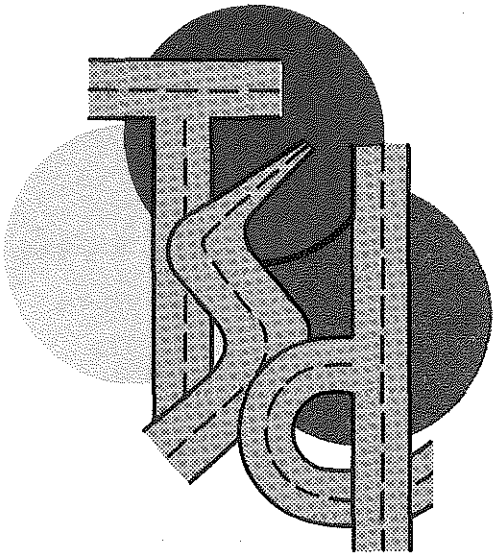
FINAL REPORT

NO PASSING ZONE RESURVEY OF STATE HIGHWAYS

TSD-277-75



TRAFFIC and SAFETY DIVISION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

AND TRANSPORTATION

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OF
STATE HIGHWAYS AND TRANSPORTATION

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By

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Project Conducted by

Michigan Department of State Highways
and Transportation

Bureau of Highways
Traffic and Safety Division
Traffic Research Unit

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

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INDEX

PAGE

INTRODUCTION 1

OBJECTIVES 2

CONCLUSIONS. 2

RECOMMENDATIONS. 3

EQUIPMENT. 4

CRITERIA FOR ESTABLISHING ZONES. 6

FIELD PROCEDURES 8

FIELD LOG. 15

PROJECT FUNDING. 18

SUMMARY SHEET. 19

ANALYSIS 20

VIOLATIONS. 20

ACCIDENT DATA 20

APPENDIX A 23

REVIEW OF DRIVER EYE HEIGHT FOR 1970 MODEL PASSENGER VEHICLES

APPENDIX B 29

FIELD MEASUREMENTS

INTRODUCTION

In 1963, the report "Criteria for Marking No Passing Zones" was issued by the Michigan Department of State Highways which evaluated Michigan's methods for marking no passing zones. The report recommended (1) the use of 48-inch eye height and vehicle target height with a 1000-foot sight distance, and (2) a review of driver eye and vehicle heights in 1967. In accordance with this report, Michigan's two- and three-lane trunkline system was resurveyed in 1966 using crews walking along the edge of the roadways and marking zone changes. Also as recommended, driver eye and vehicle heights were again evaluated in 1967 and determined as outlined in the Department report "Review of Driver Eye Height as Related to Registered Passenger Vehicles - 1967", that no change in the 48-inch criteria was needed, but a review would again be necessary in 1970.

The results of the 1970 review as evaluated in the Department report, "Review of Driver Eye Height for 1970 Model Passenger Vehicles", (Appendix A) showed a downward trend in driver eye and passenger vehicle heights. Significant numbers of cars, both American and foreign, were approaching 45-inch eye and target heights and in the loaded conditions (luggage and three passengers) a large percentage were below 45 inches.

The 1971 revision in the "National Manual on Uniform Traffic Control Devices" lowered driver eye and vehicle heights from 48 inches to 45 inches and used a sliding sight distance according

to the 85 percentile speed, beginning with 1100 feet at 65 mph. Speeds taken on Michigan's rural highways showed an 85 percentile of 63 mph. Using this data and information from actual field measurements (Appendix B), it was determined to resurvey Michigan's two- and three-lane highways establishing no passing zones, using the realistic 42-inch eye and vehicle target heights and a sliding sight distance beginning with 1000 feet at 60-65 mph.

OBJECTIVES

The project objectives were: (1) to resurvey all two- and three-lane state highways establishing no passing zones, using the 42-inch eye and target height with a sliding sight distance beginning with 1000 feet for 60-65 mph zones; (2) develop techniques and equipment to accomplish objective number one using vehicles in place of the walking crews; and (3) provide maximum safety to the motoring public by reducing opportunities for driver errors which could be attributed to an improperly marked no passing zone.

CONCLUSIONS

1. The use of the equipment and techniques developed for this project are adequate to provide a quick, economical and accurate method to survey and mark no passing zones.
2. The state trunkline system was surveyed and no passing zones marked using the 42-inch driver eye and vehicle heights with a 1000-foot sight distance criteria which should be adequate for several years.

