline rail-highway crossing projects in four funding categories were included; 32 identified as "RRS", six as "RRP", one "RSG", and one "MU" (state funded). The improvements were categorized as "railroad crossings," "flashers," or "reconstruction and flashers." The following table summarizes before-and-after accident data by funding category.

	RRS		RSG		RRP		MU	
	Before	After	Before	After	Before	After	Before	After
Projects	31		1		6		1	
Total Acc.	13	35	0	1	1	0	0	1
Prop. Damage Acc	9	22	0	0	1	0	0	1
Inj. Acc. (Injuries)	4(4)	13(16)	0	1(1)	0	0	0	0
Fatal Acc. (Fatalities)	0	0	0	0	0	0	0	0
Months	1041	2120	16	86	298	314	16	86
Rate (Acc/Year)	0.15	0.20	0.00	0.14	0.04	0.00	0.00	0.14

The "before" periods for these projects varied from 10 months to 66 months with an average of 35 months. The "after" periods varied from 36 to 92 months with an average of 67 months.

The differences in before-and-after rates for all funding categories were not statistically significant at the 90 percent confidence level using the log-likelihood ratio.

As noted previously, accident experience was not the major consideration in the selection of many of these projects. Furthermore, evaluation of the projects using before-and-after accident data without appropriate controls is misleading. We believe, however, that this information responds to the memorandum to Mr. John Hibbs dated January 6, 1983, and the subsequent January 27 memorandum from Mr. W. G. Emrich to Mr. Merchant.

This evaluation and that presented in last year's report do not support the high level of funding for the rail-highway program as a "safety" program since they fail to prove the cost-effectiveness of the improvements. We recognize, however, that many factors impact rail/highway safety and their relationship is not fully explained. Further research into the impact of this program certainly seems justified at the national level. Furthermore, it is recognized that many of the projects funded by the program are not necessarily justified solely by accident data. Some of the best rail crossing projects were designed to improve the riding quality of the crossing, only indirectly enhancing safety. We believe that these projects are very desirable and should continue to be supported by federal aid. However, consideration should be given to modifying the justification criteria and composition of the program.

Michigan | M | I |
FIPS CODE (Alpha)

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND
PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1983
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

Line	Safety [illegible] Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements ($1000) (3)	Quantity of Improvements (4)	Units (5)	NUMBER OF ACCIDENTS Before Mos. (6)	Before Fat. (7)	Before Inj. (8)	Before PDO* (9)	Before Tot. (10)	After Mos. (11)	After Fat. (12)	After Inj. (13)	After PDO* (14)	After Tot. (15)	Evaluation Status (16)	Exposure Information Before AADT (17)	After AADT (18)	(19)	Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
01	RRS	5I	60,000	1	R	45	0	0	0	0	57	0	0	0	0					R		U
02	RRP	5D	10,000	1	R	54	0	0	0	0	48	0	0	0	0					R		U
03	RRS	5I	84,000	1	R	40	0	0	0	0	62	0	0	0	0					F		U
04	RRS	5I	44,000	1	R	49	0	1(1)	0	1	53	0	0	0	0					R		U
05	RRS	5I	14,000	1	R	54	0	0	0	0	48	0	0	0	0					R		U
06	RRS	5E,I	52,000	1	R	10	0	0	0	0	92	0	0	0	0					R		U
07	RRS	5D,I	19,000	1	R	30	0	0	0	0	72	0	1(1)	0	1					R		U
08	RRS	5I	27,000	1	R	53	0	1(1)	1	2	48	0	0	1	1					U		U
09	RRS	5E,I	23,000	1	R	19	0	0	0	0	83	0	0	0	0					R		U
10	RRP	5E	21,000	1	R	40	0	0	0	0	62	0	0	0	0					R		U
11	RRS	5E	21,000	1	R	27	0	0	0	0	75	0	1(1)	1	2					U		D
12	RRS	5I	27,000	2	R	40	0	0	0	0	62	0	0	0	0					R		U
13	RRP	5I	15,000	1	R	51	0	0	0	0	51	0	0	0	0					R		U
14	RRP	5I	21,000	1	R	51	0	0	0	0	51	0	0	0	0					R		U
15	RRS	5D	25,000	1	R	28	0	0	0	0	74	0	0	0	0					R		U

