GUIDE TO MANAGEMENT OF ROADSIDE TREES

U.S. Department of Transportation

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Research, Development, and Technology

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FOREWORD

This guide provides a step-by-step approach to identify and treat higher risk roadside vegetation. The approach involves the resolution of complex legal, safety, and environmental issues associated with the removal of hazardous trees from the roadside. The guide is of interest to local jurisdiction road authorities and State highway safety and maintenance engineers.

The basis for this guide was a manual developed by the Michigan Department of Transportation titled "Guidelines for Removing Hazardous trees from Highway Rights-of-Ways: A Management Manual."[1] That manual was field tested by the Ingham County (Michigan) Road Commission, and refined by the Michigan DOT to produce this guide.

This guide was summarized and distribution of the summary made to the State highway agencies and local jurisdictions through the regular Federal Highway Administration channels and the various T^2 Centers. Copies of the guide are available from the National Technical Information Service, Springfield, Virginia 22161.

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16. Abstract

This guide to management of roadside trees was prepared for local and State authorities responsible for maintaining roads. This revised guide is a result of field testing during 1984-85 as part of an evaluative study to determine the ease or difficulty in using this step-by-step approach.

Following years of research by the Michigan Department of Transportation (MDOT), this guide addresses safety versus environmental issues. Survey forms, text format, and descriptive sections have been revised to attain a more practical document. A method to identify and treat both existing and potential locations having a higher risk of vehicle/tree accidents is included, along with a methodology to be more responsive to conditions and accident frequencies specific to local and State jurisdictions.

Information is included to identify and evaluate higher risk roadside environments, and to provide guidance for implementing roadside tree removal and for addressing environmental issues, alternative treatments, mitigation, and maintenance practices.

Special recognition is made to Mr. William Burchfield, Engineer Superintendent, and Mr. Harold Judd, Superintendent of Traffic and Safety for the Ingham County Road Commission for their participation in the field testing work.

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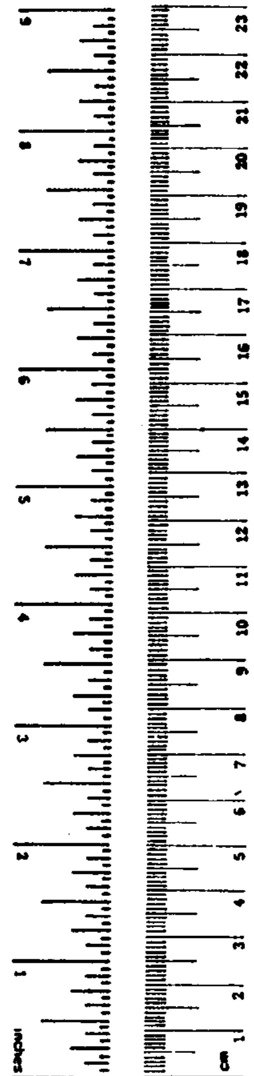
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

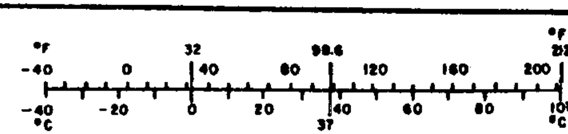
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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CHAPTER 1 USING THIS GUIDE

PURPOSE

This **Guide To Management of Roadside Trees** is an operating manual for local road authorities and their staffs. It is also hoped that State highway safety decision-makers will find it useful in determining and implementing highway safety policies.

A method to identify and treat roadsides having a higher risk of vehicle/tree accidents is presented in chapter 3. If you want to be more responsive to the local conditions, a methodology to more accurately identify and treat higher risk roadsides is also presented.

Any road authority may use this guide to accomplish a number of goals:

- To identify and evaluate higher risk roadsides.
- To identify alternative treatments.
- To identify environmental considerations regarding roadside treatment.
- To provide guidelines for roadside tree removal and maintenance practices.
- To provide documentation necessary to substantiate tree removal and/or alternative treatments.

ORGANIZATION

The guide is divided into five chapters, and four appendixes. After defining the problem of roadside tree risk and critical roadway and off-roadway factors (chapter 2), a method to evaluate higher risk roadside three environments is presented (chapter 3).

Combinations of critical factors cluster around four basic road conditions—rural local curved, rural local straight, rural U.S./State curved, rural U.S./State straight—and are used to describe typical vehicle/tree accident producing situations (chapter 2). Chapter 3 includes a method for evaluating higher risk roadsides—a step-by-step procedure during which higher risk roadsides are identified and field verified; and treatments for reducing the risk of vehicle/tree accidents are identified and evaluated. Alternative treatments, environmental and maintenance considerations are described in chapter 4. Starting from the idea that every interaction with the public is really public relations, chapter 5 looks at ways to involve the community in the treatment program, and perhaps alleviate the doubts and objections of concerned citizens and other interest groups.

Supporting material presented in the appendixes includes: field verification form, appendix A; priority treatment based on both expected and existing accident occurrence, appendix B; a method to be more responsive to actual road conditions and tree accident frequencies within any jurisdiction, appendix C; and sample letters to notify and/or request permission from property owners concerning removal of trees are included in appendix D. References and a bibliography are included at the end of the document.

CHAPTER 2 ROADSIDE TREE RISKS

DEFINING THE PROBLEM

Trees are valued as a resource along our highways, primary and secondary roads, and city streets. However, they have come under scrutiny as posing a higher risk in recent years. In Michigan, for example, although vehicle/tree accidents comprise only 2.8 percent of all vehicle accidents, trees are involved in 9 percent of all accident fatalities.(2) Over half of the 11,351 vehicle/tree accidents in 1980 resulted in death or personal injury. One or more occupants in each of 187 vehicles died; one or more occupants in 5,538 vehicles was injured. A review of Michigan traffic fatalities from 1972 to 1983, revealed that tree-related fatalities make up a larger percentage of overall traffic fatalities now than 10 years ago.

Abundant research has been devoted to identifying, ranking and tabulating the risk potential of many characteristics of vehicle/tree accidents (see bibliography). These characteristics fall into three categories:

- Driver characteristics.
- The road design, geometrics.
- Trees and the roadside environment.

Further discussion of each of these characteristics follows.

DRIVER CHARACTERISTICS(3)(4)

Traffic related research has drawn a profile of the driver most typically involved in run-off-road accidents: The driver is a young male (20 to 25 years old), a weekend driver, out during the early morning hours (2:00 to 4:00 a.m.), driving faster than the posted speed limit. The driver may also be intoxicated and/or unfamiliar with the road.

AGE AND SEX

Over 60 percent of the fatalities in run-off-road accidents are under 35 years old. Drivers under 20 years of age have an accident involvement six times higher than the average for all drivers. The risk of having a single vehicle accident decreases with age.

Accidents involving males outnumber those involving females by a ratio of more than 2 to 1.

INFLUENCE OF ALCOHOL

Drinking is a common ingredient in vehicle/tree accidents. More than 60 percent of the drivers killed in vehicle/tree crashes had been drinking; less than 30 percent of the drivers involved in property-damage-only accidents were reported to have been drinking.

RESIDENCE OF THE DRIVER

Unfamiliarity with the road may be a significant factor in tree-related crashes. Out-of-county residents are overrepresented in accident statistics within Michigan.

TIME OF DAY, WEEK, YEAR

More than two-thirds of tree related collisions occur on weekends, especially Friday and Saturday nights, usually between the hours of 2:00 and 4:00 a.m. Crashes are most frequent during the winter months, suggesting some correlation with longer periods of darkness and, perhaps, with snow covered or icy roads.

DRIVING SPEED

No method exists to determine the precise speed of a car upon impact with a tree. The probability of accident involvement, however, increases by a factor of 10 with a deviation of 15 m/h (24 km/h) above or below the designated speed limit.

Many of the factors that correlate with speeding, such as nighttime hours and young drivers, are also typical of run-off road accidents. In accident records, however, police officers have reported "speeding" more than any other violation as the reason for a vehicle/tree crash.

DRIVER'S INTENT

Drivers involved in tree-related, run-off-road accidents most commonly attribute losing control of their vehicles to attempts to avoid pedestrians, other cars, objects, or animals. "Hazardous action," usually a violation of some traffic law, though not an intentional action, is another common explanation for driving behavior. Mechanical failure is the third most cited factor by vehicle/tree accident victims.

THE ROAD ENVIRONMENT[3,4]

Vehicle/tree accidents typically occur along winding rural roads with the vehicle leaving the pavement on the outside of a curve.([4]) The road type and various physical features of the road (lane and shoulder width, traffic volume and direction, presence of curves, etc.), as well as the driver characteristics described above, determine the probability of running off the road.

Road Type—Research supporting this guide divided roads into the four types listed below.

- Interstates—limited access highways with four to eight lanes.
- Rural U.S. and State Roads (Trunklines)—Free or partially controlled access highways with two to four lanes.
- Rural Local Roads (County)—rural, local, or township; partial to full access; paved or nonpaved; two-lane; locally maintained roads.
- Urban—any roadways within city limits or are urban in character.

This guide addresses two types, rural U.S./State and rural local roads. Rural U.S./State roads are identified as rural arterial and major collector roads. These roads include all U.S. and State designated routes. Rural local roads include the remaining roads, generally maintained by local road authorities (County, township, etc.). Because of lower traffic volumes, these roads also include gravel surfaces, and are maintained to lesser standards than higher volume arterial, and some collector, roads.

Accidents involving trees are mainly rural phenomena, occurring most frequently on rural local roads. Of the fatal accidents, 81.6 percent occurred on rural roads; 70.8 percent of the injury-producing and 65.8 percent of the property-damage-only vehicle/tree accidents occurred in unincorporated areas.([3])

Compared to the abundance of trees found in close proximity of the main traveled way along rural local roads, few trees are found along Interstates and rural U.S./State highways. Consequently, these roads have a relatively low tree-involved accident frequency. With curved road sections, however, the potential vehicle/tree accident risk increases on all roads. This risk is further compounded by darkness.

Urban tree accidents are a small but significant part of the total of tree accidents in Michigan. About 10 percent of the fatal tree accidents occur in urban areas. Little data, however, have been accumulated on the potential tree risk on urban roadways. The lack of available data is compounded by a loose definition of "urban" roads—any roadways that pass through city limits. Obviously, some portions of interstates and rural U.S./State roads, as well as roads that also traverse rural areas, pass through city limits. Although the techniques and strategies for determining the risk of vehicle/tree accidents and alternatives to tree removal developed in this guide are not specifically based on data or urban roads, the discussions herein may be applicable to urban roadways where they closely resemble their rural counterparts.

Lane Width and Markings—Roadway widths of 20 to 24 feet (6.1 to 7.3 m) are typical for two lane roads (10 to 12 feet (3.1 to 3.7 m) lane width).

With lane widths of less than 10 feet (3.1 m) the number of tree crashes is expected to increase, although some drivers may compensate for narrow lanes by reducing their speeds.

In general, lane markings and delineation reduce the number and severity of accidents across all road types. Better lane delineation is recommended for all higher risk locations where night and/or weather conditions may obscure pavement markings.

Medians—At this time, no data is available on the effect of medians on tree-related accidents.

Shoulder Width and Material—For road segments on which a tree-related accident occurred, the mean width of the shoulder was 5.5 feet (1.68 m). Although some studies report the property-damage accident rate has been found to decrease steadily with an increase in shoulder width from 3 to 10 feet (0.9 to 3.1 m), and the fatal and injury accident rate have a downward trend with an increase of shoulder width from 3 to 8 feet (0.9 to 2.4 m).([3]) MDOT review of the data indicates that width considered alone had no bearing on accident rates of two-lane straight roads.([3]) Rather, composition of the shoulder may be of more importance. Injury accident rates increase with paved shoulder widths—perhaps paving of wide shoulders induces motorists to use them as an additional acceleration and passing lane. Accidents are reduced, however, as gravel shoulder width is increased.

It was found that medium-width shoulders had lower accident rates than narrow shoulders under all conditions of horizontal and vertical alignment. Shoulder width may only be unimportant if the zone immediately beyond the shoulder is free of roadside hazards. Overall, however, alignment had more effect on accident experience than shoulder width or material.

Grade—Grade, which is the rate of ascent or descent in elevation, affects accident rates. That is, the grade may increase or reduce the speed of the vehicle before a solid object is struck. Road sections with gradients of more than three percent constitute zones with a higher than average accumulation of accidents.

Curves—Seventy-seven percent of tree-related accidents on curves occur at the "outside" of curves; that is, to the right of a left curve or the left of a right curve (see figure 1). Inside curves account for 23 percent of the crash frequency. Most vehicle/tree crashes involve right departures at left curves.