3. The sample size of the no passing zone accident data and improper passing violations were too small to show that the establishment of these new or remarked zones improved safety by reducing accidents attributed to no passing zones.
4. The zones established should provide maximum safety to motorists in relation to the criteria used to set zones and existing vehicle design.
5. Several no passing zone surveys have been conducted by other agencies since this project was completed. A reoccurring error has been the overlooking or misinterpretation of checking for the dips in vertical curve zones. The specific method for checking roadway depressions is not mentioned in the National or Michigan Manual on Uniform Traffic Control Devices, and may be a reason for the error.

RECOMMENDATIONS

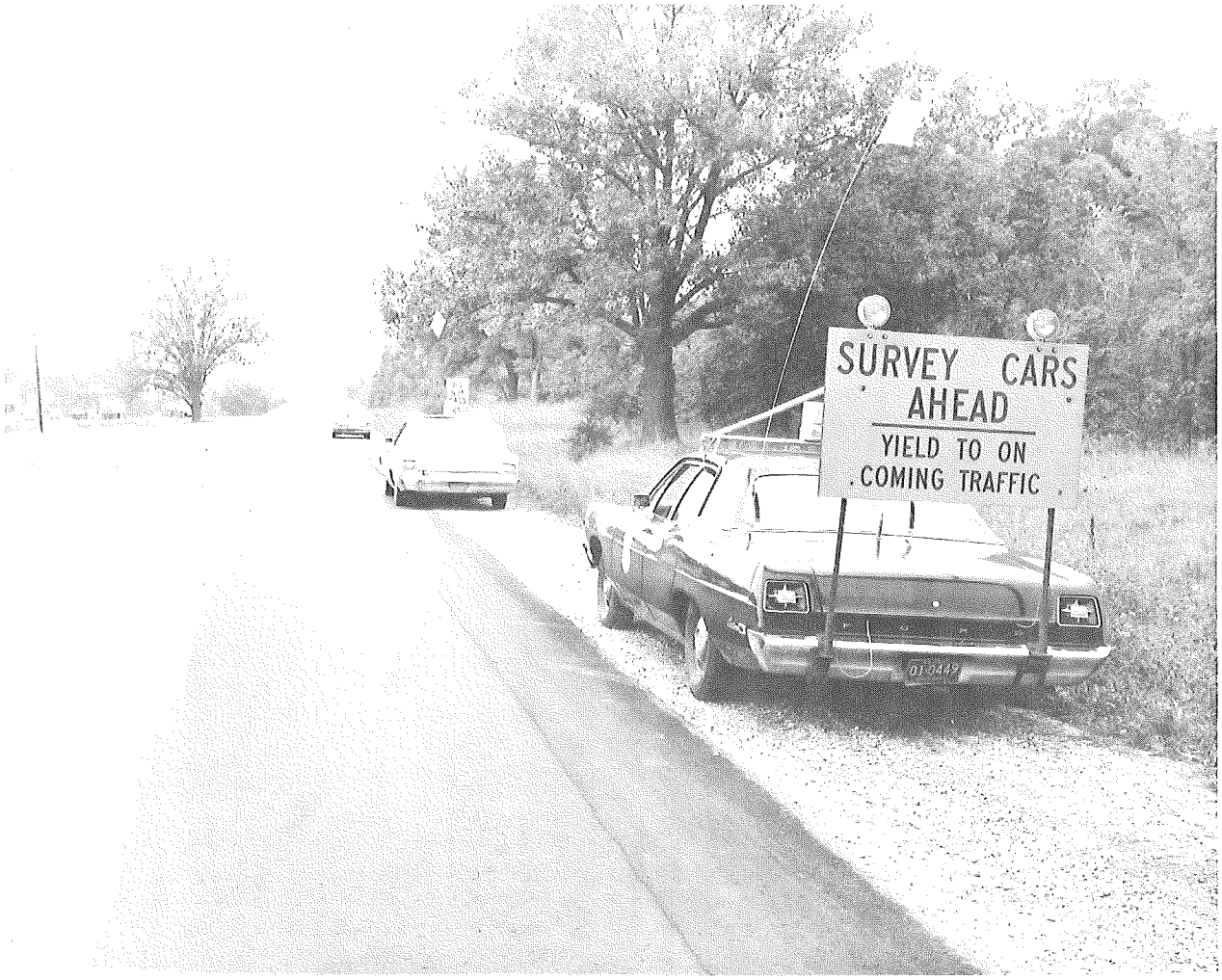
1. The 42-inch eye and vehicle target heights and other criteria outlined under field procedures should be adequate until 1980.
2. The existing no passing zones should not be resurveyed or changed due to the statewide 55 mph speed limit.
3. Passenger vehicle and driver eye heights should be checked again with the introduction of the 1980 model vehicles for conformance to the 42-inch criteria. The increased percentage of small automobiles and possible future design changes may change the 42-inch criteria. Also smaller vehicles and reduced horsepower engines may require a review of sight distance requirements before 1980.