*Threshold for reporting PDO accidents that are included in this Table (i.e., minimum dollar value, towaway, etc.) $300.00

Michigan | FIPS CODE (Alpha): M I

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1983
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

Line	Safety [illegible] Program (1)	Safety Classification Code (2)	Total Cost of Evaluated Improvements ($1000) (3)	Quantity of Improvements (4)	Units (5)	NUMBER OF ACCIDENTS — Before: Mos. (6)	Fat. (7)	Inj. (8)	PDO* (9)	Tot. (10)	After: Mos. (11)	Fat. (12)	Inj. (13)	PDO* (14)	Tot. (15)	Evaluation Status (16)	Exposure Information: Before AADT (17)	After AADT (18)	(19)	Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
01	RRS	5E	30	1	R	11	0	0	0	0	91	0	0	0	0					R		U
02	RRS	5E,I	64	I	R	22	0	0	0	0	80	0	0	0	0					R		U
03	RRS	5F,I	617	4	R	43	0	0	1	1	59	0	0	1	1					U		U
04	RRS	5F,I	135	1	R	33	0	0	0	0	69	0	1(2)	1	2					U		
05	RRS	5I	85	1	R	43	0	1(1)	0	1	59	0	0	1	1					R		U
06	RRS	5I	54	1	R	39	0	1(1)	2	3	63	0	3(3)	4	7					R		U
07	RRS	5I	111	1	R	40	0	0	0	0	62	0	0	0	0					R		U
08	RRP	5I	111	1	R	36	0	0	0	0	66	0	0	0	0					U		U
09	RRS	5I	127	1	R	47	0	0	0	0	55	0	0	0	0					R		U
10	RRS	5E,I	212	1	R	27	0	0	0	0	75	0	0	0	0					U		
11	RRP	5D,I	106	1	R	66	0	0	1	1	36	0	0	0	0					U		
12	RRS	5F	204	1	R	45	0	0	0	0	57	0	0	1	1					R		U
13	RRS	5I	44	1	R	33	0	00	0	0	69	0	1(1)	3	4					R		U
14	RRS	5E,I	45	1	R	16	0	0	3	3	86	0	0	2	2					U		
15	RRS	5I	156	1	R	31	0	0	0	0	71	0	1(2)	1	2							

Michigan — FIPS CODE (Alpha): M I

HIGHWAY SAFETY IMPROVEMENT PROGRAM AND
PAVEMENT MARKING DEMONSTRATION PROGRAM
ANNUAL REPORT 1983
EVALUATION DATA FOR COMPLETED IMPROVEMENTS

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 — Before — Mos. (6)	Fat. (7)	Inj. (8)	PDO* (9)	Tot. (10)	After — Mos. (11)	Fat. (12)	Inj. (13)	PDO* (14)	Tot. (15)	Evaluation Status (16)	Exposure Information — Before AADT (17)	After AADT (18)	(19)	Rural or Urban (20)	Number of Lanes (21)	Divided or Undivided (22)
01	RRS	5E,I	69	1	R	19	0	0	0	0	83	0	0	0	0					U		U
02	RRS	5I	34	1	R	25	0	0	0	0	77	0	3(3)	3	6					U		
03	RRS	5F,I	199	1	R	27	0	0	2	2	75	0	0	2	2					U		
04	RSG	5E,I	36	1	R	16	0	0	0	0	86	0	1(1)	0	1					R		U
05	RRS	5G,I	228	1	R	52	0	0	0	0	50	0	0	0	0					U		
06	MU	5E,I	89	1	R	16	0	0	0	0	86	0	0	1	1					U		
07	RRS	5F,I	186	1	R	28	0	0	0	0	74	0	1(1)	0	1					U		D
08	RRS	5E,I	60	1	R	13	0	0	0	0	89	0	0	0	0					U		U
09	RRS	5F,I	107	2	R	52	0	0	0	0	50	0	1(2)	1	2					U		D
10																						
11																						
12							0	4(4)	10	14		0	14(17)	23	37							
13																						
14																						
15																						

SAFETY IMPROVEMENT PROCESS IN MICHIGAN

Michigan's safety improvement process was outlined in detail in our Eighth Annual Report dated August 31, 1981.