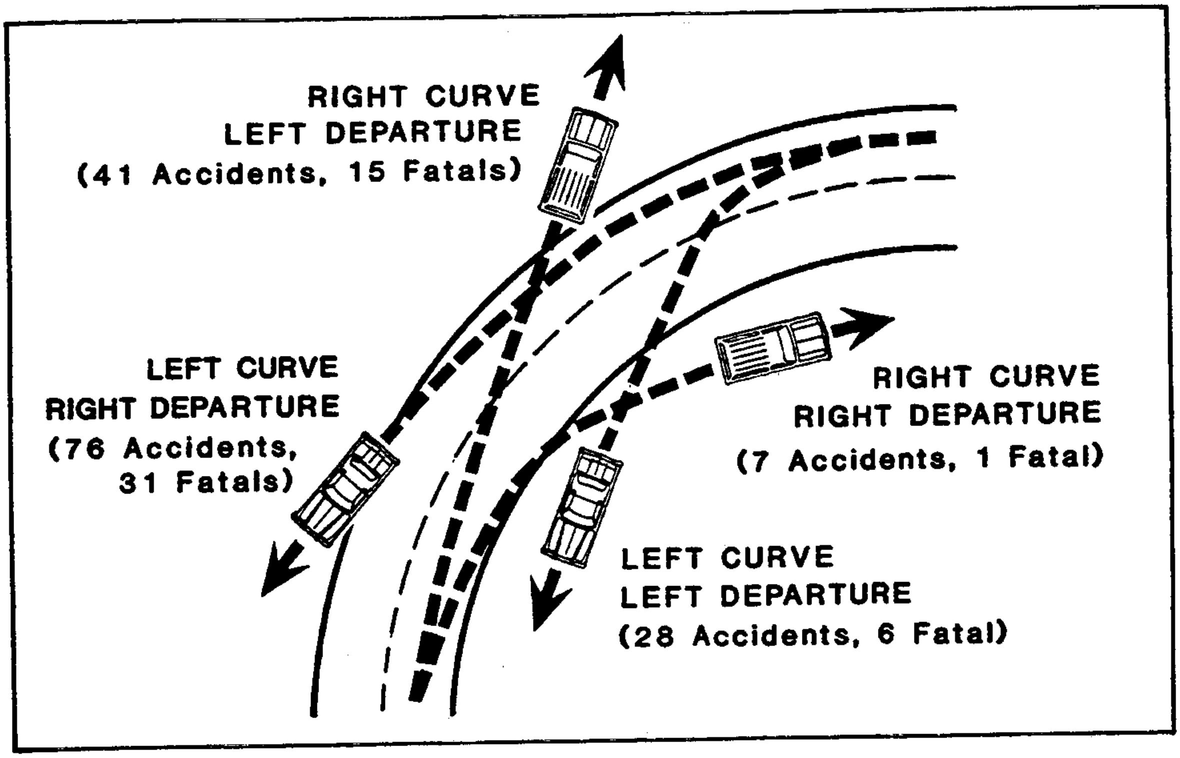


Figure 1. Curve direction and accident frequency.[4]

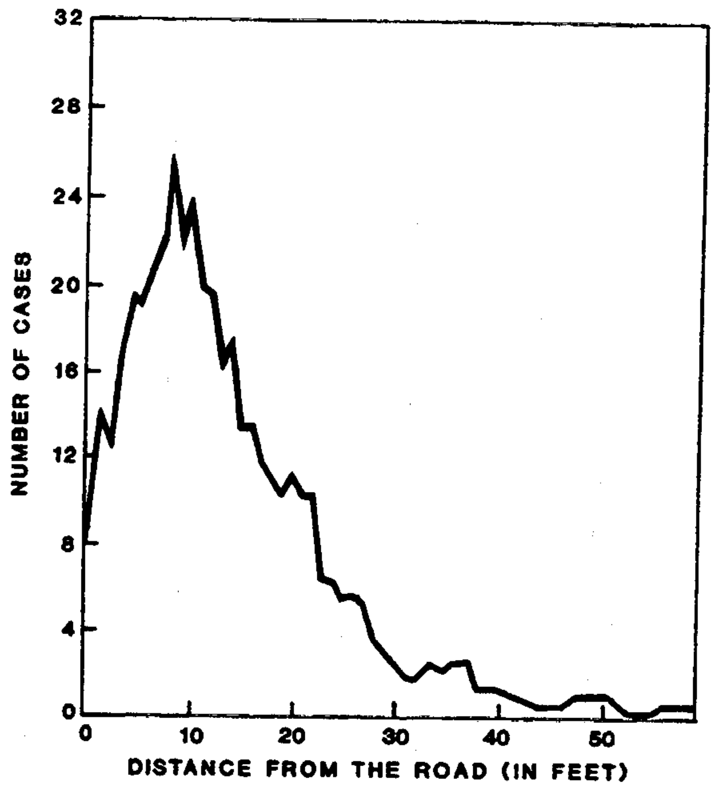
Traffic Volume—Under volumes of 4,000 vehicles per day, the frequency of tree-related accidents correlates positively with traffic volume. At average daily traffic (ADT) volumes above 4,000, the rate of incidents actually decreases—perhaps due to increased driver attentiveness, or physical conditions that limit driving speeds such as traffic congestion.

TREES AND THE ROADSIDE ENVIRONMENT[5]

The typical vehicle/tree accident involves a larger tree within 30 feet (9.15 m) of the road edge, located in a drainage ditch or at the bottom of a downward grade. The target tree and its immediate surroundings (size, density, distance from the road, the presence of other obstructions, etc.) determine the probability of the vehicle striking the tree.

Tree Size—Fatal tree accidents are more closely associated with larger trees than are nonfatal accidents. For fatal tree accidents the median tree diameter at breast height (DBH) is 20 inches (50.8 cm); in nonfatal tree accidents, the median tree diameter is 15 inches (38.1 cm). Of 154 crashes that occurred in Michigan in 1976, eight involved trees under 6 inches (15.2 cm) in diameter—thus, hitting a small tree does not insure safety in a run-off-road collision.

Distance of Trees From Road—Although trees involved in accidents have been as far from the pavement edge as 90 feet (27.45 m), 85 percent of the trees involved in vehicle/tree crashes were within 30 feet (9.15 m) of the road edge (see figure 2).



Metric Conversion: 1 ft. = 0.31 m

Figure 2. Distance of struck trees from road.[4]

Tree Density—Accident frequency and severity diminish with increasing distances between trees. Perhaps the presence of gaps between trees allows drivers of run-off-road vehicles to avoid collision.

Other Environmental Factors—A number of other factors may reduce or increase the probability of striking a tree as well as affect the severity of the crash. For instance, the presence of guardrails may change the character of the accident; roadside edge slope design may reduce the speed of a vehicle before it strikes a solid object; a drainage ditch may guide the vehicle directly into a tree.

ACCIDENT PROFILES

In trying to explain run-off-road accidents, no single feature of the road environment accounts for all the accidents that occur, and cannot be used to determine the level of risk present. For example, the distance of the tree from the road is not sufficient by itself to determine the probability of a vehicle/tree accident. Accidents involving trees have occurred at a wide range of distances from the pavement's edge. Employing such one-dimensional models limits our ability to understand and, consequently, to prevent, vehicle/tree accidents.

In developing this guide, identifying and ranking nonhuman factors that contribute to the risk of vehicle/tree accidents is an essential task. Two realms of the roadside environment must be considered: the actual roadway and the off-roadway environment. Studies indicate(1)(4) that the various roadway and off roadway characteristics of vehicle/tree accidents cluster together into particular patterns associated with road type and alignment. These accident profiles identify potentially higher risk sites so they can be treated. Sites can also be ranked for treatment. The accident profiles are presented in this section.

The accident profiles relate to the road types identified earlier in this chapter. They are Interstates, rural U.S./States roads, and rural local roads; and the horizontal alignment (curved or straight roads) of these roads. This analysis yields six road types: Interstate curved, Interstate straight, rural U.S./State curved, rural U.S./State straight, rural local curved, and rural local straight.

Although more vehicle/tree accidents occur along straight roads, curved rural local roads are typically higher risk, followed by curved rural U.S./State roads, then straight rural local roads and straight rural U.S./State roads. Fatalities arising out of impacting trees are very rare occurrences along Interstate highways. In 1976, for example, rural local roads accounted for over three-quarters of all fatal vehicle/tree accidents in Michigan (5) (table 1). Interstate highways, on the other hand, were very rarely the scene of such accidents; only three fatalities involving trees occurred along Michigan Interstates in 1976 (less than 3 percent of all tree related fatalities).

Given the heavy traffic carried by these Interstates (table 2), the risk of a fatal vehicle/tree accident along an Interstate highway is almost negligible. Thus, the accident profiles presented below are for rural local roads and rural U.S./State roads only. It is on these road types that a program for management of roadside trees should be focused. Because of the difficulty of defining "city streets" and a lack of data on vehicle/tree accidents occurring along this road type, city streets have been excluded from this guide. Exceptions include rural U.S./State and rural local roads that pass through city limits, but more closely resemble rural conditions (i.e., no curbs). Here, accident profiles and this guide may be applicable. In the accident profile descriptions below, critical roadway and off-roadway factors are identified, then clustered together into scenarios of typical accident conditions.

Accident profiles are presented here as a guide to describe conditions that have been typically present at higher risk accident locations, and so that these locations may be more easily recognized for treatment.

By necessity, accident profiles are generalizations. Critical factors may not all be present at every accident site or road location. It is likely that other site-specific factors also play a role.

TABLE 1. Number of fatal tree accidents on each type of road segment in Michigan for 1976.[1]

	Interstate Curve	Interstate Straight	Rural U.S./State Curved	Rural U.S./State Straight	Rural Local Curved	Rural Local Straight	Total
Number of Accidents	0	3	10	17	40	56	126
Percent of Total	0	2.3	7.9	13.5	31.7	44.4	100.0

TABLE 2. Average volumes and miles traveled per fatal tree accident on each type of road segment in Michigan for 1976.[1]

	Interstate Curved	Interstate Straight	Rural U.S./State Curved	Rural U.S./State Straight	Rural Local Curved	Rural Local Straight	Total
Total Vehicle Miles Traveled (Billions)	0.136	13.446	0.188	18.390	0.200	19.800	52.160
Percent of Total (above)	0.261	25.778	0.360	35.257	5.0900	37.960	100.000
Miles Traveled per Death (Millions)	Infinite	4,482.000	18.800	1,082.000	5.000	353.600	--

Metric Conversion: 1 mile = 1.6 kilometers

[1]Asplundh Environmental Services and The University of Michigan Highway Safety Research Institute. 1979. Roadside Obstacle/Tree Removal Management Program and Preparation of Environmental Assessment. Phase II Report. For the Michigan Department of Transportation. 199 pp.

CURVED RURAL LOCAL ROAD SECTIONS

Curved rural local roads (figure 3) constitute a substantially higher risk driving environment than do straight rural local roads. Most curved rural local road accident sites are found on left-hand turns with downhill gradients, following a series of curves. Likelihood of an accident increases with tree density near the outside of the curve.[4] The impacted tree is often 20 feet (6.1 m) or more from the road edge.

Figure 3. Curved rural local road section. (Actual site of fatal vehicle/tree accident in 1976.)

Critical Factors At Accident Site

- Roadway curves left.
- Approach roadway for ¼ mile (0.4 cm) contains multiple curves.
- Roadside is on a downgrade.
- Trees involved are one of a row or part of adjacent woodland.
- Inadequate warning signs for conditions.

Accident Profiles

- Superelevated cross-sections with **downhill segments,** downslopes and unstable shoulders.
- Left turns and narrow lanes, **particularly on downhill segments.**
- Clusterings of trees at the curves; with clusters up to 20 feet (6.1 m) or more from the road's travel lane.

CURVED RURAL U.S./STATE ROADS

In every case studied, accidents along curved rural U.S./State roads occurred on left-hand curves (figure 4). Most often, the fatal tree was one of a grove of trees and was rarely the first tree struck. Typically, the vehicle ran down an embankment into a grove of trees. Almost half of the accidents studied occurred at the location of at least one previous serious vehicle/tree accident.

Treatment of curved rural U.S./State roads is more difficult than treatment of curved rural local roads. The trees tend to be even farther from the road's edge.

Figure 4. Curved rural U.S./state road section. (Actual site of fatal vehicle/tree accident in 1976.)

Critical Factors At Accident Site

As was the case with curved rural local road accidents, vehicles often miss a left turn and continue down a side slope into a tree. Slope of the road is a less critical factor on rural U.S./State roads than on rural local roads, however.

- Roadway curves left.
- Roadway cross-section superelevated.
- Roadside embankment downgrade.
- Trees involved are clustered or grouped together.
- Trees are located 20 feet (6.1 m) or more from edge of pavement.
- Site of previous accident.

Accident Profiles

- Vehicle runs down embankment, strikes tree, careens into another tree resulting in an accident.
- Vehicle misses left turn and strikes tree 20 feet (6.1 m) or more from road's edge.

STRAIGHT RURAL LOCAL ROAD SECTIONS

Straight sections of rural local roads have quite different accident profiles than curved sections (figure 5). The distances of trees from the road's edge tend to be appreciably less along straight rural local roads. Typically, the vehicle enters a ditch from a narrow and often unstable (soft) shoulder and is then channelled into several trees.

Considering the total number of fatalities that occur along Michigan roads, for example, straight rural local road sections are the leading category.