4. Two Lansing based vehicles should be equipped and made available, on call, to assist District Traffic and Safety Engineers in re-marking no passing zones due to detours and reconstruction projects.
5. Provisions for checking vertical curves for dips should be included in the Michigan Manual on Uniform Traffic Control Devices.

EQUIPMENT

A no passing zone survey crew consists of three automobiles, (Photograph #1), one operator per vehicle, each equipped with an amber strobe warning light, two-way radio and a distance measuring instrument (DMI). In addition, the lead and middle vehicles are equipped with automatic paint markers and a 42-inch target and eye height sight. Equipment details are as follows:

1. Two-way radio - 5-watt short range radios (Photograph #2) for communication between survey crew vehicles only.
2. Strobe warning lights - each vehicle is equipped with top-mounted 1,000,000 cp amber flasher. In addition, the trail vehicle is equipped with two rear-mounted 5,000,000 cp amber strobe flasher to alert motorists to the slow-moving survey vehicles.
3. DMI - this electronic unit (Photograph #2) measures, by feet, from 0 mph to speeds in excess of 60 mph. Steel sensors, attached to the vehicles' rear wheel, pulse a proximity switch which feeds the DMI. The DMI has a six-digit readout and is unique in that it has a programmable thumbwheel switch to



Photograph 1 - 3 man - 3 vehicle survey crew positioned to simulate actual zone marking

manually set in digits which represent conversion numbers. This allows the operator to adjust the DMI for changes in temperature, tire pressure, and other conditions which could affect measurement accuracy. Using a vehicle equipped with eight-wheel tabs, the DMI calibration switch is set to 1000 and the vehicle driven a measured 1000 feet, recording the number of target pulses received by the DMI. A number from the conversion chart is programmed into the DMI by the external switches, and the unit is accurately set to measure in feet. The DMI is bi-directional, allowing subtraction of distance when the vehicle is backed up.

4. Automatic paint markers - a stainless steel tank of three-gallon paint capacity under 70 pounds air pressure is push-button activated, by a solenoid, allowing the operator to mark zone beginnings and endings without leaving the vehicle. A latex or oil base paint may be used in the paint markers. However, oil base paint should be used if the marks must remain visible for several months.
5. Vehicle height targets are high intensity miniature 12-volt DC lamps, attached to the vehicle bumpers at a 42-inch height.

CRITERIA FOR ESTABLISHING ZONES

The basic criteria used to set no passing zones are:

1. Sight distance - a sliding sight distance following the

800 feet - 50 mph zone

700 feet - 45 mph zone

600 feet - 40 mph zone

500 feet - 30 mph zone

Photograph 2 - View of 2-way radio and Distance Measuring Instrument (DMI). Pushbutton switches operate paint markers.

2. Target and driver eye height - established at 42 inches.
3. Minimum length of a zone - 500 feet, with beginning of the zone always being extended.
4. Minimum distance between two zones - previously determined to be 400 feet. If less, combine the two zones into one.
5. Minimum sight restriction - a sight restriction of 200 feet is usually necessary before a no passing zone is established.
6. Depression or dip in roadway with a zone - care must be taken that a dip or depression within the zone being established does not cause an additional sight restriction. The zone ending shall always be extended to adjust for this situation.

FIELD PROCEDURES

The detailed field procedures are outlined in the Department report "Procedures Manual for Determination and Establishment of No Passing Zones", T50-TR-105-69 with the addition of the third or trail vehicle.

The three-vehicle crew stops along the roadway, usually at the beginning of a control section and the lead vehicle moves ahead the required sight distance. The lead and middle vehicles then proceed together at a speed of 5 mph to 30 mph depending upon the roadway conditions. The lead vehicle operator calls out footage readings from the DMI and the middle vehicle operator adjusts speed to maintain the proper sight distance.

Photograph 3 - Middle vehicle operator applying two paint marks to designate a zone ending.