In general, the process remains the same. The MALI (Michigan Accident Location Index) continues to be the source of accident data in Michigan. In addition to serving as the basis of our traffic engineering reviews, the system is used extensively by police agencies to direct patrols to areas experiencing accident concentrations. The MIDAS (Michigan Dimensional Accident Surveillance model) accident analysis model continues to generate lists of locations for engineering review which are experiencing statistically significant concentrations of accidents or accident types. Action is now underway to update geometric and traffic control device data which is integral to the MIDAS model.

We have also initiated steps to improve engineering evaluation and analysis of the accident data. That function is the primary responsibility of the Traffic and Safety Division's Safety Programs Unit and its four operating groups, Crash Analysis, Roadside Improvement, TOPICS, and Community Safety. During the past year we have taken action to improve each group's work output and to coordinate their activities by better defining responsibilities. Following are brief discussions of each group's activities, highlights from last year, problems encountered and proposed enhancements for the future:

Crash Analysis Program

The activities and functions of the Crash Analysis Group were generally defined under "Spot Safety Improvement Program" of the "Safety Improvement Process" included in our Eighth Annual Report "Appendix 1, Section I, C, 2."

The Crash Analysis team of engineers and technicians reviews the MIDAS generated accident lists of locations experiencing concentrations of accidents or accident types. After initial office review, additional data is collected and the locations are reviewed in the field with the district traffic and safety engineer, who is aware of local factors which may have impacted accident experience. Alternatives are identified and recommendations developed and implemented. Last year over 2,000 locations were reviewed by the Crash Analysis Group.

Some problems have arisen, however, which have negatively impacted our ability to systematically review all of the MIDAS generated locations.

Because the geometry and traffic control devices data inherent in the model is antiquated to varying degrees, a significant manual effort is required to correct the MIDAS lists prior to further engineering review. In addition, if a MIDAS "peer group" (locations with similar geometry and traffic controls) is small, locations will be indicated for further attention which, in fact, are not experiencing disproportionate accident concentrations.

Problems with the MIDAS model are being addressed by division staff. Geometry and traffic control device information will be updated within the year and additional constraints of the MIDAS model are being explored to minimize the number of locations being identified which do not warrant attention.

We are also reviewing what steps can be taken to utilize available staff more efficiently. One action already taken is to transfer some of the accident review in large urban areas to the TOPICS group. We believe that the comprehensive traffic engineering review of citywide networks afforded by the TOPICS program is a better, more efficient method of accident surveillance review and correction in urban areas.

An additional measure now being considered is altering the MIDAS accident surveillance cycle to two years. Presently it is an annual process. The economies of a two-year cycle are obvious and we believe that using two years of accident data may also reflect a more meaningful assessment of which locations warrant further engineering attention.

Roadside Safety Program

The Michigan Department of Transportation continues its program of identifying roadside obstacles and implementing safety improvements to provide a more forgiving environment for ran-off-road vehicles. Essentially, this program consists of three concurrent activities: roadside safety surveillance, guardrail upgrading, and plan review.

Roadside safety surveillance addresses documented concentrations of off-road fixed-object crashes. State trunkline segments which have experienced a disproportionate frequency of ran-off-road accidents are identified and subjected to preliminary review by staff to isolate specific crash site concentrations. After review of the photolog to define the general scope of the problem, our district traffic and safety engineer's review and comments are requested. Following this review, potential countermeasures are reviewed at the site and recommendations developed.

Eighty miles of state trunkline segments were identified and analyzed in this manner last year, resulting in the implementation of several accident countermeasures such as removal or relocation of utility poles, tree removal, guardrail upgrading, and placement of signs and streetlights on breakaway supports.