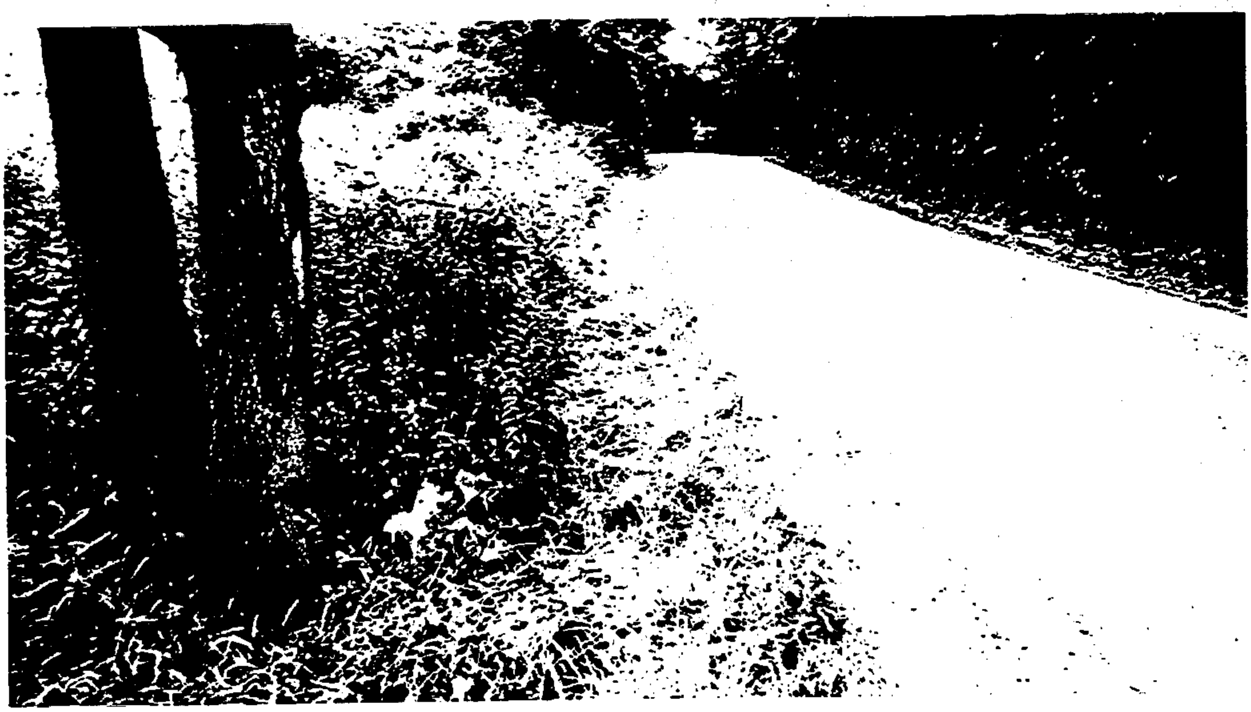


Figure 5. Straight rural local road section. (Actual site of fatal vehicle/tree accident in 1976.)

Critical Factors

- Approaching roadway gradient is downhill.
- Roadside includes ditch.
- Trees are located closer to the road, often less than 15 feet (4.58 m).
- A row of trees or woodlot exists adjacent to the road.
- Site of previous accidents.
- Unstable or soft shoulder exists.

Accident Profiles

- Crowned cross-section, narrow shoulder, and a ditch. These factors appear to steer the vehicle into the ditch and into a tree.
- Narrow shoulders, trees close together, and trees within 10 to 14 feet (3.05 to 4.27 m) from the road's edge. Another tree struck prior to the fatal one.
- Trees in ditches; ditch leads vehicle into tree. Another tree is usually struck before the one finally impacted, or tree resulting in a serious injury or fatality.
- Side slopes leading down into woodlots.

STRAIGHT RURAL U.S./STATE ROAD SECTIONS

The impacted trees along straight rural U.S./State road sections are farther from the road's edge than trees along rural local roads (figure 6). The ditches are usually wider and less likely to direct the vehicle into a tree. Another tree is usually struck first; the vehicle then careens into the final tree resulting in injury or fatality.

Figure 6. Straight rural U.S./state road section. (Actual site of fatal vehicle/tree accident in 1976.)

Critical Factors

- Roadside includes ditch.
- A row of trees or woodlot exists adjacent to the road.
- Trees are located 20 feet (6.1 m) or more from edge of pavement.
- Inadequate warning signs for conditions.

Accident Profiles

- Vehicle enters ditch; hits another tree; strikes fatal tree. Fatal tree typically is 20 feet (6.1 m) or more from road's edge; first tree struck is 10 feet (3.05 m) or less from road's edge.
- Vehicle runs down embankment and hits tree. Tree is 20 feet (6.1 m) or more from road's edge and part of adjacent woodlot.

SOLVING THE PROBLEM[1]

To substantially reduce the risk of vehicle/tree collisions three approaches are necessary.

The first approach is to treat trees that pose a higher risk by removing them and/or taking other measures to reduce the vehicle tree accident risk. Alternatives to tree removal include: building barriers around existing trees, spacing trees to create "safety gaps," or channeling the run-off-road traffic away from roadside trees. Pavement markings and reflectors, rumble strips, object markers, chevrons, target arrows and lighting should also be considered.

A second approach is to reduce roadside tree risk by altering the road itself. Higher risk elements of road design, such as sharper curves and narrow lanes and soft shoulders, can sometimes be modified by major reconstruction or new roadways. Modifications in maintenance programs should also be considered. Protective barriers (e.g., guardrails) can be considered along higher risk road segments.

A third approach is to consider the driver. Unfortunately, driving speed and behavior is not easily modified. Although some attempts have been made to raise driver consciousness about the incompatibility of driving and drinking and the risks of speeding, the behavior modifications required to change American driving habits, beyond posting lower speeds on curves, cannot easily be accomplished.

Only the consideration of all these approaches will successfully reduce tree-related accidents. This program would ideally be cost efficient, environmentally sound, and effective in reducing or eliminating that risk.

Since sufficient resources do not exist to fully institute all three approaches and remove all objects that pose a risk in the roadside environment, those road sections with a higher risk for a serious accident involving a tree must be identified. To do this, one must determine what factors make a particular road section a higher risk.

Generally, the higher risk locations are in order of risk:

- Curved rural local road sections.
- Curved rural U.S./State road sections.
- Straight rural local road sections.
- Straight rural U.S./State road sections.

In chapter 3, this ranking by risk is taken further. Average daily traffic (ADT), and the incidence of vehicle/tree accidents is taken into account. This allows you to more appropriately rank order specific roads and/or locations that are more frequently traveled first; and if known, include actual accident occurrence as a critical basis for identifying specific locations of higher risk. Critical factors and accident profiles presented in the previous section allow you to more easily identify potentially higher risk locations for treatment.

The advantage of the method presented in chapter 3, is that it provides an easy way to classify road sections by risk for priority treatment, considering both potential risk and accident frequency. Along with safety and environmental concerns, the method presented in subsequent chapters is based on the driver characteristics, factors concerning the road environment, and characteristics of roadsides with trees described in this chapter. Interstates are eliminated from consideration because of the very low vehicle/tree accident frequency associated with this road type.

To be more responsive to actual roadway conditions and tree accident frequencies in any State or county, a treatment program can be specifically tailored using the methods described in appendix C. Also, if roads described in this guide as rural local versus rural U.S./State are not applicable to a road authority jurisdiction (State or county), the methods described in appendix C will allow for a more appropriate classification. Differentiation of roads simply by ADT (then curved or straight sections) may more implicitly reflect typical cross-section design and roadside conditions. Use of functional classifications based on AASHTO guidelines [6], may also be of additional benefit toward application of various treatments.

CHAPTER 3 A METHOD FOR EVALUATING HIGHER RISK ROADSIDE TREE ENVIRONMENTS

A method for examining roadside vehicle/tree accident risk is necessary in areas where trees are near roads. To decrease the risk of vehicle/tree accidents, the following step-by-step procedure can be used to identify and treat the higher risk road sections. (figure 7).

Although the following step-by-step approach as presented here is done manually, the methodology may be computerized in part or whole, or adopted as part of an already existing accident data system for analysis. If computerized, this would greatly expedite any information updating on a year to year basis.

This step-by-step procedure for evaluating higher risk roadside tree environments serves two functions:

1. To create a master county (or State) map or file that pinpoints locations of higher risk accident sites, trees and/or roadside locations that have historic significance, trees that are exceptionally big, endangered and threatened plant species.
2. To determine whether a specific tree or trees should be removed or an alternative treatment applied because of applicable State and/or Federal laws.

The procedure involves five tasks. Materials required for each task are specified. Field forms are included in appendix A.

To perform the tasks, a county or local map, or a set of rural local maps, with enough detail that road curves are apparent and roads are clearly identifiable as Interstate, rural U.S./State, rural local, or city is needed.

TASK 1: PREPARE A BASE MAP AND PLOT ROADWAY INFORMATION

In the office, use accident reports and existing information about the local area or county, and identify site-specific conditions associated with the roads on a base map. It is important to prepare a reproducable (sepia or mylar) base map of a suitably large scale (about 2 inches (5 cm) per mile (1.6 km)) to allow space for ploting information and making copies for field use. Then use this map to assign priorities in task 2, and then for field verification in task 3. Materials required:

- County or local base map (reproducable sepia or mylar, of suitably large scale).
- ADT data.
- Accident reports.
- Historic and "big tree" registries.
- State and Federal endangered/threatened species lists.
  (or review by appropriate natural resource agency).

Step 1: Identify rural roads on the map by road type: Interstate, rural U.S./State, rural local, and city (figure 8).

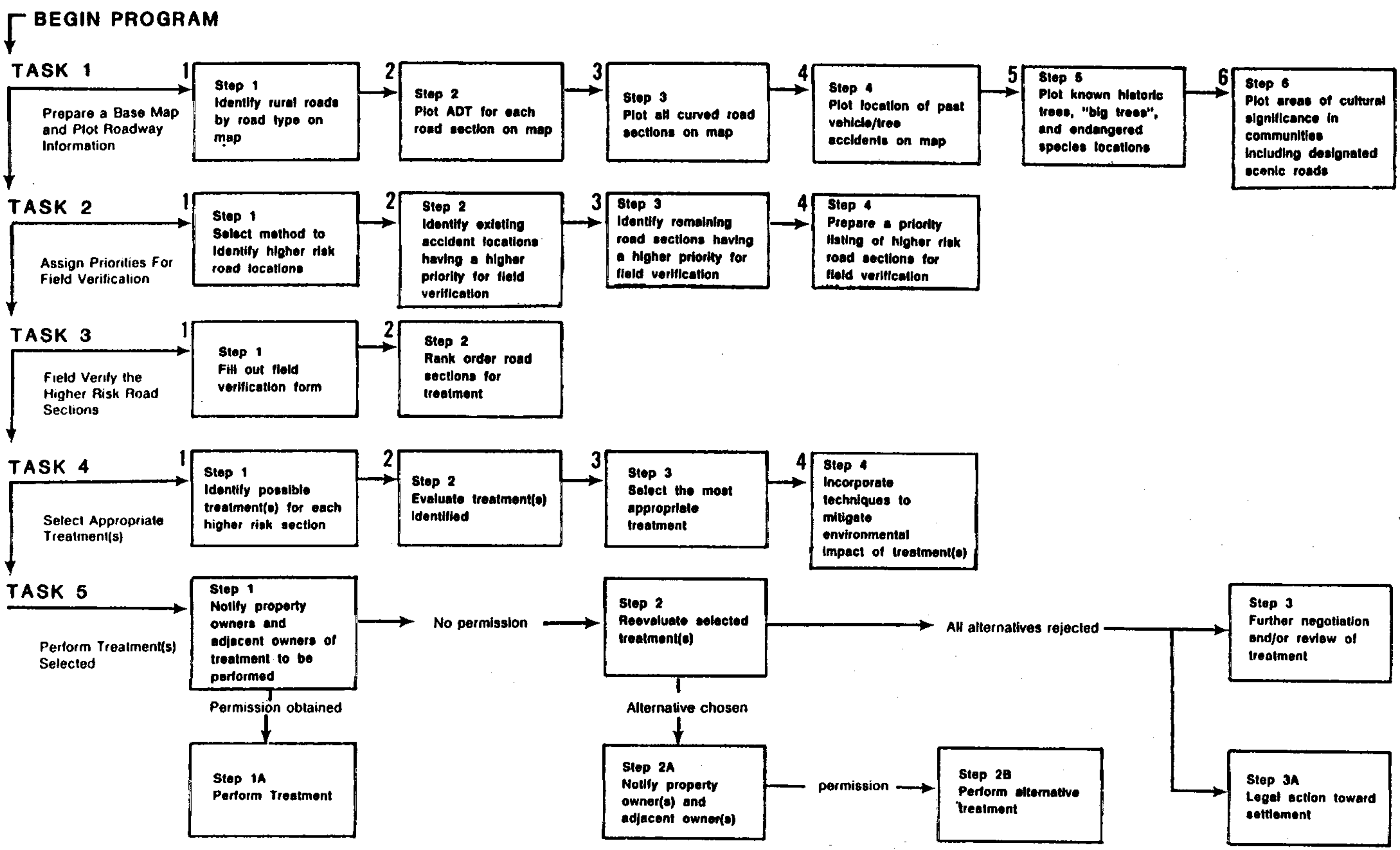


Figure 7. Method for evaluating higher risk roadside environments.