As they approach a vertical curve and the lead vehicle's target light begins to disappear, both vehicles stop and adjust to the proper sight distance until the lead vehicle's 42-inch target light is just at the vertical crest when viewed through the middle vehicle's 42-inch eye height sight. At this point, the middle vehicle is at the beginning of the no passing zone for the direction the vehicles are traveling, and a single orange paint mark is applied on the pavement. The lead vehicle is at the zone ending for the opposite direction of travel and applies two yellow paint marks. If a dip is anticipated, the middle vehicle proceeds forward and the lead vehicle backs up, keeping the middle vehicle target light in sight, extending the zone ending and applying two yellow paint marks. (If no dip adjustments are necessary, the paint marks are applied at the original zone ending). Reestablishing their 1000-foot sight distance, the two vehicles again proceed until the lead vehicle's target light is again visible through the middle vehicle's 42-inch eye height sight and the vehicles again stop and adjust to the proper sight distance. The lead vehicle is now at the beginning of the zone for the opposite direction of travel and applies one yellow paint mark. The middle vehicle is at the end of the zone being established in the direction the crews are traveling and places two orange paint marks unless a dip in the roadway is anticipated. The lead vehicle then backs up through the zone, while the middle vehicle moves forward keeping the lead vehicle's 42-inch target light in view, extending the zone ending, and placing two orange paint marks. Again if no dip adjustment is necessary, the original zone ending is used.

Photograph 4 - Front vehicle showing the 42-inch target and the 42-inch driver eye height sight

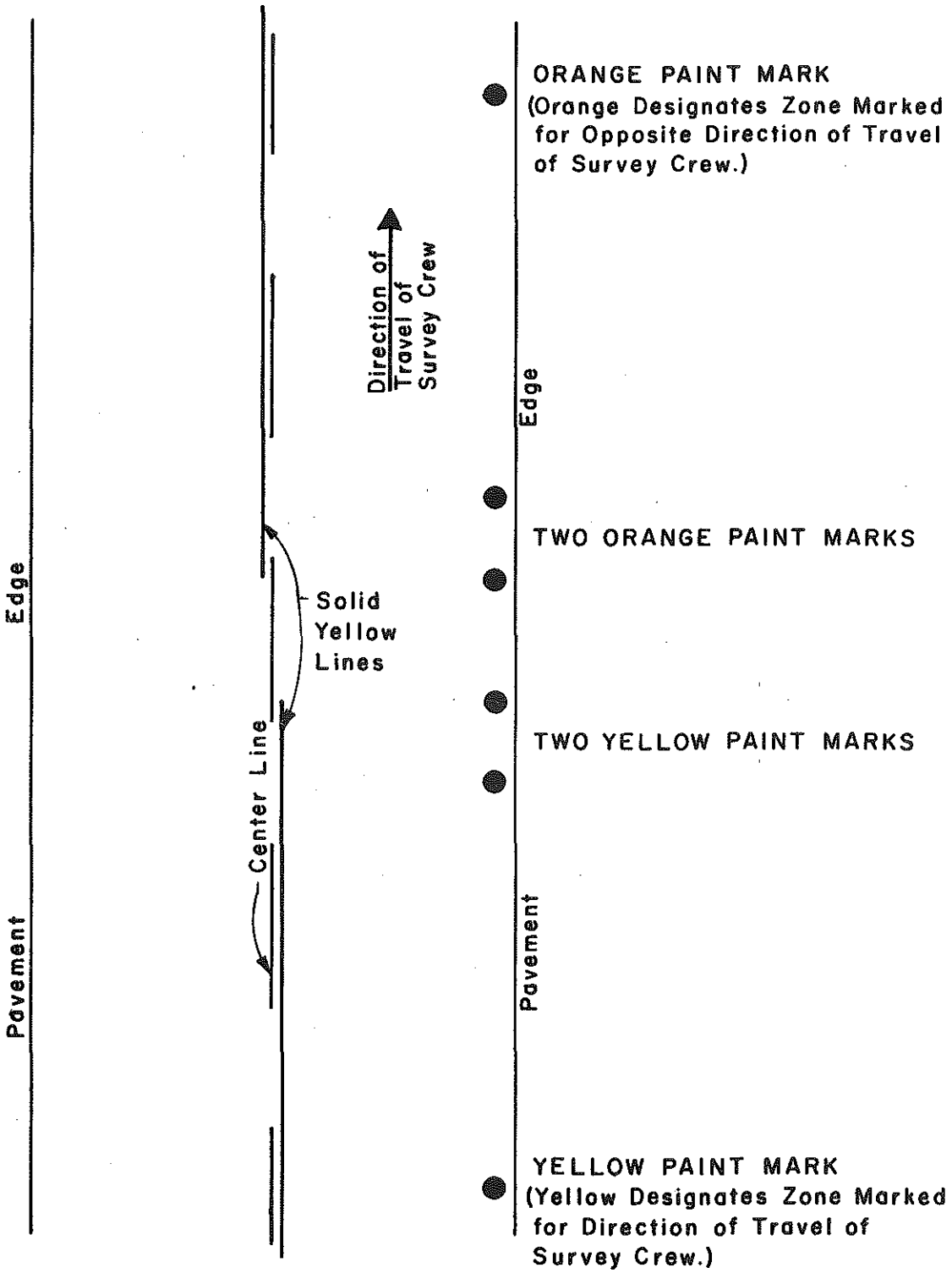
The procedure is the same for horizontal curves except no check for roadway dips is necessary. However, care must be taken that during certain seasons, foliage, farm crops or snow could change the sight restrictions requiring extending zone limits. Also the operators must make adjustments since sight restrictions can differ on a horizontal curve, depending if the zone is marked from the inside or outside of the curve.