The guardrail upgrading program is based on the inventory of all guardrail on the state trunkline system which is described in detail in the last section of this report. The inventory, which was prepared from department photologs, identifies guardrail type, post condition, height, lateral offset, and type of guardrail ending.

The inventory has identified several deficiencies. As a result, seven projects were let to contract this August to replace the curved end shoes with buffered endings. Two projects have also been programmed for complete guardrail upgrading on the US-10 freeway in Bay and Midland counties as a result of this inventory.

We intend to utilize the guardrail inventory to prioritize the upgrading of guardrail on the state trunkline system to the latest standards.

All construction plans prepared by the Department of Transportation are reviewed for safety considerations. With the passage of the Surface Transportation Act and increased state gas tax revenues, as well as increased Federal Highway Administration emphasis on roadside safety analysis, this activity now requires about 50 percent of the roadside safety staff's time.

Approximately 350 project plans were reviewed this past year. The safety review includes an office plan review at a minimum, and frequently includes a photolog or field review, an accident analysis, and cost-effectivness evaluations of various safety alternatives.

TOPICS Program

The Traffic Operations Program to Increase Capacity and Safety (TOPICS) is the traffic engineering element of the department's Transportation System Management (TSM) process. The program intent is to provide recommendations for improving traffic safety and operational efficiency on the existing roadway system of Michigan's 13 urbanized areas.

The program encompasses both state trunklines and local streets in order to reflect a comprehensive, integrated effort to identify and solve traffic engineering problems. The local street review is accommodated by our Community Assistance group (discussed elsewhere in this section). This activity is funded by Federal Section 402 monies distributed through the Office of Highway Safety Planning. The TOPICS reviews are closely coordinated with the Metropolitan Planning Organization (MPO) in the 13 urbanized areas.

Program activities include data collection and analysis, identification of corrective countermeasures, preparation of a written report of the findings and recommendations, identification of funding sources, and before-and-after evaluation of implemented recommendations.

Data analysis focuses on accidents, capacity deficiencies, signal system optimization, and identification of unwarranted signals. One major difficulty in this study phase has been the inability to accurately define capacity deficient roadway segments since the data base for some of the models is out-of-date.

The focus of the TOPICS program and the majority of recommended solutions are low-cost operational countermeasures such as parking restrictions, improved signing and/or lane markings, revised signal timing, revised signal placement, and turn prohibitions. However, some construction projects such as pavement friction improvements, radius improvements, and additional laneage are identified and funded with safety improvement monies or integrated into the local MPO Transportation Improvement or Long Range Plans.

At this time, our reviews have culminated in two separate reports. The first addresses accident locations and capacity deficient corridors. The second focuses on signal system optimization and a review of existing unwarranted signals.

During the past year, we completed TOPICS studies in three urbanized areas; Bay City, Jackson, and Kalamazoo. Many of the recommendations have been implemented but none long enough to permit a before-after analysis. Following is a brief description of each study and estimated TOR of invested safety monies. Estimates were based on a conservative 10 percent expected reduction in accidents, 1981 National Safety Council figures for the cost of property damage, injury, and fatal accidents, and the May 1981 U.S. Department of Transportation Publication "Energy Saving Traffic Operations Project Guide" (ESTOP).

Bay City - The Bay City report addresses 18 accident study locations, 13 determined as warranting corrective action. Recommendations included 19 low-cost operational improvements and three capital outlay (construction) projects. The construction recommendations involve two pavement friction improvement and one intersection approach widening projects. Total implementation costs are estimated to be $83,000, the annual safety benefit in reduced accidents is estimated to be $57,000, yielding an expected TOR of approximately 1.5 years.

Jackson - The Jackson study addressed 50 accident locations and 16 locations where the need for existing traffic signals is questionable. Corrective actions were recommended for 37 of the accident study locations. Recommendations included 60 low-cost operational and three capital outlay (construction) projects. The construction recommendations include two pavement friction and one geometric modification projects. Total implementation costs are estimated to be $114,000 and the annual safety benefit $145,000, yielding a TOR of less than one year.

