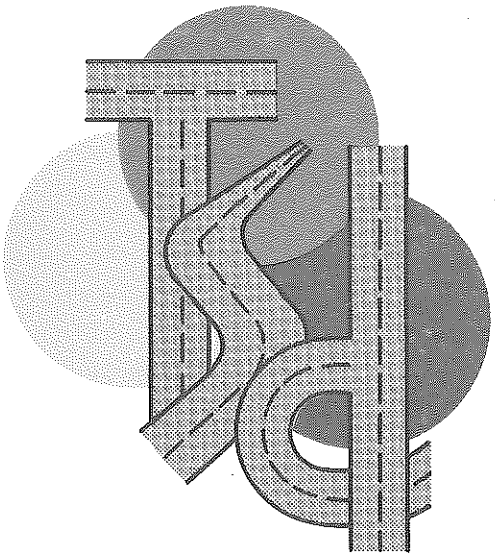
AN EVALUATION OF THE 1965-66, 1966-67 TREE REMOVAL PROGRAMS

Report TSD-SS-149-70



TRAFFIC and SAFETY DIVISION

DEPARTMENT OF STATE HIGHWAYS
STATE OF MICHIGAN

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Report TSD-SS-149-70

by

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ABSTRACT

This report is an evaluation of the "before" and "after" accident experience on scattered sections of trunkline where trees were removed in safety programs during the 1965-66 and 1966-67 fiscal years.

Car-tree accidents were analyzed separately. Car-tree fatalities were reduced from 13 to 4 (69 percent reduction) while personal injuries were reduced from 120 to 85 (29 percent) in a one year "after" period as compared to a one year "before" period. Total car-tree accidents were reduced from 144 to 123 (15 percent). This reduction in the accident severity resulted in a savings of $466,000.

Overall accidents were also evaluated. Overall fatalities decreased from 83 to 50 (40 percent) and injuries decreased from 2,173 to 2,114 (3 percent). Total accidents also decreased from 3,054 to 3,006 (2 percent).

In addition to the above figures, it was noted that the average daily traffic increased 14 percent during the same period.

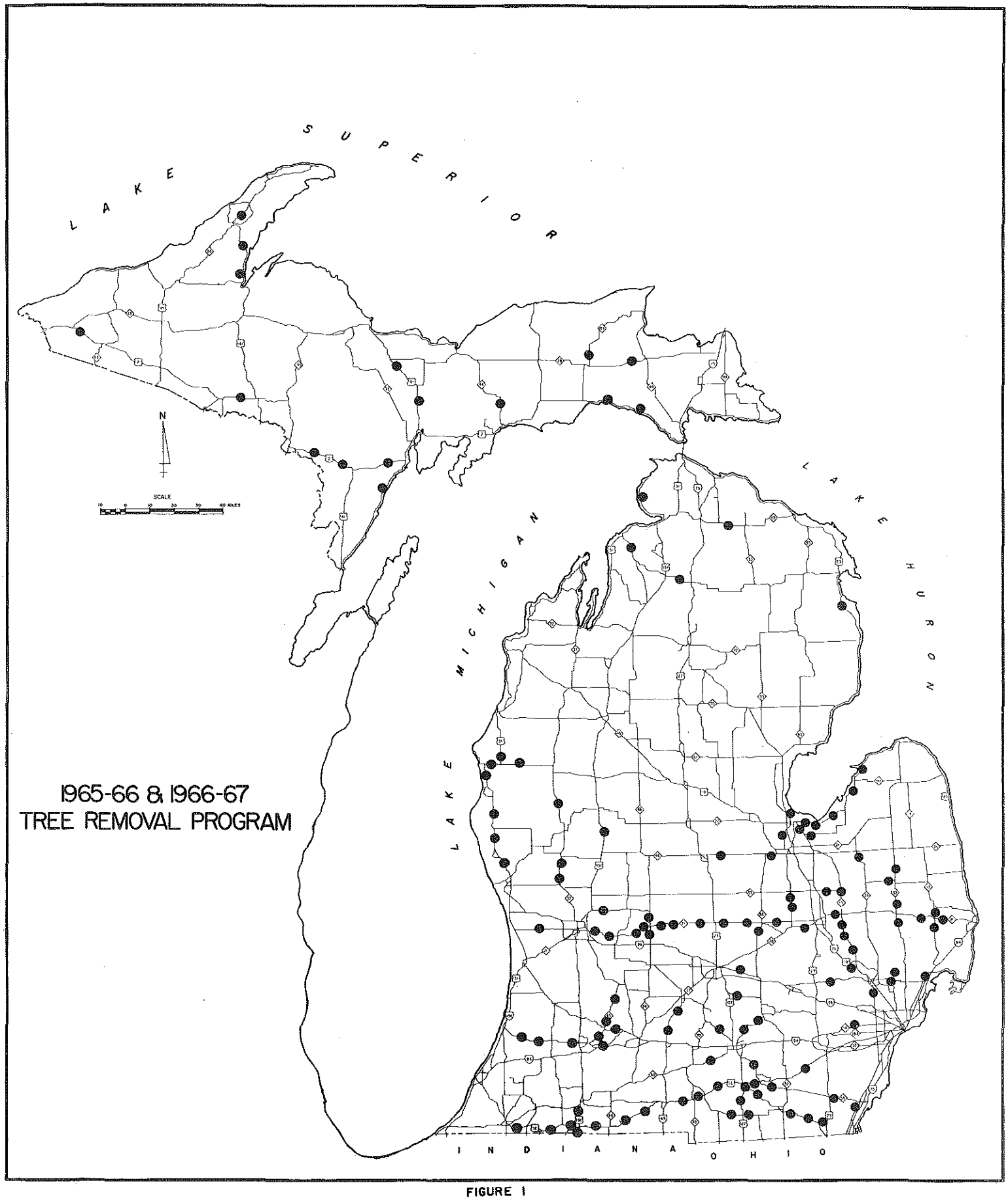
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
N
SCALE
10 0 10 20 30 40 MILES
1965-66 & 1966-67
TREE REMOVAL PROGRAM
INDIANA
OHIO