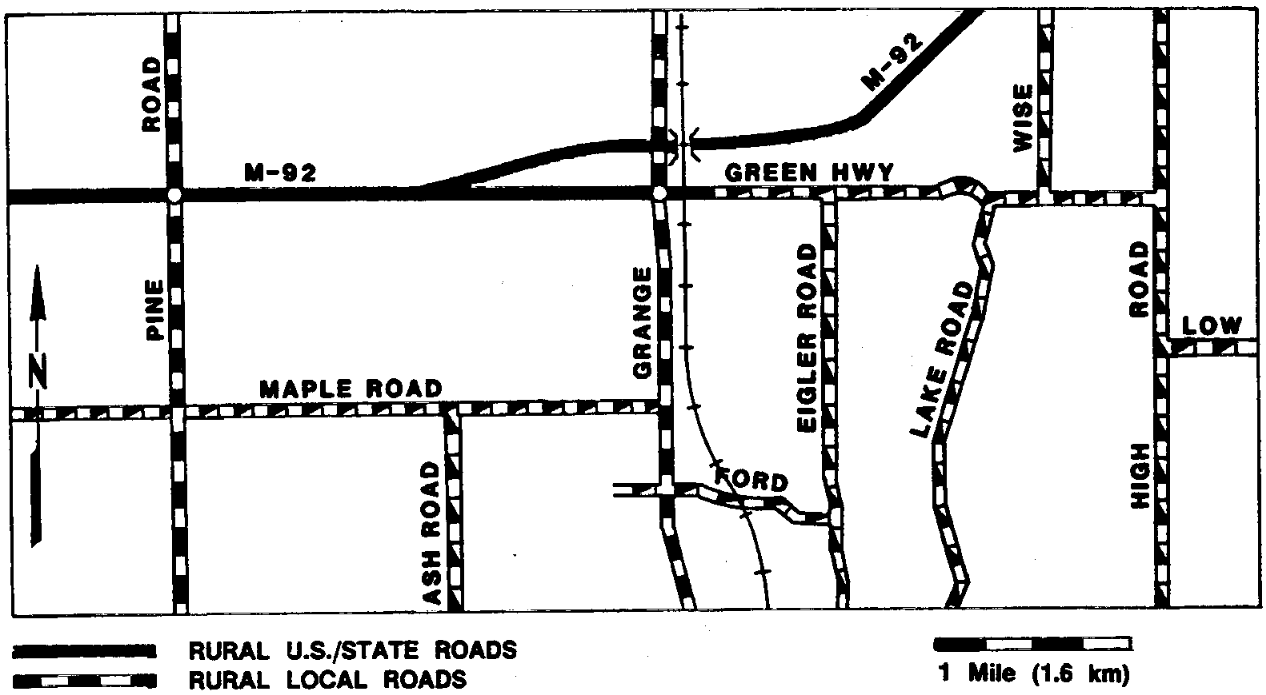


Figure 8. Typical map showing roads by type.

Step 2: Write the ADT, or best estimate, by each road section on the map (see figure 9).

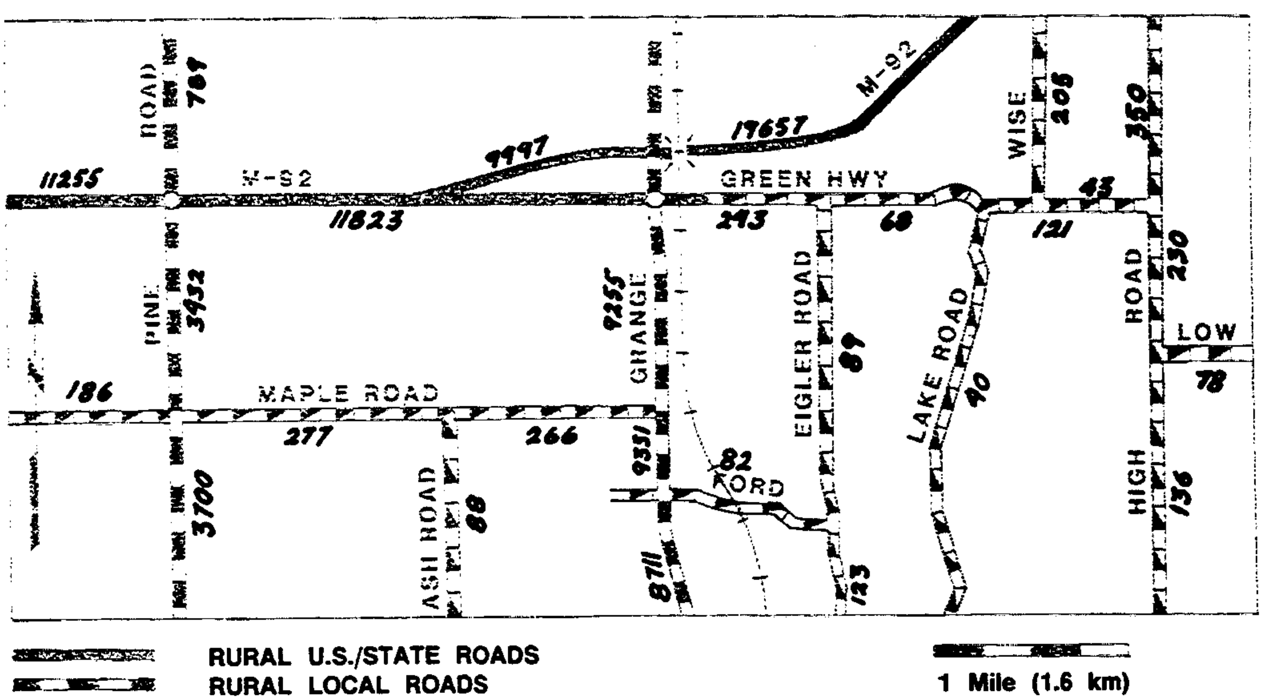


Figure 9. Typical map showing ADT by each road section.

Step 3: Circle all curved rural local road and rural U.S./State road sections (figure 10).

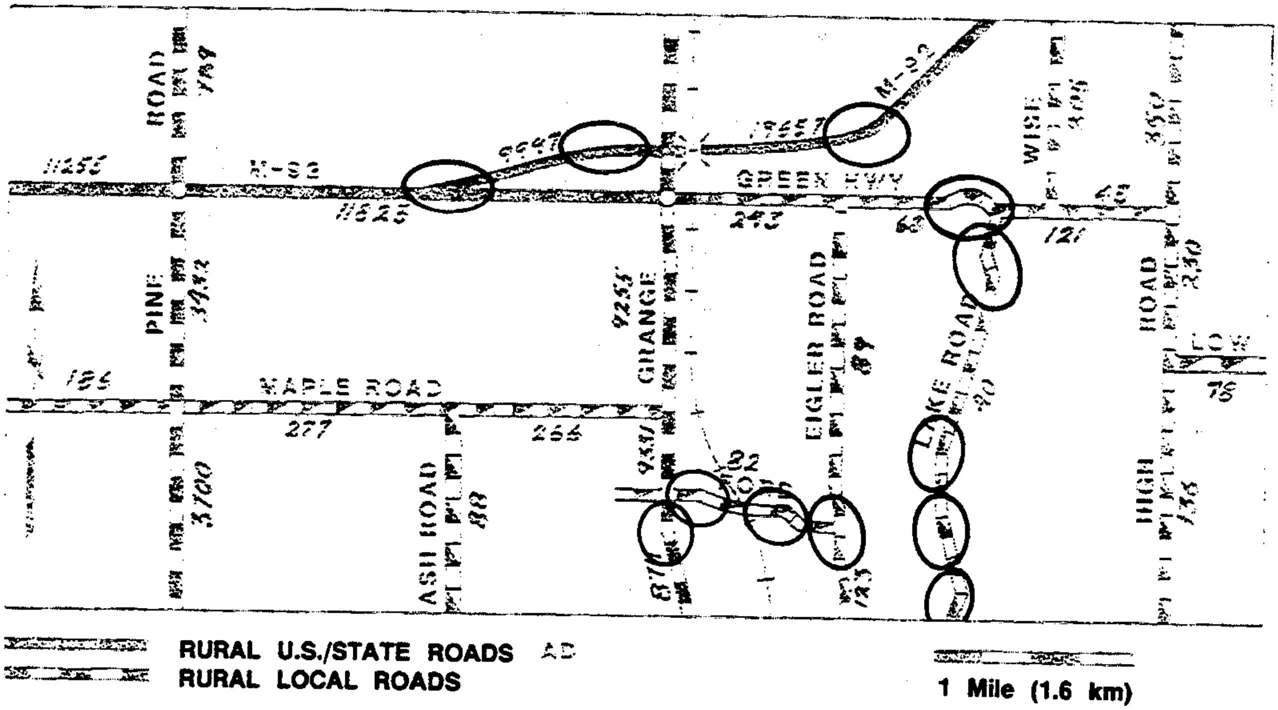
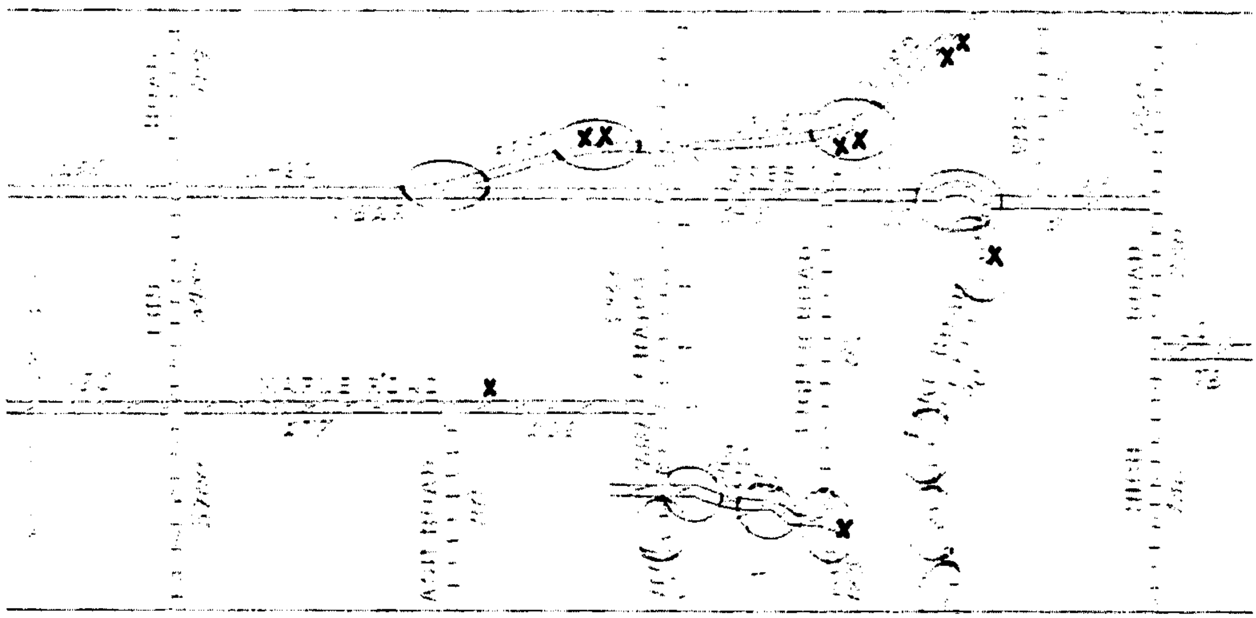


Figure 10. Map identifying curved rural local and rural U.S./State road sections.

Step 4: Place an X in locations of past vehicle/tree accidents (fatal, injury and property damage) that have occurred over an accident data period of 3, 4, or 5 years (figure 11). Locate accident sites as precisely as possible, taking care to plot locations by distance from road intersections and proper side of road.



RURAL U.S./STATE ROADS
RURAL LOCAL ROADS

1 Mile (1.6 km)

Figure 11. Map showing locations of past vehicle/tree accident sites.

Step 5: Plot, using a "T" sign, the locations of trees known to have historic significance, "big trees", and/or endangered/threatened species (figure 12).

Known roadside locations having historic significance may be obtained from State and local historic commissions (see Historic Vegetation, chapter 4). Locations of "big trees" may be obtained from national or State registers through state natural resource agencies (see "Tree Species Size," chapter 4). Endangered, threatened, and rare species locations and/or habitats that may be effected along the roadside can also be identified through state natural resource departments or similar agency (see "Endangered/Threatened Species and Unique Habitats," chapter 4).