A review of the 16 traffic signals in the Jackson area resulted in recommendations for seven removals and nine flasher schedule extensions. Estimated annual fuel savings to the motoring public total $84,000 (at $1.30/gal.). Removal of the seven signals (scheduled for a six-month trial flash period) would save the city an estimated $4,000 annually in maintenance and electrical energy costs. These recommendations are now being considered by the city.

Kalamazoo - The Kalamazoo Area study involved review of 72 accident locations and 21 locations where the need for existing traffic signals is questionable. Corrective actions were recommended for 61 of the accident study locations and included 128 low-cost operational and nine capital outlay (construction) projects. The construction projects ranged from pavement friction improvements to intersection geometric modifications. Total implementation costs are estimated to be $410,000. The annual safety benefit at $490,000, yields a TOR of less than one year.

A review of the 21 questionable Kalamazoo area traffic signals resulted in recommendations for 13 removals and eight flasher schedule extensions. Estimated annual fuel savings total $103,000. Removal of the 13 signals (scheduled for a six-month trial flash period) would save the city an additional estimated $7,500 in maintenance and electrical energy costs annually. These recommendations are also being considered locally.

Last year's report documented completed TOPICS studies in Muskegon and Holland. Of particular interest is the recommendation for removal of 17 signals in the Muskegon area. Removal of all 17 is estimated to save motorists $75,000 annually in reduced fuel consumption and local communities $10,000 annually in reduced maintenance and electrical energy costs. The signals have been operating as flashers for approximately six months and determination of actual removals will be made in the near future.

We have initiated a TOPICS study in the Ann Arbor-Ypsilanti area and are planning to begin one for the Flint area. In an attempt to expand our TOPICS program, we have identified an additional 17 smaller communities that have over 10,000 population but are not a part of the 13 urban areas. In this regard, we are in the final stages of a study of the Mt. Pleasant area.

Traffic Engineering Services Program
Community Assistance

The Community Assistance Program assists in the identification, analysis, and correction of locations experiencing accident concentrations. The program is funded by a Section 402 grant administered by Michigan Office of Highway Safety Planning.

During this past year we initiated integration of the Community Assistance Program with our TOPICS program. This action has resulted in a much higher level of activity and, we believe, a more efficient, cost-effective use of personnel. The Community Assistance Program does, however, continue to be available to any local agency in need of its services.

In fiscal 1982-83, the Community Assistance Program analyzed 114 locations in 19 local jurisdictions. Recommendations included traffic signal installations and modernizations, intersection reconstruction, signing modifications, pavement resurfacing and markings, rural road realignments, and plans for urban parking. Federal Highway safety funds in the amount of $4,400,000 were programmed to assist local agencies in implementing highway improvements. Much of the project funding was the direct result of Community Assistance involvement in prior years.

TOPICS studies were conducted for the Kalamazoo, Jackson, and Bay City metropolitan areas. The Community Assistance Program assisted in evaluation of all locations on the nontrunkline system in those areas. Low-cost, short-range recommendations included all-red intervals, revised signing and pavement markings, revised signal timing and flasher schedules, improved pavement friction qualities, and parking prohibitions. Higher-cost, longer-range recommendations included revised geometrics and signal modernizations. A signal warrant review, as well as a signal optimization study, was also conducted as part of the TOPICS studies.

A signal warrant study was completed for the Muskegon metropolitan area. Further discussion of that study is included in the TOPICS part of this section.

A signal optimization study was also conducted for the city of Holland as part of a comprehensive study completed last year. As a result of the proposed signal timing changes, Holland motorists will save about 12,000 gallons of fuel, or about $15,000, annually. In addition, about 11,000 vehicle-hours of delay will be eliminated.

For the Bay City, Jackson, and Kalamazoo TOPICS reviews discussed in the TOPICS section of this report, a total of 62 nontrunkline locations were analyzed. The nontrunkline locations included eight in Bay City, 13 in Jackson, and 41 in Kalamazoo. The aggregate estimated costs and safety benefits for each urban area is included in the TOPICS section.