FIGURE 1

Introduction

Trees, although they add to the beauty of the countryside, are very unmerciful when they are hit by motorists. During 1965, car-tree accidents on state trunklines numbered 729 (10.1 percent of all fixed object accidents) and resulted in 658 injuries and 43 persons killed.

Tree removal along the state trunklines has always been a practice of the Department, but these and previous serious statistics resulted in an accelerated program.

This report is an evaluation of an accelerated tree removal Safety Program for the 1965-66 and 1966-67 fiscal years * which covered 709 miles of state trunkline (see Figure #1).

Accident Experience

The accident information was obtained from the Michigan Department of State Highways' computer printout. The information was gathered for that area starting at 0.1 miles in advance of the first tree removed within a control section and continuing to 0.1 miles past the last tree removed within that control section.

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*Fiscal year 1965-66 runs from July 1, 1965 to June 30, 1966

FIGURE #2

Scene of a fatal accident

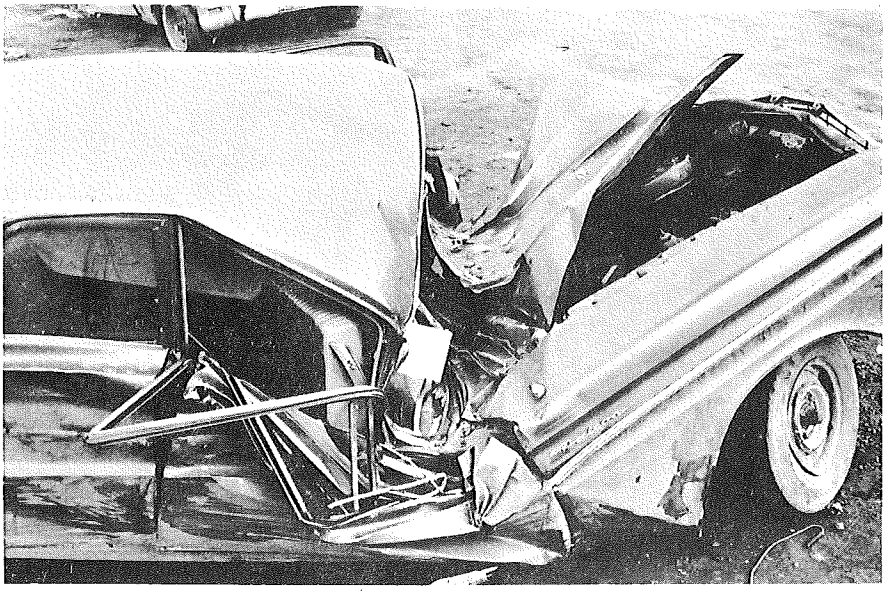

FIGURE #3

The extreme damage to this vehicle resulted from striking the trees in Figure #2.