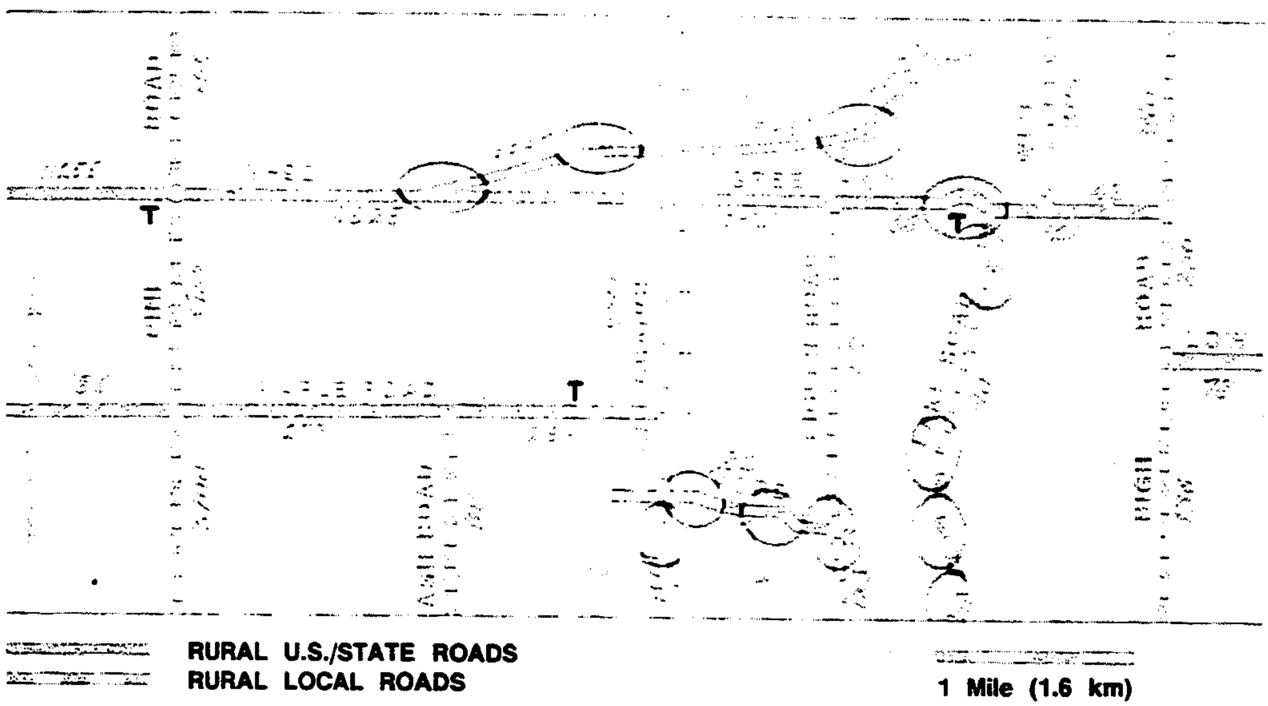


Figure 12. Map showing locations of trees known to have historic significance, "big trees," endangered, threatened species, and unique areas.

Step 6: Circle with a dashed line, areas considered by the community to be of cultural significance (cultural or historic properties). This should specifically include locations of existing or potentially designated "scenic roads" (figure 13).[1]

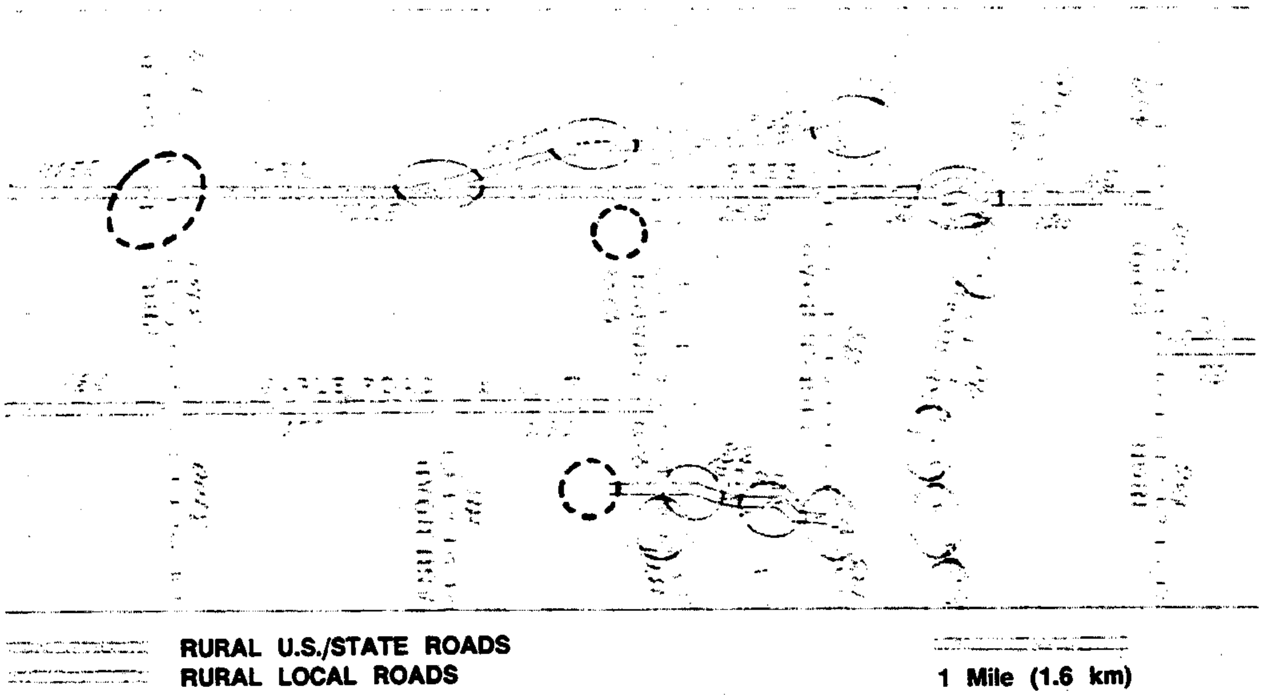


Figure 13. Map showing areas of cultural significance.

[1]In Michigan for example, a natural beauty road is one having outstanding beauty or natural qualities which has been formally designated under the Natural Beauty Road Act of 1970, P.S. 1970, N150, M.C.L.A. 247.381 et seq., M.S.A. 9.195 (61) et seq. Other states may similarly protect scenic roadways, by using designations as rustic roads, scenic highways, etc.

TASK 2: ASSIGN PRIORITIES FOR FIELD VERIFICATION

This task is also done in the office. A number of factors can be used to determine the order in which to field check the higher risk road sections: road type (rural U.S./State, rural local, curved or straight), ADT's, and the occurrence of vehicle/tree accidents. The techniques described here take into account these factors.

Step 1: Select method to identify higher risk road locations.

While the county (or State) may appear to have an existing vehicle/tree accident problem along specific road sections, many of these locations may simply reflect random accident occurrence. A policy to treat only existing accident sites (because of perceived legal or liability issues, and/or limited funding) therefore, is likely to miss the majority of higher risk locations. Many nonaccident sites will have a much higher vehicle/tree accident risk, although not demonstrated within the last five years.

Earlier work has established that curved rural local road sections are typically the higher risk, followed by curved rural U.S./State roads, straight rural local roads, and straight rural U.S./State roads. To be responsive to road sections that are more frequently traveled, identify and list for review those with the higher ADT's first, then the next higher ADT, etc.

However, priority review and treatment of locations based solely on expected accident occurrence, may miss locations having significant accident clusterings that identify road sections of unusual risk. A more responsive approach is to consider both expected accident occurrence and locations of significant accident frequency to determine priorities for field verification and treatment.

This may be done by proceeding with this task to identify roads having a higher priority for treatment based on **both** expected and existing accident occurrence. This would address both long term prevention (10 to 20 years), while being responsive to locations having a significant accident history. Tables 4 and 5 (appendix B) may be used, but to be more responsive, these tables may be modified to reflect actual conditions and tree accident frequencies in any county or state (refer to appendix C).

Step 2: Identify existing accident locations having a higher priority for field verification.

When available, accident history over the last 3 to 5 years should be used to identify locations of particularly high vehicle/tree accident frequency. Beyond 5 years there is a strong likelihood that either road, shoulder, or even adjacent land use changes will affect accident data. By using the following method to exclude locations of random accident occurrence, significant accident clusters may be identified for field review based on the actual number of accidents per year (averaged over the data collection period). These locations may be identified by proceeding with the following steps:

1. Using a sepia or reproducable mylar of the rural county or local base map prepared in task 1, divide each road section (between crossroads or other logical boundry) having any vehicle/tree accidents, into 1/4-mile (0.4-km) sections (figure 14). A template scaled into 1/4-mile (0.4-km) sections may be used to quickly line your map with these reference marks.

2. For each 1/4-mile (0.4-km) road section having any vehicle/tree accidents, determine the average number of accidents per year and note this number adjacent to the road section on your map. (Do this by dividing the number of vehicle/tree accidents identified for each 1/4-mile section, by the number of years of accident data represented on your map.)

3. Then using table 5 (appendix B), compare this number (average number of accidents per year) with the threshold value for each respective road section by road type (rural local or rural U.S./State), curve or straight alignment, and ADT.

   If the average number of accidents per year meets or exceeds the threshold number, **underline** the number of actual vehicle/tree accidents per year, that were noted adjacent to the road section on the map, and circle the entire 1/4-mile (0.4-km) section (see example figure 15).

   This will identify straight road sections in addition to curved sections that have an unusually high vehicle/tree accident frequency for priority field verification and listing in step 4.

   Erase the remaining vehicle/tree accident numbers noted that do not meet the threshold. They do not yet warrant priority consideration based on existing accident frequency.

Step 3: Identify remaining road sections having a higher priority for field verification.

The location of curved rural local and curved rural U.S./State road sections should already be identified on the map (see task 1, steps 1, 2, and 3).

A reasonable approach then, for identifying the remaining higher risk road sections not having a significant accident history (see task 2, step 2), or having no accident incidence at all, is to first proceed as follows:

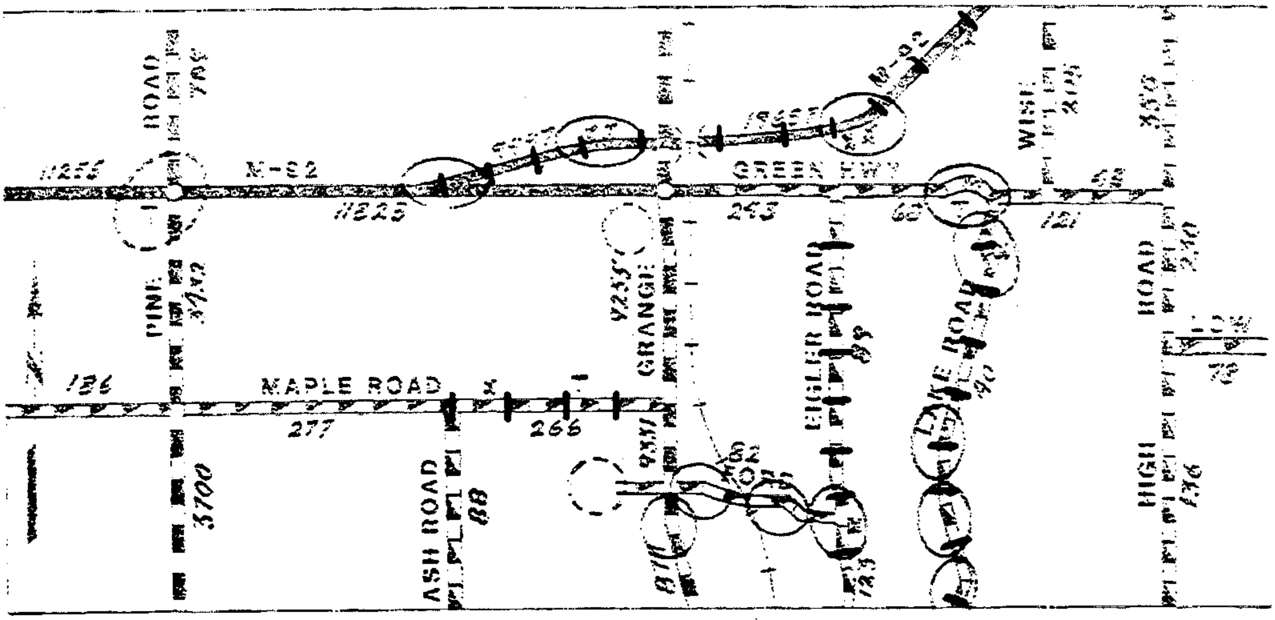
1. Using table 4 (appendix B) and the nearest value listed, identify the expected number of vehicle/tree accidents per year (risk) for each remaining curved road section. These sections may be of variable length, and/or they will include the 1/4-mile (0.4-km) curved road sections not meeting the accident threshold values to step 2.

2. Then write the expected number of vehicle/tree accidents adjacent to each respective circled curved road section on the map (example figure 16).