The benefits of the Community Assistance Program are detailed in last year's evaluation of 20 projects identified or administered by the Community Assistance Program. Those projects witnessed a 31 percent accident reduction, nearly $800,000 in annual accident savings, and a project TOR of about five years. In addition, many of the HES projects evaluated in this and previous reports were identified by the Community Assistance Program. We believe that integration of the Community Assistance and TOPICS programs will further the goals of both programs.

Operational Inventories

The Operational Inventories program develops inventories of traffic control devices on local roads.

As of June 30, 1982, traffic control device inventories have been finalized for:

22,646 miles of county primary roads in 68 counties
21,464 miles of county local roads in 27 counties
12,093 miles of major and local streets in 321 cities and villages

In addition, completed field inventories need to be reviewed for:

992 miles of roads and streets in 16 cities and villages
848 miles of county local roads in one county needs to be reviewed

Emphasis is being placed on expediting review and finalization of completed field inventories.

To date, 127 local agencies have been inventoried by traffic engineering consultants. One traffic control devices inventory was completed by a trained agency between July 1, 1982, and June 30, 1983.

From July 1, 1982, to June 30, 1983, department personnel prepared engineer estimates for 11 local agency sign upgrading projects. Contracts were awarded for 14 off-trunkline agency sign upgrading projects. Funds from the Safer-Off System and Federal Aid Secondary Programs were utilized involving $282,411 in federal monies.

SPECIAL PROJECTS, STUDIES, AND NEW DEVELOPMENTS

Early Warning Ice Detection System For Bridges

During the winter of 82-83, the Michigan Department of Transportation began testing an ice-detection system for bridge decks. The detection system called "Scan 16" was developed by Surface Systems Incorporated and is being tested as an experimental device by approval of the Federal Highway Administration.

The system is designed to detect atmospheric conditions associated with a phenomenon known as preferential bridge deck icing. This condition occurs when a bridge surface suddenly develops ice before the adjacent roadway. The most critical time for this condition is early morning in the late fall or early winter. The system functions by measuring and evaluating air temperature, dew point, relative humidity, surface temperature, and surface moisture.

Objectives of the project are:

1. Verify the ability of the system to detect and predict the formation of ice on bridge decks.

2. Evaluate the durability of sensors and electronic equipment in Michigan's climate.

3. Identify the conditions which result in icy bridge decks.

4. Determine if the system enables a faster response to an icing situation and if icy bridge accidents can be reduced.

5. Determine if expansion of a grid of sensors statewide is justified.

The "Scan 16" system appears to be working with a minimum number of malfunctions and/or need for operator intervention. However, maintenance personnel cannot rely solely on the system outputs and definition of bridge deck conditions. Data generated are not infallible and need interpretation. Our experience this year was limited due to a mild winter.

We have monitored the system through the summer, using it to keep track of surface temperatures and we will resume visual observations in late fall to confirm the accuracy of the bridge deck condition reports. A final report will be developed summarizing the operation of the "Scan 16" system in 1984.

Macroscopic Traffic Simulation Model (TRAFLO-M)

The TRAFLO-M integrated traffic simulation model is being programmed onto our Burroughs 7700 computer by the consulting firm of KLD Associates, Inc. through an HPR Part II research contract. TRAFLO-M is an enhanced version of TRAFLO, developed specifically for the Michigan Department of Transportation, and an enhanced version of the TRAF 1.5 family of models recently released by FHWA.

TRAFLO-M is a system of models that includes NETFLO (urban network model), DYNEV (a freeway model), and TRAFFIC (an equilibrium traffic assignment model).

The model performs macroscopic simulations on urban networks along with simulations of subnetworks similar to microscopic NETSIM analyses. Vehicles are represented macroscopically in terms of traffic flow parameters rather than being monitored individually as with NETSIM analyses. The possible analyses available include three urban level submodels, the freeway model, and the equilibrium traffic assignment model.