The trail vehicle provides a warning to motorists approaching the survey crew. If the two front vehicles are out of sight of approaching motorists, the trail vehicle is positioned at the crest of the vertical hill, where the oncoming motorists can be alerted and safely slow down. The trail vehicle, using a DMI, logs the zone beginning and endings, in feet, from the beginning of the control section. The trail vehicle operator is also responsible for lengthening any zone that is not the required 500-foot minimum length, which is always added to the beginning of the zone. Successive zones are also checked for the 400-foot minimum distance between zones. If less than 400 feet, the operator closes the zone (makes one zone from previous two).

Zone endings are marked as they occur, even if the endings fall at private driveways, intersections or other locations where no passing zone signs cannot be installed. The final decision on the placement of the zone endings is the responsibility of District Traffic and Safety Engineers.

The abbreviated steps as provided field crews follow:

Photograph 5 - Middle vehicle showing the 42-inch target light and the 42-inch driver eye height sight.



MARKING ZONE BEGINNING AND ENDINGS USING ORANGE AND YELLOW PAINTS.

1. Obtain 1000-foot spacing.
2. Both cars advance.
3. Middle man paint just as lead target goes out of sight (note DMI reading - zone beginning).
4. Make dip adjustment - middle man advance.
5. Lead man paint after making adjustment - zone ending opposite direction.
6. Both cars advance at 1000-foot spacing.
7. Stop on target sighting.
8. Lead man paint zone beginning - opposite direction.
9. Make dip adjustment lead man backup.
10. Middle man paint after making adjustment - zone ending.
11. Adjust beginning of zone to 500 feet, if necessary.
12. Third vehicle logs zone beginnings and endings, checks for 400-foot minimum between zones and 500-foot minimum length of yellow line.

NO PASSING ZONE FIELD LOGS

No passing zone limits are recorded on the field log by the operator of the third vehicle. A copy of an actual log is attached showing detailed information listed at the top such as district, trunkline and control section. Zone endings are recorded in feet from the beginning of the control section in the left-hand column. The left zone column lists zone ending first since they represent zones established in the opposite direction of crew travel. The right zone column represents zones established in the direction of travel. The comments column is used to list information of

NO PASSING ZONE FIELD LOG

Form 1536
(New 6/72)

Recorder: J. Munn District: 1 Trunkline: M-95

Date: September 13, 1972 County: Dickinson Control Section # 22012

Beginning Point of Control Section: Intersection M-95 & M-69 Direction of Travel: South

Feet From Beginning of Control Sect.	Left Zone ℄ Marking Type Yellow	Zone # L	Zone # R	Right Zone Marking Type Orange	Comments	Time Set
2303			1	BEGIN		
3335	END	1				
3639			1	END		
4691	BEGIN	1				
7607			2	BEGIN		
8626	END	2				
9258			2	END		
10247	BEGIN	2				
11533					Weeds & Grass should be cut on right side of road	
15397			3	BEGIN	NEW ZONE	
15961			3	END		
16413	END	3			NEW ZONE	
16972	BEGIN	3				
20754			4	BEGIN	NEW ZONE	
21302			4	END		
21772	END	4			NEW ZONE	
22318	BEGIN	4				
24637			5	BEGIN		
25326			5	END		
25650	END	5				
26342	BEGIN	5				
28918			6	BEGIN		

NO PASSING ZONE FIELD LOG

Form 1536
(New 6/72)

Recorder: J. Munn District: 1 Trunkline: M-95

Date: September 13, 1972 County: Dickinson Control Section # 22012

Beginning Point of Control Section: Intersection M-95 & M-69 Direction of Travel: South

Feet From Beginning of Control Sect.	Left Zone ℄ Marking Type Yellow	Zone # L	Zone # R	Right Zone Marking Type Orange	Comments	Time Set
29542			6	END		
29937	END	6				
30562	BEGIN	6				
40968					intersection Groveland Mine R.R. XO1	
START OVER					XO1	
44484				NO ZONES	intersection of M-95 & US-2 & US-141	

special interest such as new zones, areas where foliage restricts sight distance or reference points. Each District Traffic and Safety Engineer receives a copy of the logs for his district for use in determining final zone endings and a permanent record for future use.