   This identifies the remaining higher risk curved road sections, not having a significant accident history, for field verification.

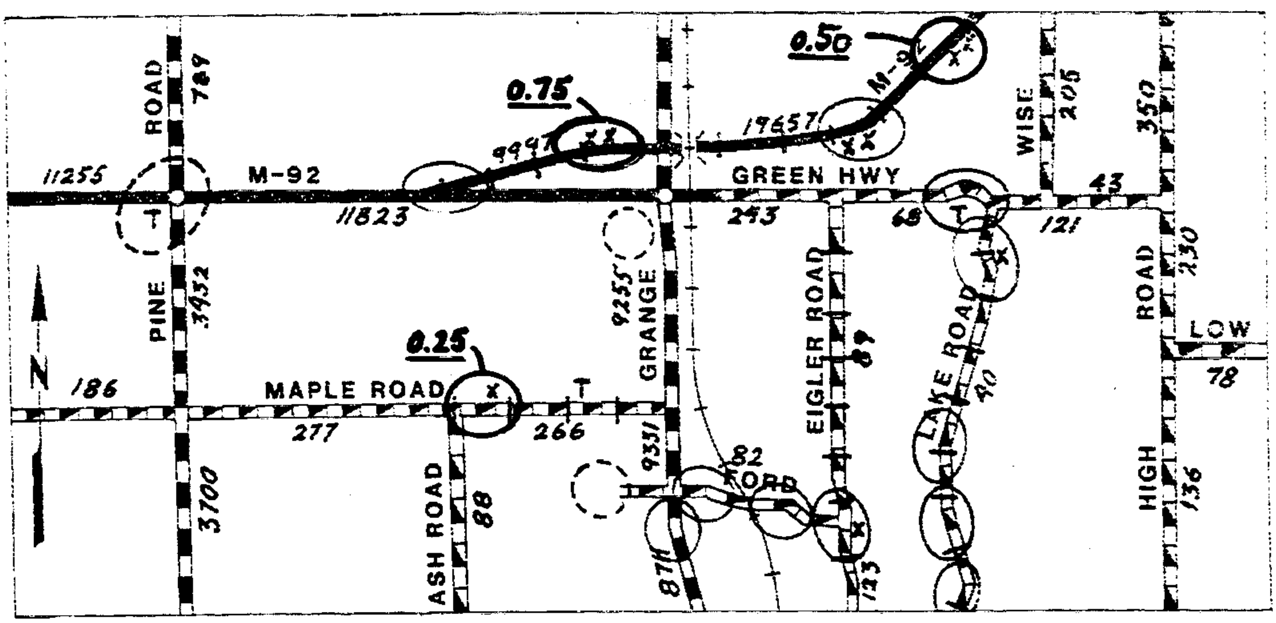
3. Now, for each of the remaining straight rural local and rural U.S./State road sections not already meeting threshold values (step 2), use table 4 (appendix B) to identify the expected number of vehicle/tree accidents per year for each. Write that number adjacent to each respective road section on the map (example figure 17).

   Include only those roads with the higher ADT's. This should be done to limit the number of locations for field verification to those having a higher risk, based on the manpower and budget limitations of the treatment program.



RURAL U.S./STATE ROADS
RURAL LOCAL ROADS
1 Mile (1.6 km)

Figure 14. Map showing 1/4-mile (0.4-km) reference marks on road sections having vehicle/tree accidents.



RURAL U.S./STATE ROADS
RURAL LOCAL ROADS
1 Mile (1.6 km)

Figure 15. Map showing the number of vehicle/tree accidents per year (underlined) for locations (circled) meeting threshold values (appendix B, table 5).

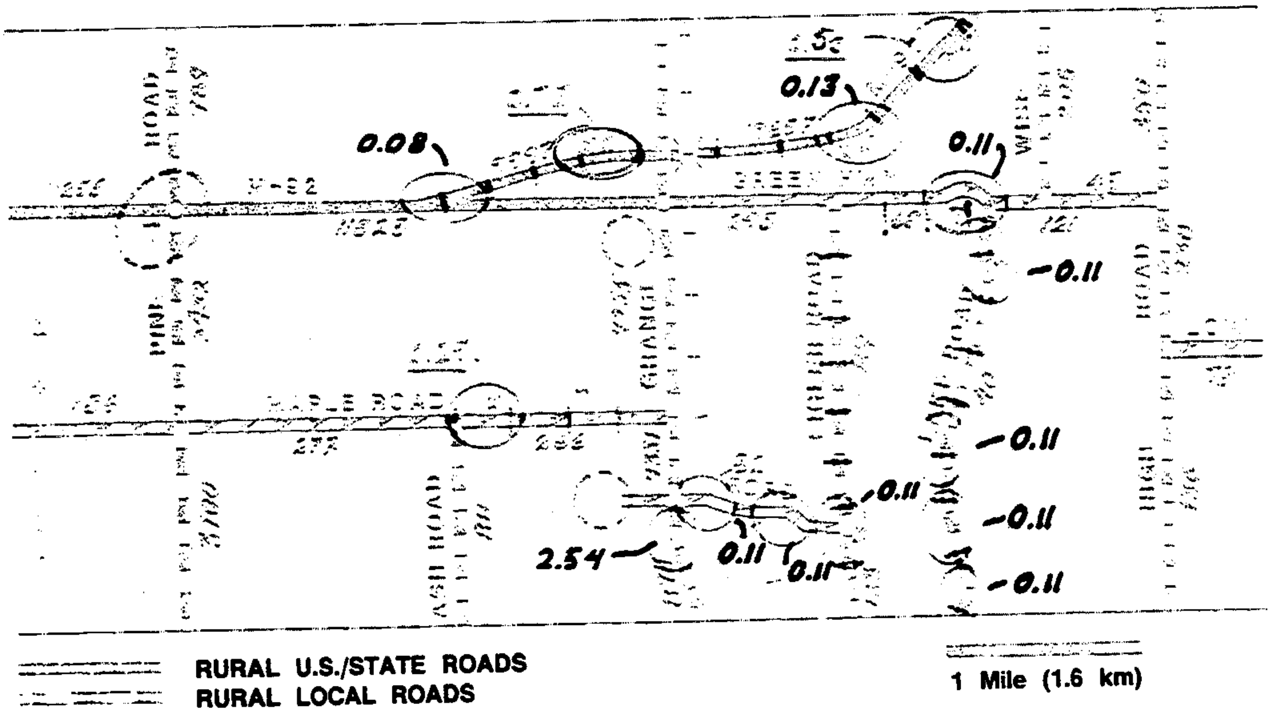


Figure 16. Map showing the expected number of vehicle/tree accidents per year for remaining curved road sections (appendix B, table 4).

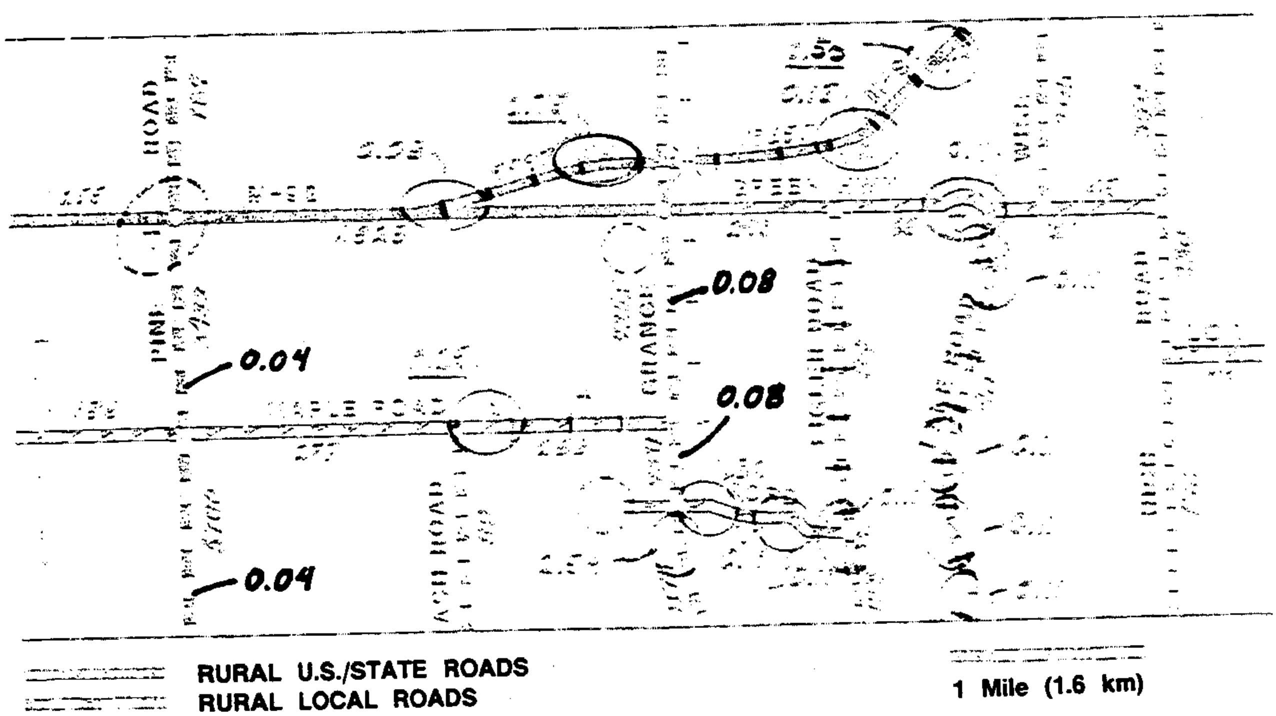


Figure 17. Map showing the expected number of vehicle/tree accidents per year for each remaining higher risk straight road section.

TABLE 3. Priority listing of higher risk road sections for field verification and treatment.[1]

Location	Road Condition[2]	Number of Vehicle/tree Accidents	ADT (Actual or Estimated)	Vehicle/Tree Accidents/Yr.[3] [4]
Grange Rd., ¼ mi. (0.4 km) S. of Ford Road	rural local/curved	—	8,711	2.64
M-92, ¾ to 1 mi. (1.2 to 1.6 km) E. of Green Hwy.	rural U.S./State/curved	3	9,997	0.75
M-92, 1½ to 1¾ mi. (2.4 to 2.8 km) NE. of Grange Rd.	rural U.S./State/straight	2	19,657	0.50
Maple Rd., From Ash Rd. E. ¼ mi. (0.4 km)	rural local/straight	1	266	0.25
M-92, ¾ to 1 mi. (1.2 to 1.6 km) E. of Grange Rd.	rural U.S./State/curved	2	19,657	0.13
Elgler Rd., at Ford Rd.	rural local/curved	1	123	0.11
Ford Rd., From Grange Rd. E. ¼ mi. (0.4 km)	rural local/curved	—	82	0.11
Ford Rd., From ¼ mi. (0.4 km) E. of Grange Rd. to Elgler Rd.	rural local/curved	—	82	0.11
Green Hwy., From Lake Rd. W. ¼ mi. (0.4 km)	rural local/curved	—	68	0.11
Lake Rd., From Green Hwy. S. ½ mi. (0.8 km)	rural local/curved	—	50	0.11
Lake Rd., Approx. 1¼ mi. (2 km) S. of Green Hwy.	rural local/curved	—	50	0.11
Lake Rd. 1½ to 1¾ mi. (2.4 to 1.8 km) S. of Green Hwy.	rural local/curved	—	50	0.11
Lake Rd., Approx. 2 miles (3.2 km) S. of Green Hwy.	rural local/curved	—	50	0.11
M-92, at M-92 & Green Hwy.	rural U.S./State/curved	—	11,623	0.09
Grange Rd., between Maple Rd. and Ford Rd.	rural local/straight	—	9,331	0.08
Grange Rd., between Maple Rd. and M-92	rural local/straight	—	9,255	0.08

1. This listing is taken from information compiled on the example base map (refer to figure 17). Here the list was arbitrarily ended, simply to serve as an example. An actual priority listing could be as long or short as desired, depending on availability of manpower and funding to reasonably field review and treat locations within a regular maintenance cycle or limitations of program funding.

2. If the cross-sectional design between rural local or rural U.S./State roads cannot be differentiated on your road system, a single road condition listing (curved or straight section) should be used. Tables 4 and 5 (appendix B) of this guide, will then also need to be revised to be more responsive to actual accident conditions in the respective county or state (see appendix C).

3. Actual vehicle/tree accidents per year are underlined for locations meeting the threshold (see table 4). This is the actual number of vehicle/tree accidents per year or average per year over data period. This example is based on an accident data period of 4 years.

4. The expected number of vehicle/tree accidents per year was identified from table 4 (appendix B) using the nearest value. If the expected number of accidents per year is the same for 2 or more locations, rank order locations from higher to lower risk first by road type (i.e., rural local curved, rural U.S./State curved, rural local straight, rural U.S./State straight), then by ADT within each type.