TRAFLO-M is designed for use by both transportation planning and traffic engineers to simulate traffic on large urban networks and freeways. The models provide the means for evaluating a wide range of traffic management alternatives. Each alternative strategy can be tested and compared to other alternatives before a strategy is implemented.

The outputs include vehicle miles of travel, delay, travel time, queue links by lane, mean velocity, vehicle occupancy, percent of saturation, vehicle stops, person trips, fuel consumption, and exhaust emissions.

Practical applications in Michigan include the Woodward Corridor Light Rail Transit project, and the Surveillance, Control, and Driver Information (SCANDI) system on Detroit area freeways as well as other transportation systems management projects and arterial corridor studies. Other applications include network analyses that are too large to be simulated using NETSIM simulation.

The TRAFLO-M forms display program was developed to provide an efficient means to interactively create input data files for TRAFLO-M. The program also allows for the creation of data files used for TRAF 1.5 and NETSIM analyses.

Statewide Guardrail Inventory and Inspection Project

This program was discussed in last year's annual report. During 1983, Phase 2 of the project involving guardrail post inspection, data verification, and guardrail run numbering was expanded statewide.

A procedure was developed to update the computerized guardrail data file to ensure future file integrity. Also, a process was developed to enable district or Lansing department personnel to review, add, change, and delete guardrail run computerized records. An historical file of guardrail construction and maintenance activity has been developed as part of the system.

Two output reports were designed to enable data file users to select and sort out pertinent guardrail inventory records, "The General Use Report" and the "Guardrail Section Accident Rating Report." These reports are being used to locate guardrail runs warranting possible removal or upgrading projects. Upgrading of guardrail using these outputs is discussed earlier in this report.

To ensure the integrity of the guardrail post inspection data, procedures and guidelines are being developed for future inspections of guardrail posts. The feasibility of electronic post testing in lieu of manual probing and the frequency of post testing are two issues that will be addressed prior to the next phase of the project.

Speed Limit Traffic Control Order Inventory

A computerized system for storing speed limit traffic control orders was developed and implemented during this past year. The system will allow the Departments of Transportation and State Police to better access speed studies and speed limit information on state trunkline highways. Each traffic control order is referenced by a control section and drawing number. Hard copy output report listings can be generated or the information can be displayed on a computer terminal screen. The data available includes current and previous speed limit traffic control orders, the results of the most recent and previous speed study at each location, and the current speed limits. The system will allow the department to systematically and efficiently review and analyze the appropriateness of speed limits on a regular basis.

Evaluation of Concrete Median Barrier

An evaluation of concrete median barriers (CMB) was completed by the Department of Transportation which assessed accidents and accident severity associated with CMB, steel beam guardrail, and open medians on freeways. Also, the effects of certain roadway characteristics were investigated along with the effect of vehicle weight class on CMB accident severity.

Concrete Median Barrier has replaced steel beam guardrail on many high volume freeways in recent years. CMB is virtually maintenance-free compared to steel beam guardrail. Also, the shape of the CMB was designed to minimize vehicular property damage and safely redirect vehicles which leave the road.

CMB's experienced more reported accidents per mile than median guardrail. However, since all accidents in the study period generally increased, by 1981 the percentage of CMB accidents was about the same as for steel beam median accidents in 1971. Although accidents involving CMB were greater in number than the cross-median crashes through open medians, the particularly severe head-on and sideswipe-opposite direction crashes decreased by 70 percent when CMB was installed in open medians.

Reported CMB accidents have a higher severity ratio than left-side steel beam guardrail accidents. However, the possiblity of a higher rate of unreported property damage accidents adds some uncertainty to this conclusion. Also, CMB accidents have a lower severity ratio than head-on and sideswipe-opposite direction accidents associated with open medians. Secondary, multivehicle accidents did not increase with the installation of CMB.

Average Daily Traffic was the roadway characteristic most strongly associated with injury and fatal CMB accidents. The geometric cross section associated with the least accidents was a 7-foot to 13-foot shoulder without curb and with a negative shoulder slope.