PROJECT FUNDING

The project was funded by a 50 percent grant from the Office of Highway Safety Planning at an estimated cost of $223,000 to develop the technique, purchase equipment, and resurvey and establish no passing zones prior to a statewide installation of pennant "No Passing Zone" signs on state highways. The final project cost was $128,867. Using data from the summary sheet, average cost figures are:

(1) $\frac{\$128,867}{6786 \text{ miles}} = \$18.99$ per mile

(2) $\frac{\$128,867}{8842 \text{ zones}} = \$14.57$ per zone

NO PASSING ZONE PROJECT

SUMMARY SHEET

District	Total Trunkline Mileage	2 & 3 Lane Trunkline Mileage	Zones Logged- 1966 Survey	New Zones Logged- 1972 Survey	*Total Zones Logged- 1972 Survey
1	922	870	1000	196	1128
2	788	716	480	96	536
3	1074	1021	1660	348	1768
4	969	822	620	172	858
5	1134	731	650	80	1118
6	1338	962	600	68	642
7	1130	758	890	266	1378
8	978	607	966	92	1184
9	917	299	220	30	230
Total	9250	6786	7086	1348	8842

*1966 zones logged plus new 1972 zones logged do not equal total 1972 zones logged since no passing zone changes were made since the 1966 survey and before the 1972 survey.

A trained crew, working nine hours per day can resurvey and mark 141 zones per week. This is an average, considering travel time, bad weather and equipment malfunctions.

ANALYSIS

The actual field resurvey began in September, 1972, and was completed in June, 1973. The resurveyed zones were permanently marked during 1973 by installation of left side "No Passing Zone" signs and the placement of pavement markings. Therefore, in considering accidents and violations, 1972 becomes the before period and 1974 the after.

A summary of tickets issued by the Michigan State Police for improper passing is as follows:

Year	Curves	% Change	Hills	% Change	Other	Total	% Change
1972	564	-	1431	-	2074	4069	-
1973	538	- 4.6	1367	- 4.4	2029	3934	- 3.3
1974	418	-25.8	916	-35.9	1419	2753	-32.3

The data shows a large drop in violations from 1972 to 1974. However, the information cannot be used to show improvements in no passing zones because (1) tickets issued for improper passing do not necessarily mean improper use of a no passing zone; (it could mean passing on the right), and (2) a reduction in speed limits and the energy crisis influenced vehicle travel during 1974 with a reduction in nonfreeway accidents from 1972 to 1974 of 11.3 percent.

ANALYSIS OF ACCIDENT EXPERIENCE WITHIN NO PASSING ZONES

Marquette and Menominee Counties in District 1 were picked for a preliminary study of No Passing Zone accidents using 1971 and 1972 trunkline accident data. The objectives were to sample the two counties for accuracy of accident reporting and the number of no passing zone accidents occurring.

Two accident printouts for each calendar year, 1971 and 1972, were assembled: (1) a printout of those accidents specified as no passing zone accidents by the reporting police agency, and (2) a printout of all accidents occurring within the no passing zones (1000 feet in advance of beginning and 1000 feet beyond ending).

For 1971, three accidents were indicated as no passing zone accidents. A review of the individual reports showed a pedestrian accident, a fixed object accident and a slippery curve accident, all occurring within a zone, but not considered being caused by improper use of a no passing zone. 349 accidents were reported within the zone limits, with 78 records studied in detail. A review of the 78 reports showed none of the accidents were caused due to drivers violating no passing zone restrictions.

For 1972, one accident was reported as a no passing zone accident. A review of the record showed a fixed object accident within one zone, but not considered a no passing zone accident. 327 accidents were recorded within the zone limits with 60 records studied in detail. Two of the accidents could possibly be considered as being caused by drivers violating no passing zone restrictions.

A second set of counties, Kalkaska and Cass, were picked for an additional study of no passing zone accidents. Accident report printouts were assembled for calendar years 1971 and 1974.

For 1971, one accident was indicated as no passing zone accidents by the reporting police agency. A review of the report showed the accident was not a cause of improper use of the no passing zone. 523 accidents were recorded within the established zone limits. A detailed study of the reports showed no accidents were caused by improper use of a no passing zone. For 1974, two accidents were indicated as no passing zone accidents. A review of the individual reports showed the accidents were not a cause of improper use of the zones. 337 accidents were recorded within the zone limits. Again a detailed study of the reports showed no accidents being caused by the improper use of a no passing zone.