- Presence or absence of trees.
- Vehicle/tree accident sites (task 2, step 2.)
- Tree scars.
- Target trees or trees that would be in direct path of errant vehicle (e.g., outside of curves, in ditches, etc.).
- Danger trees (dead or decayed trees and branches that pose a risk to the traveled way).

Additional field verification forms (appendix A) may need to be used to reflect these changes.

Locations having "S" curves may be more appropriately considered one site, where similar road and roadside conditions are present. But remember, selection and evaluation of specific locations for treatment must be based on the experience and professional judgement of the road engineer performing the review.

Step 2: Rank order road sections by risk for treatment:

Use information summarized in item No. 22 (field recommendation(s) for treatment and maintenance) of the field verification form (appendix A). Road sections not having trees, or that no longer present a significant roadside vehicle/tree accident risk because of safety improvements or other changes, should first be eliminated from further consideration. The remaining locations should be rank ordered based on any changes in risk, resulting from field verification. The higher risk locations should be treated first.

Rank order higher risk road sections for treatment (example table 3). This priority listing for each road section and associated field verification forms, is to be used in task 4 to select appropriate treatments, based on costs, benefits, and consideration of environmental effects (if any).

TASK 4: SELECT APPROPRIATE TREATMENT(S)

This task may be done in the office. It involves a review of the field verification forms and listing of higher risk road sections to determine and/or confirm appropriate treatments. The treatment(s) selected should be based on a simplified benefit/cost analysis of the alternatives considered for the site(s).

A variety of factors must be considered to determine the appropriate treatment(s) for each site. Since most treatments are costly, the available budget will influence the number and type of treatments that can be undertaken. Treatments are selected to produce the greatest reduction in expected accidents, within the available budget. The environmental effect resulting from the treatment must be considered.[7][8]

Monetary cost of specific treatments include not only implementation, but also costs expected in the future—repair, maintenance, replacement. Environmental effects of treatments further complicate selection. Impacts may be short or long term. A treatment that will reduce the risk of run-off-road accidents may increase soil erosion problems for example. Environmental effects could well tip the balance in favor of a slightly more expensive treatment, so that both safety and environmental concerns are addressed.

Materials required:

- County or local map(s).
- Priority listing of higher risk road sections (task 3, step 2).
- Field verification forms (appendix A).

Step 1: For each higher risk road section, identify possible treatments, keeping in mind the following considerations:

1. Look at the treatment recommended in the field for the particular roadway and roadside environment (adjacent land use) being considered. (appendix A, item No. 22; and chapter 4, "Alternative Treatments.")
2. Consider the presence of other considerations (chapter 4, "Environmental Considerations").
3. Consider alternative treatments (chapter 4, "Alternative Treatments").
4. Consider the functional classification of the road concerning application of various treatments.(6)

Step 2: Evaluate the treatment(s) identified:

Consider the following points, and be careful to appropriately document use or nonuse of various alternatives. Professional judgement and experience is important here to decide whether limited or careful analysis is necessary. Simple notes, comments, or detailed descriptions may be more or less appropriate depending on potential issues or controversies. Each site may be different.

1. Consider the road section involved. Curved rural local roads are generally the higher risk, followed by curved rural U.S./State, straight rural local and straight rural U.S./State roads.
2. When available, consider the accident frequency, and whether the accident threshold was met (task 2, step 2).
3. Consider both the road conditions present at various locations, as well as the average daily traffic (ADT). Use the relationships presented in Chapter 2, (including critical factors and accident profiles) to aid in this procedure.
4. List the feasible (physically possible) treatments for each site. For each of these alternative treatments, consider the following:
   - Implementation cost: tree cutting, sign or barrier erection, grading, etc.,
   - Maintenance cost: clearing, painting, brush control, etc.,
   - Replacement or repair costs: repair or replacement of damaged signs, guardrails, protective vegetation, etc.
5. On a site-specific basis, evaluate the suitability of each treatment in terms of its effectiveness in preventing or reducing the severity of roadside accidents, and functional classification.(6)

When completed, the map will have specifically identified those locations for priority field verification based on risk (example figure 14). These will include road sections having a higher potential risk, as well as 1/4-mile (0.4-km) road sections with unusually high vehicle/tree accident frequencies. Both have been **circled** for reference emphasis (figure 17).

Step 4: Prepare a priority listing of higher risk road sections for field verification.

Road sections have been **circled** on the map (example figure 17) to more easily identify them first, as higher risk roads for priority field verification and treatment. Remembering this, prepare a priority listing of higher risk road sections for field verification by proceeding as follows:

1. Using either the actual number of vehicle/tree accidents (underlined) or expected number of vehicle/tree accidents noted on the map (example figure 17) rank order the **circled** road sections from higher to lower risk, as shown by example table 3.
2. Include the road name; location, ADT, road type, number of accidents, and accident frequency.
3. For road sections having an unusually high vehicle/tree accident frequency and meeting threshold values (task 2, steps 2 and 3) be sure to list the actual accident frequency; and **underline** it on the list (table 3), to emphasize this fact.
4. All other locations not meeting threshold values shall be listed by expected vehicle/tree accident frequency (appendix B, table 4).

Do not be surprised if most of the road sections for field verification include only rural local curved roads having higher ADT's. For example, curved rural local roads account for 95 percent of the top 30 percent of the higher risk locations in Michigan.[5]

Because of limited funding available for any safety program, it may be desirable to limit the list of higher risk locations to those that can reasonably be field investigated and treated within a regular maintenance cycle of 1, 2, or 3 years.

It is important to update the priority listing regularly. This will reflect changes in road and right-of-way conditions including ADT, treatment of higher risk locations, and vehicle/tree accident incidence.

Although this rank ordered listing (example table 3) is specifically intended to identify locations for field verification and treatment of higher risk vehicle/tree accident locations, it may also be used as part of a broader fixed object safety program. Because road sections are identified on the basis of risk (either existing or expected accident frequency), locations may be included as part of a benefit/cost analysis along with other fixed object safety programs.

This list provides a reasonable approach to selectively identify locations for field verification on a priority risk basis, addressing both immediate and long-term resolution of the vehicle/tree accident problem.

Use this list to field verify higher risk locations in task 3.

TASK 3: FIELD VERIFY THE HIGHER RISK ROAD SECTIONS

Using the priority listing established in task 2 (example table 3), field verify higher risk road sections first. Before beginning, however, techniques discussed in chapter 5, Treatment Programs and Public Relations should be read. Materials required:

- Priority listing of higher risk road sections.
- Field verification form
  (one for each site to be visited—appendix A).
- Tape measure (at least 100 feet (30.3 m)).
- Instant camera and film.
- Stapler (to staple pictures to field verification form).
- County or local map(s) from task 1.

Step 1: For each road section location, fill out the field verification form (appendix A) making sure to complete the following:

1. Verify the locations of any vehicle/tree accidents and historic/big/endangered or threatened trees identified at the road section. Note location on the base map.
2. Plot location(s) of higher risk trees or groups of trees on the field verification form. As appropriate, this should be considered out to a maximum of 40 feet (12.1 m) or to the right-of-way limits. It may be desirable to identify higher risk trees on the outside of curves, in a ditch, and at bottom of a downgrade. Plot any additional trees found with accident scars.
3. During field verification, trees may be identified as dead or potentially dangerous, exhibiting structural weakness, attack by insects, diseased or lack of wind firmness that would jeopardize the safety of the motoring public. They should be noted on the field verification form (appendix A, items No. 17 and/or No. 19) and recommended for removal.

   Also, if other higher risk fixed objects exist, they should be noted (field verification form item No. 19, other higher risk fixed objects) and incorporated into a hazard elimination program and treated.
4. Contact adjacent property owner(s). If possible, confirm knowledge of previous vehicle/tree accidents, and site information that may have a bearing on potential treatment (see chapter 4, "Environmental Considerations").
5. Field verify any additional considerations and excepting conditions (see chapter 4, "Environmental Considerations") identified by property owner/adjacent owner(s) and plot findings on the field verification form and map.
6. Complete item No. 22 (field recommendation(s) for treatment and maintenance) on the field verification form.
7. For higher risk road sections that are neither straight nor curved, but meandering, identify logical sections in the field (they may be up to a mile or more in length).

   Presence or absence of the following, in addition to accident profile and critical factors described in chapter 2, should aid in identifying these higher risk locations:

6. Add site-specific costs. If an easement on private land must be purchased for a specific treatment (e.g., clearing trees beyond the right-of-way limits of the road section), these costs should be added as appropriate.
7. Consider environmental effects. The expected environmental impacts of each treatment are generally discussed in chapter 4. It cannot be overemphasized that aesthetic and ecological impacts of a given treatment must be considered along with direct monetary costs. In certain cases, a lower cost treatment will be ruled out by the environmental impacts or public controversy involved.

Step 3: Select the most appropriate treatment(s).

If tree removal is selected, determine the distance from the edge of road that trees must be removed to reduce the risk of vehicle/tree accidents. This distance should be based on specific roadside conditions, field observations on the field verification form (appendix A), knowledge and professional judgment.

Step 4: Incorporate techniques to lessen or eliminate environmental impacts of treatment(s) selected (see chapter 4, "Environmental Considerations").

TASK 5: PERFORM TREATMENT(S) SELECTED

This involves contacting property owners and adjacent owners, securing property owners permission to perform the selected treatment, and performing the treatment (refer to figure 7, task 5).

1. Notify the property owner(s) and adjacent owner(s) of the proposed treatment(s) (chapter 4, "Environmental Considerations", "Ownership").

   Using sample letters, (appendix D, figures 18 and 19), notify property owners and adjacent owners involved by mail. Registered mail may be used, as appropriate, to document receipt of notice by property owners. Typically, where treatment is on right-of-way owned by the road authority, contact with adjacent property owners may be in person with an appropriate record of contact.

2. As needed, if permission is obtained from property owner(s), and no significant objection is received from adjacent property owner(s) following notification, treatment(s) may be performed as proposed.
3. If the landowner(s) does not grant permission, or significant objection is received from the adjacent owner(s), revaluate the selected treatment based on these objections and considerations (return to task 4, step 1, and work through the remaining steps). Permission must be granted or received from the property owner before any treatment can be performed on land not owned or under jurisdiction of the road authority.
4. If after reevaluation, another treatment is chosen, notify the property owner(s) and/or adjacent owner(s), obtain written permission or agreement as appropriate, and perform the treatment(s).
5. If after reevaluation, the original treatment is still preferred, further negotiation or legal action toward settlement must be considered when it involves the property owner or land not under jurisdiction of road authority. (chapter 5, "Public Relations").

CHAPTER 4 ALTERNATIVE TREATMENTS, ENVIRONMENTAL AND MAINTENANCE CONSIDERATIONS

ALTERNATIVE TREATMENTS

This chapter includes both roadway and roadside treatments that can be performed to reduce the risk of vehicle/tree accidents. It is not intended to be a comprehensive list, only to suggest the more basic measures that may be considered, depending on specific site conditions. For example, lane widening (especially in conjunction with shoulder widening) is also a possible roadway treatment. Other alternative treatments that are derivations of pavement marking, delineators, and advance warning signs include: raised and recessed pavement reflectors, long-lasting tape and plastic pavement markings, audible rumble strips, object markers, chevrons, and target arrows. Others, such as wig-way flashers, transverse pavement markings, and even lighting are possible alternative treatments.

The feasibility and effectiveness of any treatment, including tree removal, will depend on specific application and whether treatments are used in combination or individually. Treatment should also reflect or be appropriate for the functional classification of the road (i.e., higher volume arterial vs. lower volume collectors, local or recreation roads).[6]

Roadway treatments that can be performed to alleviate the risk of run-off-road vehicle/tree accidents, for the most part, include upgrading of the informational and warning sign system, and better marking of the roadway. Roadway protection is relatively inexpensive and can be performed along with regular maintenance procedures. Roadside treatments to reduce the risk of vehicle/tree accidents, requires at least a nominal modification of the roadside environment, and may include major reconstruction projects that are expensive.

This section discusses each alternative treatment. The treatment and what it entails is descriptively defined. Installation requirements are noted, then the environmental impact of the treatment is delineated. On a site-specific basis, the roadside area that may be impacted is limited for most treatments. Natural factors that may be affected include soil/water relationships, vegetation, and drainage. Cultural factors of greatest significance include effects on adjacent land use, traffic flow, and aesthetic qualities. Generally, for both roadway and roadside treatments, the extent of impact is proportional to the extent of soil disturbance. Most impacts are of short duration (occurring during construction), and are site specific. Road relocation and shoulder widening, however, may have significant impacts that require impact assessment.[7][8]

Feasibility is a measure of the practicality and appropriateness of the treatment. Each treatment is rated using the following system:

- **Feasible**—Based on basic design and safety requirements.
- **Feasible with Limitations**—Possible application depending on the width of the right of way and/or road alignment.
- **Not Feasible**—Impractical based on engineering considerations.

Effectiveness is the extent to which the treatment has been demonstrated to reduce the number of severity of all types of accidents.