During the "before" periods prior to the tree removal program, there were 144 accidents involving trees along these 709 miles of trunkline. Nine of these accidents were fatal, in which 13 persons were killed and 4 persons were injured. Another 86 accidents involved injuries to 116 persons. Therefore, including the 4 persons injured in the fatal accidents, there was a total of 120 persons injured during the year "before" period.

A typical example of a car-tree accident is illustrated in Figures #2 and #3. These pictures show trees which were struck and the resultant damage to the vehicle. As is evident, the probability of death or serious injury is high in this type of accident.

Inprovement and Results

The tree removal program during the two fiscal years, 1965-66 and 1966-67 covered 709 miles of trunkline. During 1965-66 there were 9,355 trees removed at a cost of $407,336 and during 1966-67 there were 3,830 trees removed at a cost of $164,055. Combining both years, the total cost of removing 13,815 trees was $571,391.

The study period for each year's program includes one year prior to the start of tree removal (the "before" period) and one year after the project was completed (the "after" period).

The summary of the accident record tables (page 7) show that during the "after" period, car-tree accidents were decreased by 15 percent (144 to 123), injuries were reduced by 29 percent (120 to 85) and fatalities were reduced by 69 percent (13 to 4). These reductions were accomplished in spite of 14 percent increase in average daily traffic. The total number of all accidents decreased by 2 percent (3,054 to 3,006).

SUMMARY

1965-66 and 1966-67 Fiscal Years

CAR-TREE ACCIDENTS - RECORD TABLE

	B E F O R E (Car-Tree Accidents)			A F T E R (Car-Tree Accidents)		
	Inj. Accs.	Fatal Accs.	Total Accs.	Inj. Accs.	Fatal Accs.	Total Accs.
Total (both programs)	86(116)	9(13*,4)	144	65(84)	4(4*,1)	123

ALL
ACCIDENT RECORD TABLE

	B E F O R E			A F T E R		
	Inj. Accs.	Fatal Accs.	Total Accs.	Inj. Accs.	Fatal Accs.	Total Accs.
Total (both programs)	1165(2092)	55(83*,81)	3054	1142(2046)	45(50*,68)	3006

() Number of persons injured

(*) Number of persons killed

CAR-TREE ACCIDENTS - RECORD TABLE

1965-66 Fiscal Year

Contract No.	B E F O R E (Car-Tree Accidents)			A F T E R (Car-Tree Accidents)		
	Inj. Accs.	Fatal Accs.	Total Accs.	Inj. Accs.	Fatal Accs.	Total Accs.
88600						
C1	6(9)	0(0,0)	7	0(0)	0(0,0)	1
C2	9(13)	2(5*,0)	17	10(13)	1(1*,0)	16
C3	7(9)	1(1*,0)	12	6(6)	1(1*,0)	9
C4	3(7)	0(0,0)	4	7(13)	0(0,0)	12
C5	2(3)	0(0,0)	6	2(3)	1(1*,1)	10
C6	1(2)	0(0,0)	1	0(0)	0(0,0)	0
C7	5(5)	0(0,0)	5	6(7)	0(0,0)	6
C8	2(3)	0(0,0)	2	0(0)	0(0,0)	1
C9	10(11)	2(3*,0)	18	14(20)	0(0,0)	27
C10	1(1)	0(0,0)	1	2(2)	0(0,0)	2
C11	2(2)	0(0,0)	4	1(1)	0(0,0)	3
C12	2(2)	0(0,0)	2	1(1)	0(0,0)	1
C13	0(0)	0(0,0)	1	0(0)	0(0,0)	0
C14	3(3)	1(1*,1)	10	6(8)	0(0,0)	16
TOTALS	53(70)	6(10*,1)	90	55(74)	3(3*,1)	104

() Number of persons injured

(*) Number of persons killed

CAR-TREE ACCIDENTS - RECORD TABLE

1966-67 Fiscal Year

Contract No.	B E F O R E (Car-Tree Accidents)			A F T E R (Car-Tree Accidents)		
	Inj. Accs.	Fatal Accs.	Total Accs.	Inj. Accs.	Fatal Accs.	Total Accs.
88600						
C15 & 16	8(12)	0(0,0)	10	2(2)	0(0,0)	5
C17	6(8)	0(0,0)	9	2(2)	1(1*,0)	5
C18 & 19	4(5)	1(1*,1)	6	4(4)	0(0,0)	6
C20 & 21	4(6)	0(0,0)	5	1(1)	0(0,0)	1
C22	11(15)	2(2*0)	14	1(1)	0(0,0)	2
TOTALS	33(46)	3(3*,1)	54	10(10)	1(1*,0)	19