Six and one-half percent of CMB injury and fatal accidents were rollovers. Less than one percent mounted the barrier but did not cross, and slightly more than one percent crossed the barrier. Vehicle size had little effect on the severity ratio of the CMB accidents.

Copies of the full concrete median barrier report are available from the department's Traffic and Safety Division.

Surveillance, Control, and Driver Information (SCANDI)

As reported in previous annual reports, the Michigan Department of Transportation has undertaken a major effort to improve freeway operations in the Detroit metropolitan area. The Surveillance, Control, and Driver Information (SCANDI) system, involves 32.5 miles of freeway within the city.

This past year, ramp metering was initiated on six ramps along a six-mile segment of eastbound I-94. A study of traffic volumes indicated that peak hourly volumes increased from 5,600 to 6,400 in the metered segment. Travel times did not change significantly.

Preliminary accident data is also encouraging. During the six weeks following implementation of ramp metering, three accidents were reported in the study area between 3 p.m. and 7 p.m., Monday through Friday. In the comparable period the previous year, 20 accidents were reported.

The study concludes that this initial ramp metering effort was very cost-effective. As a result, we have initiated expansion of the system to an additional 22 ramps on I-94.

Also completed this past year was expansion of the Closed Circuit Television (CCTV) system to ten cameras and repair of 370 system detector loops.

Traffic Engineering Cost Controls

The Traffic and Safety Division has identified a number of cost savings associated with its operations. Several such economics were reported in last year's annual report. Following are additional measures taken this past year to ensure that our limited funding is allocated in the most cost-effective way.

A. Photolog

As reported previously, a photolog of the state trunkline system is maintained by the department on a two-year filming cycle.

Use of a new higher quality color film was initiated in 1982. It can be used under reduced lighting conditions, permitting longer filming days. Film editing is done in a more timely manner so that retakes, if necessary, can be run while the photolog van is still in the area. The photolog program continues to afford annual estimated cost savings of about $270,000 by reducing the number of field trips by department staff.

B. Signing Economies

Assessment of the relative importance of traffic generator guide signs, in relation to other guide signs, has resulted in reduction of the legend size thereby reducing sign size. Long-term annual savings are estimated at $35,000, assuming sign replacement every ten years.

One-way arrows located on each side of the roadway at freeway entrance ramps are being eliminated and replaced with NO LEFT TURN signs on the right side of each ramp. Motorists are now familiar with freeway operations and elimination of the one-way arrow signs and supports will enhance safety and reduce signing costs.

On free access highways, several small sign support systems are being evaluated in terms of cost-effectiveness, particularly with respect to cost of replacing knockdowns. Supports being evaluated include Telespar, Eze-erect, two-pound steel channel, three-pound steel channel with separate base section, V-Loc socket system, and four-inch by four-inch treated timber. Records are being kept by sign maintenance crews of time, material, and equipment costs as replacements are completed.

In addition, on freeway sign upgrading projects, we are now investigating each installation to determine if alternatives to relocating these signs would be cost-effective.

C. Polyester Pavement Markings

The department awarded five contracts in 1983 for 900 line miles of polyester markings. Polyester pavement markings are considered the most cost-effective markings available. They are generally justified in urban areas where standard paint markings require application twice annually. The average life expectancy of polyester is three to four years. Their use ensures year-round line visibility and results in a 48 percent savings when compared to standard painted markings applied over the same time period.

D. Traffic Signal Improvements

A number of actions have been implemented to economize traffic signal operations and improve service quality.

1. A comprehensive computerized traffic control device inventory and a new computerized status report of statewide signal studies and work authorizations was developed.

2. A new procedure was implemented to expedite routine maintenance of existing traffic signals on the trunkline system.

3. A methodology was developed to analyze signalized intersections to determine where left-turn phasing is justified. This procedure was published in the ITE Journal.

Further accomplishments included signalization and retiming of 65 signals on the trunkline system. These improvements contributed to an estimated savings of 260,000 gallons of fuel per year and improved air quality.