The conclusions from the study of the four counties were (1) details of data on accident reports are limited for studying no passing zone accidents on a statewide basis, and (2) sample size of accidents due to no passing zones is small, and it appears significant data to show changes due to the resurvey is not available.

APPENDIX A

REVIEW OF DRIVER EYE HEIGHT FOR 1970 MODEL PASSENGER VEHICLES

All available 1970 model passenger vehicles were measured using a man with a 30.5" eye level above a firm seat. This was an accepted eye level of an average man according to studies conducted by the Air Force. This man would get in each automobile and adjust the front seat to a comfortable driving position, his eye level would then be measured as well as the overall height of the vehicle. From this data, the attached table was compiled showing driver eye heights of 1970 model passenger vehicles. Similar data from the 1967 driver eye height review was added to this table to use as a comparison and show any trend. Comparing the 1967 data with the 1970 data in this table, the overall height of vehicles has been lowered about one inch. The driver eye height has been lowered about .5 inch or less. Assuming that the recommended eye height in the forthcoming National Manual of Uniform Traffic Control Devices will be 3.75 feet or 45 inches, and reviewing this data on eye height with one person in the vehicle, there are three American made models with an eye height of less than 45 inches, but these models are within one inch of the 45-inch level. The data on foreign vehicles show three models with an eye height less than 45 inches. Two of the models are within two inches of the 45-inch eye height and one model is about six inches under. This is a special model Fiat convertible which is extremely low.

The data for driver eye height loaded is for that model of vehicle with the amount of passengers it is designed for, plus luggage for each passenger. This data shows that, when comparable, the 1970 driver eye height is approximately one-half inch lower than in 1967.

Of the 1970 model vehicles, the loaded eye height is below 45 inches in 13 of the vehicles checked. Of these, the lowest for American-made vehicles is approximately 2 inches below the 45 inch level. In foreign vehicles, five are lower than the 45 inch level. Only two of the vehicles are a significant amount lower. These are a special model of the Porsche, about 4 inches below, and again the Fiat convertible at 6 inches.

Taking the worst possible case of two fully loaded Fiat convertibles approaching each other, and each traveling at 40 MPH on a minimum vertical curve, which would not require a marked zone and allows a sight distance of 1000 feet for an eye height of 45 inches. The table below shows the time lapse, the distance between cars, and the part of the approaching vehicle that is seen.

TIME (SECONDS)/DISTANCE APART		PART OF APPROACHING VEHICLE SEEN
0	1000 ft.	None
.25	971 ft.	Top of Vehicle
.50	942 ft.	Eye Level of Driver
.75	913 ft.	Hood of Vehicle
1.00	883 ft.	Headlights of Vehicle

This table is based on information contained in Table IV of A Review of the Criteria for Marking No-Passing Zones, May 1963.

It is unlikely that this model vehicle amounts to any appreciable percentage of total registered vehicles or they would meet on the same vertical curve in a passing situation very often. If this situation did occur, the driver would have 942 feet of sight distance.

Several new sub-compact models are shortly going to be introduced by American manufacturers. None of these models is available at this time for actual measurement of eye height. The overall heights of these models were obtained from the manufacturer and are listed below:

Ford	Pinto	50.0"
Chevrolet	Vega	51.2"
Dodge	Colt	54.5"
Plymouth	Cricket	54.6"

The American Motors Gremlin was available for measurement. The overall height of this vehicle is 51.8' and the loaded eye height 44.2". It seems reasonable to assume that other sub-compacts will fall in the 43" to 44.5" eye-height range.

Complete information on registered vehicles is unavailable at the present time. By using tables given in Ward's Automotive Reports, it was found that as of July 1, 1969 approximately 78,494,167 vehicles were registered in the United States. Foreign vehicles account for approximately 7.4 percent of the total registration. All Fiat motor vehicles comprise approximately .14 of one percent of total registered vehicles.