() Number of persons injured

(*) Number of persons killed

ALL
ACCIDENT RECORD TABLE

1965-66 Fiscal Year

Contract No.	B E F O R E			A F T E R		
	Inj. Accs.	Fatal Accs.	Total Accs.	Inj. Accs.	Fatal Accs.	Total Accs.
88600						
C1	10(18)	2(2*,2)	37	20(35)	0(0,0)	61
C2	135(237)	6(9*,6)	337	152(296)	8(9*,23)	390
C3	61(95)	6(9*,7)	143	75(124)	2(3*,0)	163
C4	48(107)	3(5*,2)	131	71(133)	3(3*,5)	200
C5	51(93)	2(2*,3)	119	73(143)	5(5*,11)	197
C6	52(90)	2(3*,9)	132	47(72)	2(2*,4)	112
C7	72(144)	2(2*,0)	158	76(138)	4(4*,1)	162
C8	40(65)	3(3*,4)	87	32(48)	1(1*,3)	76
C9	134(234)	2(3*,0)	368	164(288)	7(8*,4)	489
C10	9(17)	0(0,0)	26	9(11)	1(1*,1)	47
C11	14(28)	0(0,0)	38	9(14)	0(0,0)	25
C12	67(144)	6(7*,11)	166	101(210)	2(2*,2)	199
C13	14(21)	4(4*,3)	68	24(38)	1(3*,3)	76
C14	25(42)	0(0,0)	112	44(80)	2(2*,5)	152
TOTALS	732(1335)	38(49*,47)	1922	897(1630)	38(43*,62)	2349

() Number of persons injured

(*) Number of persons killed

ALL
ACCIDENT RECORD TABLE

1966-67 Fiscal Year

Contract No.	BEFORE			AFTER		
	Inj. Accs.	Fatal Accs.	Total Accs.	Inj. Accs.	Fatal Accs.	Total Accs.
88600						
C15 & 16	53(86)	3(10*,3)	167	40(70)	1(1*,0)	102
C17	76(140)	1(1*,5)	179	41(71)	3(3*,4)	103
C18 & 19	71(124)	5(5*,14)	255	40(60)	0(0,0)	135
C20 & 21	73(120)	0(0,0)	160	39(65)	0(0,0)	97
C22	160(287)	8(18*,12)	371	85(150)	3(3*,2)	220
TOTALS	433(757)	17(34*,34)	1132	245(416)	7(7*,6)	657

() Number of persons injured

(*) Number of persons killed

Conclusions

The 15 percent reduction in the car-tree accidents was found to be statistically significant at the 97.5 percent confidence level (see Appendix B).

The summary of the accident record table shows that the number of persons being injured or killed in the car-tree accidents was reduced substantially. The total number of persons injured was decreased by 35 (120 to 85) and the persons killed decreased by 9 (13 to 4).

The benefit to the motoring public was calculated to be $466,000 (see Appendix C) resulting from the reduction in accident severity during the year "after". This rate is sufficient to repay the project's cost ($571,391) within less than two years after the completion of the projects.

Therefore, the tree removal program is definitely an asset to motorists' safety. However, to insure a still safer roadside further "Yellow Book" projects have to be implemented. The Traffic and Safety Division of the Department of State Highways recently released a report entitled, "SCORE" (Systematic Correction of Roadside Environment, TSD-SS-142-70). This report (a pictorial display of hazards and methods of correcting the hazards) can be used as a guideline in accomplishing such projects. The "Yellow Book" projects presently being implemented in cooperation with the Federal Highway Administration are an excellent method of clearing our roadside environment. However, tree removal is also needed in coordination with these projects to provide the errant motorist with some degree of forgiveness.

APPENDIX A

GUIDE FOR TREE REMOVAL ALONG STATE TRUNKLINE HIGHWAYS IN RURAL AREAS

The purpose of this guide is to establish criteria for the removal of trees within right-of-way limits along existing State trunkline highways. Continued highway fatalities resulting from vehicle collisions with trees necessitate the determination of a Departmental policy governing tree removal in order to improve traffic safety.

Generally, trees having a diameter of six inches or more may be considered capable of producing fatal or serious injury accidents. Studies conducted by Cornell University and the General Motors Proving Ground show that 80 percent of ran-off-roadway accidents involve obstructions located within 33 feet of the pavement edge. Therefore, it would generally be desirable to keep the roadside clear of obstructions for a distance of about 30 feet from the pavement edge. However, it is economically infeasible and impractical in many areas (and aesthetically undesirable on scenic highways) to effect tree removal within those limits and a distance of 20 feet has been chosen as being more realistic. The 20-foot distance is not an inflexible figure and should not be considered as an absolute control distance, as indicated in the following criteria:

First Priority

1. Accident Frequency - If a tree or group of trees has an accident history or the marks of a vehicle collision (non-reported accident), there is adequate reason for removing the tree or group of trees located within 30 feet of the pavement edge.