DRIVER EYE HEIGHT OF PASSENGER VEHICLES

VEHICLE	MEASURED EYE HEIGHT WITH ONE PERSON IN VEHICLE		OVERALL VEHICLE HEIGHT LOADED		DRIVER EYE HEIGHT LOADED	
	1967	1970	1967	1970	1967	1970
American Motors						
Gremlin	--	46.2	--	51.8	--	44.2
Javelin	--	45.7	--	51.5	--	42.9
Hornett	47.4	46.8	54.6	52.7	45.0	44.7
Ambassador	--	47.4	--	55.2	--	46.4
Buick						
Skylark	46.3	47.0	54.0	54.0	45.2	44.5
LeSabre	48.4	47.6	55.6	55.4	46.2	46.0
Electra	--	48.2	--	55.9	--	46.5
Cadillac						
Calais	48.4	48.4	55.6	54.4	46.2	45.5
Eldorado	--	47.7	--	53.7	--	45.6
Chevrolet						
Camaro	45.6	45.0	51.4	50.5	43.7	43.7
Chevelle	--	47.2	--	53.2	--	45.2
Standard	47.2	46.3	55.4	56.0	46.0	47.2
Chrysler						
Newport	49.3	48.4	56.4	55.9	47.0	46.9
300	--	46.4	--	54.7	--	45.3
Dodge						
Dart	47.6	46.7	53.8	54.0	45.0	44.6
Challenger	--	43.9	--	50.9	--	42.6
Polara or Monaco	--	47.6	--	55.7	--	47.0

DRIVER EYE HEIGHT OF PASSENGER VEHICLES

VEHICLE	MEASURED EYE HEIGHT WITH ONE PERSON IN VEHICLE		OVERALL VEHICLE HEIGHT LOADED		DRIVER EYE HEIGHT LOADED	
	1967	1970	1967	1970	1967	1970
Ford						
Maverick	--	46.2	--	52.3	--	42.8
Falcon	47.9	47.6	54.6	52.2	45.8	44.1
Mustang	45.7	45.7	51.6	51.6	43.9	43.3
Torino	--	48.3	--	53.0	--	45.3
Ford Std.	47.8	48.6	55.7	54.9	46.3	46.1
T-Bird	--	--	51.4	52.8	--	45.2
Mercury						
Montego	--	47.4	--	53.1	--	45.6
Monterey	49.2	47.2	55.2	55.0	45.8	46.4
Marquis	--	47.3	--	54.1	--	47.3
Cougar	45.1	--	51.8	--	44.1	--
Oldsmobile						
98	--	47.0	--	55.8	--	45.8
F-85	47.6	46.1	55.5	53.5	46.7	45.2
Toronado	47.4	46.3	52.8	52.8	45.2	43.9
Delta 88	47.9	--	54.4	--	45.0	--
Chrysler						
Valiant	46.6	47.6	54.0	54.0	45.2	47.4
Barracuda	--	44.0	--	50.8	--	42.6
Belevedere	48.2	--	55.0	54.8	45.6	--
Fury	--	46.9	--	55.1	--	43.8

DRIVER EYE HEIGHT OF PASSENGER VEHICLES

VEHICLE	MEASURED EYE HEIGHT WITH ONE PERSON IN VEHICLE		OVERALL VEHICLE HEIGHT LOADED		DRIVER EYE HEIGHT LOADED	
	1967	1970	1967	1970	1967	1970
Pontiac						
Tempest	46.9	45.1	55.0	52.6	46.2	44.5
Catalina	47.8	45.4	55.3	54.8	45.7	45.3
Foreign						
Toyota	47.8	45.9	55.9	56.9	46.9	46.9
Fiat	--	38.9	55.3	48.0	46.3	38.5
Datsun	--	42.5	56.2	50.5	47.2	42.5
Porsche	--	41.6	52.0	48.4	43.0	40.8
Mercedes-Benz	--	48.2	51.3	56.7	42.3	47.3
Volkswagen						
Karmann-Ghia	--	45.0	52.4	52.4	43.4	44.0
Standard	48.4	48.3	58.1	57.9	49.1	46.8
BMW	--	47.3	55.00	55.00	46.0	46.5

HRS:8-20-70

APPENDIX B

Actual field measurements were taken to establish the differences between using the FHWA criteria for 1100 feet at 65 mph with 45-inch eye and target heights vs. the Michigan criteria using 1000 feet at 60-65 mph with a 42-inch eye and target height.

Increasing sight distance from 1000 feet to 1100 feet while maintaining a constant eye and vehicle height adds approximately seventy feet to the beginning of a zone and thirty feet to the zone ending.

Lowering eye and vehicle target height three inches while maintaining constant sight distance adds approximately fifteen feet to the zone beginning and thirty-five feet to the critical zone ending. The Michigan Criteria adds more to the zone ending and less to the zone beginning. Using this data in conjunction with vehicle measurements and speed data, it was determined to resurvey Michigan's two- and three-lane highways for no passing zones using the realistic 42-inch eye and vehicle target heights with the sliding sight distance beginning with 1000 feet at 60-65 mph.