2. Diseased Trees - In the removal of dead or dying trees, those located within 30 feet of the edge of the traveled way* should be given preference.

3. Outside of horizontal curves - Trees in target position to an approaching vehicle should not be controlled by the 20-foot side clearance. The 20 foot distance may be increased to 30 feet unless a bank exceeding four feet in height with at least a 1 on 3 slope is between the trees and the traveled way.

4. Volume - In the allocation of monies for tree removal current traffic volume should be used as a criteria in the following order:

ADT
3,000 or more
1,500 to 3,000
Less than 1,500

Second Priority

1. Inside of horizontal curves - Removal of trees on the inside of curves should provide for adequate stopping sight distance, and where practicable, for adequate passing sight distance.

2. Intersection - Trees hindering adequate sight distance or particulary vulnerable to vehicle contact should be removed

*Traveled way - that portion designed for vehicular travel excluding shoulders.

to a distance of 25 to 30 feet from the edge of the traveled way.

3. Foreslopes - on foreslopes of 1 on 4 or flatter, trees located within 20 feet of the edge of pavement should be removed.

APPENDIX B

The Significance of Accident Reduction

To test the aggregate accident reduction for statistical "significance" reference is made to the "Null Hypothesis" (H_0)* stating that there is no change in "before" and "after" accident numbers.

Where

	"Before"	"After"
Number of vehicles not involved in accidents	A	B
Number of vehicles involved in accidents	C	D

Assume

$$A/B = C/D \qquad (H_0)$$

Using Chi-square statistics

$$\chi^2 = \frac{(AD - BC)^2 N}{(A + B)(C + D)(A + C)(B + D)}$$

Where $N = A + B + C + D$

From Chi-square "2 x 2" Table

$\chi^2_{.975,1}$ (read Chi-square at the 97.5% confidence level, with 1 degree of freedom) = 5.02

and using

$A = (502,132 \times 365) - 144 = 183,278,036$
$B = (572,667 \times 365) - 125 = 209,023,330$
$C = 144$
$D = 123$

Then

$$\chi^2 = 5.58 > 5.02$$

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*Reference is made to "Statistical Inference" by Helen M. Walker, page 100.

Therefore, the original hypothesis, H_0, (stating that the number of accidents during the "after" period could have been equal to the number of accidents in the "before" period) is rejected within a 97.5 percent level of confidence and the reduction is shown to be statistically significant.

APPENDIX C

Computed Benefits Derived Through Car-Tree Accident Reductions - Cost Analysis

The method of evaluating accident costs, used below is given on page 67 of Roy Jorgensen's report of Highway Safety Improvement Criteria, 1966 edition. The same method is given in the Federal Highway Administration PP 21-16 (March 7, 1969).

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

	Y E A R			
	1966	1967	1968	Avg.
Death	36,000	37,000	38,700	37,233
Non-fatal injury	2,000	2,200	2,300	2,167
Property Damage Accident	340	360	360	353

$$B = \frac{ADT_a}{ADT_b} \times (37{,}233 \times R_1^* + 2{,}167 \times R_2^* + 353\ R_3^*)$$

Where

B = annual benefit in dollars

ADT_a = average traffic volume after the improvement

ADT_b = average traffic volume before the improvement

$$\frac{ADT_a}{ADT_b} = \frac{572{,}667}{502{,}132} = 1.14$$

R_1 = reduction in fatalities (13 - 4 = 9)

R_2 = reduction in injuries (120 - 85 = 35)

R_3 = reduction in property damage accidents (49 - 54 = -5)

The computed benefits to the motoring public accrued during the year "after" period is then:

$$B = 1.14 \times (37{,}233 \times 9 + 2{,}167 \times 35 - 353 \times 5) = 466{,}000$$

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*In the aboved noted reference, R_1 is listed as $A_f \times P_f$. It is evident upon inspection that $P_f = \frac{R_1}{A_f}$ (see definition above) so that $A_f \times P_f = A_f \times \frac{R_1}{A_f} = R_1$. Similarly R_2 replaces $A_{fi} \times P_{fi}$ and R_3 replaces $A_{pd} \times P_{pd}$.