The decision to employ or not employ a particular treatment is also determined by cost-effectiveness. For purposes of comparison, treatments are ranked as follows:

- **Least cost.**
- **Moderate cost.**
- **Highest cost.**

In considering alternative treatments, several assumptions are made:

- The tree(s) involved is(are) a higher risk.
- The tree(s) should not be removed because of special circumstances.
- Cost of the treatment is a major consideration.
- Effectiveness in reducing vehicle/tree accidents is a major consideration.
- The alternative treatment must not result in a potentially higher risk situation than currently exists with the tree.
- Unlike tree removal, the other treatments will not totally eliminate the accident risk, but will lessen the frequency or severity of run-off-road accidents.
- The treatment will satisfy the authority's responsibility to improve safety.

In all considerations of treatments; existing standards, guidelines, and warrant systems are assumed to continue in effect. In any consideration, one should analyze the following:

1. **The type of highway activity planned (new construction, reconstruction, or maintenance)**—In construction and reconstruction activities, treatment of higher risk trees leads to an integrated safety design which resolves the tree obstacle problem. Maintenance operations are likely to view the obstacle as a problem and attempt to use a special treatment to solve that particular problem. Each type of highway activity may have a different funding source and varying standards and requirements.
2. **Applicability of alternative treatment**—Include those that can be applied generally to all situations and those that require certain physical conditions, such as when the higher risk location involves ditches, curves, and downslopes, in addition to the tree(s).
3. **The type of control inherent in the treatment to keep vehicles on the roadway**—This may imply traffic control (a more passive treatment), or to protect run-off-road vehicles, it may include treatments to redirect, deflect, or decelerate run-off-road vehicles.
4. **Design effectiveness criteria**—Effectiveness of treatments will vary by road type. Higher volume roads often have been signed or upgraded to already include one or more of the alternative treatments, lessening the choices available. The treatment should also be appropriate for the functional classification of the road (i.e., high volume arterial vs. low volume collectors, local or special purposes roads).[6]

Because of the variability posed by situational factors, and the need to consider existing design and location standards, typical treatment recommendations cannot be made in this manual. The final decision can only be made by the responsible authority after evaluating all appropriate locational, feasibility, effectiveness, and cost factors.

Alternatives that improve the design characteristics of the road should be investigated first. Such treatments as pavement marking, superelevation correction and shoulder paving make it easier for motorists to stay on the road.

Improvements which should be considered next are those which involve the roadside. From a safety standpoint, the most effective treatment may be tree removal. This is generally the least costly and the simplest to accomplish physically. However, for various reasons, tree removal is sometimes not an appropriate treatment (chapter 4, Environmental Considerations).

Other treatments such as guardrail, ditch regrading and slope alterations also provide a more forgiving roadside for motorists who inadvertently leave the road. These need to be considered as well, and may provide suitable alternatives to tree removal. Combinations of alternatives that improve both the design characteristics of the road and create a more forgiving roadside, would provide the most complete improvement.

When selecting the appropriate treatment to alleviate the risk of run-off-road accidents, keep in mind that the interaction of the driver, the vehicle, and the roadway is a complex relationship. Therefore, combinations of treatments, rather than one treatment used exclusively, are likely to alleviate the risk of vehicle/tree accidents to a greater degree.

PAVEMENT MARKING

Description—Pavement markings (center line, lane line, edge line) help drivers stay in their lanes at night and during periods of inclement weather. They can be used along paved roadways of all types. Markings are especially effective for roads with heavy nighttime traffic, areas frequently blanketed with fog, and sections of roadway with narrow pavement. They are less effective when obscured by snow, water and ice. Reflectorized markings may be used on long, continuous sections of road or through short stretches where there are many changes in horizontal alignment. Derivations of pavement marking described here include: long-lasting tape and plastic pavement markings, raised and recessed pavement reflectors.

Installation—Pavement markings can be done at the same time and utilizing the same equipment and materials as centerline pavement marking routinely performed by maintenance units. Care should be taken to adhere to the principles set forth in designated traffic and safety manuals, for example, in Michigan the **Michigan Manual of Uniform Traffic Control Devices.** Field observations indicate the paint durability is a factor which may influence future maintenance. Markings at curves are crossed more often than on straight sections and thus wear faster. In such areas, wider markings or more durable paint may be more appropriate, than annual restriping.

Environmental Impacts—Pavement markings produce no significant environmental effects. However, visual uniformity may be a consideration in scenic or special use areas.

Feasibility—Feasible for all paved road conditions.

Effectiveness—Effective across all paved road conditions.

Cost—One of the least costly alternative treatments.

DELINEATORS AND ADVANCE WARNING SIGNS

Description—Roadway delineators and chevrons, placed at consistent intervals along the edge of shoulders, give the driver better visual perception of changes in roadway alignment or the presence of side obstructions (trees, narrow bridges, etc.). This treatment is effective for roadways with heavy nighttime traffic and especially along curves. Installation of reflectorized delineators and warning signs can help reduce the number of run-off-road incidents and is among the least costly alternatives. Suggested spacing of delineators is discussed in designated traffic and safety manuals, for example, in Michigan the **Michigan Manual of Uniform Traffic Control Devices.** All traffic signs should conform in design and placement with the requirements outlined by that document. Field observations show that the proximity of the sign to the roadside obstacle is important, and warning signs (i.e., curve) should not conflict with other signs and treatments.

Installation—Both delineators and advance warnings signs can be installed using the same equipment, materials, and procedures used for installing standard traffic signs. Highway departments generally do not install delineators on trees, but residents living along the roadway sometimes mount them on trees themselves, particularly near driveways.

Environmental Impacts—Roadway delineators and signs produce no significant environmental effects; however, visual conflicts may occur. For example, the positioning of the signs can affect the integrity or aesthetic qualities of structures of historical importance.

Feasibility—Feasible for all road conditions.

Effectiveness—Roadway delineators and signing are effective across all road conditions.

Cost—One of the least costly alternative treatments.

ADVISORY SPEED SIGNS

Description—Excessive speed and curvilinear alignment increase the possibility of run-off-road accidents. Advisory speed signs can be used to supplement warning signs or to emphasize the need for reduced speed through an area within a higher risk roadside section. A speed limit restriction may be imposed on a road section only after the new limit has been established by law or regulation and a thorough engineering and traffic investigation has been performed according to established traffic engineering practices.

Installation—The signs can be erected using equipment, materials, and procedures utilized to install standard traffic signs. All traffic signs should conform in design and placement to the requirements of the state's designated traffic and safety manual, like the **Michigan Manual of Uniform Traffic Control Devices.**

Environmental Impacts—Creates no significant environmental effects.

Feasibility—Feasible for rural U.S./State and rural local roads.

Effectiveness—Studies have shown that speed reductions have little or no effect on 85 percent of the drivers or in the number of accidents. Additional enforcement of existing speed limits also has shown little effect.

Cost—One of the least costly alternative treatments.

DESIGNATION OF SPECIAL PURPOSE ROADS

Description—Special designation of roads offering a particular scenic and/or recreational experience may be appropriate. The application of more liberal design dimensions as established in AASHTO guidelines (recreational road design) is recommended where appropriate.[6] The intent is to protect and enhance the existing aesthetic, ecological, environmental, and cultural amenities that distinguish a particular road section. Among the considerations implicit in this treatment, is the understanding that providing a clear zone adjacent to a road involves a tradeoff between safety and aesthetics. As defined by AASHTO[9] a clear zone is that roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. As applied here for special purpose roads, and in this guide, it does not imply that a minimum width clear zone be established. A driver who leaves the road should have a reasonable chance to regain control and avoid serious injury. On the other hand, the philosophy of a special purpose road designation (i.e., scenic, or recreational) dictates that natural roadside features be preserved where possible. Roads designated in a special purpose category are generally lightly traveled and of low speed. Wide clear zones are not as important as on high speed high volume facilities. In some cases, where economic and environmental concerns are great, clear zone dimensions of 10 feet (3 m) or less, may be appropriate.

However, areas having a higher accident potential, such as on the outside of curves or at the end of long steep downgrades, should have more (forgiving) clear zone widths.

Advisory speed restrictions may typically be imposed with the designation as a special purpose road. This restriction may be imposed only after engineering and traffic investigation has been completed in accordance with established engineering practices.

Installation—All traffic signs should conform in design and placement to the requirements of the State's designated traffic and safety manuals, like the **Michigan Manual of Uniform Traffic Control Devices.** The signs may be installed along with standard traffic signs using the same equipment, materials, and procedures. Use of standardized markers or signs officially recognized in your State to designate the road as scenic or recreational should be used. Should other official signs be used to designate historically unique or architecturally significant features, for example, existing guidelines in each State should be strictly adhered to.

Trees may be removed selectively using chain saws to limit disruption and effect of using larger machines or equipment.

Environmental Impacts—This treatment may eventually allow more vegetation to grow closer to the road edge, reducing sight distances and increasing shade, thus increasing road icing in the winter and creating higher risk driving conditions. The presence of roadside trees, however, reduces glare on the roadway. Designation as a special purpose road has positive resource implications for protection of important natural and cultural features, aesthetics, and encourages tourism (summer beauty, fall color tours, etc.) on a local and statewide basis.

Feasibility—Feasible along low volume rural local and rural U.S./State roads, of at least 1/2 mile in length.

Effectiveness—If drivers are forced to go slower because of the road alignment and/or respond to advisory warning signs to reduce speeds, etc., this treatment may be effective on a site-specific basis. Selective removal of trees at higher risk locations will greatly increase effectiveness. However, drivers may choose to ignore speed limit restrictions, or not recognize higher risk conditions despite warnings, because of inattentiveness, or as a result of alcohol or drug related effects while driving.

Cost—One of the least costly treatment alternatives to implement.

SUPERELEVATION OR MODIFICATION OF ROAD CROSS-SLOPE

Description—Trees existing along the outside of curved road sections may be in a target position to traffic. An errant vehicle failing to make the curve has a much higher risk of hitting trees in these locations. By using bituminous materials to wedge up the outside edges of the pavement along curved road sections, a new surface contour can be created which will assist in steering vehicles away from roadside trees. In addition, an excessive or incorrectly shaped crown may exist on straight road sections. Changes in road cross-slope and/or superelevation should follow established AASHTO guidelines.(6)

Installation—Superelevation is usually done by the maintenance staff using road graders, and steel or rubber tired rollers.

Environmental Impacts—Environmental impact of this treatment includes restricted traffic flow during application and the possibility of additional shoulder, embankment and ditch work. In addition, roadside use of heavy equipment, such as asphalt pavers and trucks transporting asphalt, might add to the loss of ground cover and promote local soil erosion. Generally, no significant environmental impacts result if activities are restricted to within the road shoulders.

Feasibility—Feasible along rural U.S./State and rural local roads.

Effectiveness—Somewhat effective along rural local and rural U.S./State roads.

Cost—Moderate cost.

SHOULDER WIDENING AND PAVING

Description—Shoulder widening and paving can be used along segments of approximately a half mile or longer, to improve the recovery potential of vehicles straying off the roadway.

Installation—Shoulder widening and paving is usually done by maintenance staff using road graders, and steel or rubber tired rollers.

Environmental Impacts—Assuming trees are not removed, this treatment has little environmental impact because most of the activity takes place on already disturbed areas immediately adjacent to the roadway. Earthwork can cause erosion and sedimentation of adjacent water and wetland areas if no erosion control measures are taken.

Feasibility—Feasible along rural U.S./State and rural local roads.

Effectiveness—Research and evidence relating shoulder design to safety is conflicting. Median or about average shoulder widths have lower accident rates than narrow shoulders under all conditions of horizontal and vertical alignment. The overall effects of shoulder design are often overshadowed by other attendant alignment elements (chapter 2, "The Road Environment").

Cost—Moderate.

TREE REMOVAL

Description—Higher risk locations include the outside of curved road sections, particularly in "target" locations, and include ditches along straight road sections. Here vehicles may be channeled into trees once they have left the road shoulder.

In dealing with tree removal, embankment slope rate and recovery area at the toe of the slope should be taken into account. For example, 3:1 and flatter slopes may be traversable, but because there are no redirection capabilities on a 3:1 slope, a vehicle is likely to continue until it either hits a fixed object such as a tree, or reaches a recovery area provided at the toe of slope.

If no recovery area is provided at the toe of slope, tree removal along the slope will not generally reduce the vehicle/tree accident risk along a wooded roadside. Alternatives other than tree removal should be considered that would be more appropriate and/or cost-effective. higher risk roadside trees (along with other roadside obstacles) should therefore be considered for removal on 3:1 and 4:1 slopes that have recovery areas at the toe of slope. In addition, higher risk roadside trees (including other roadside hazards such as utility poles, culverts, etc.) should be considered for removal within the clear zone on 6:1 and flatter slopes. In many locations, even tree trimming can improve vision for drivers, thereby reducing risk.

Installation—Trees may be removed easily using chain saws and power chippers to dispose of brush.

Environmental Impacts—Environmental concerns with tree removal include loss of aesthetic and/or functional values such as shade, visual buffer, wind protection, protection against soil erosion and sedimentation, change in landscape character, historic association with site, and botanical uniqueness. Value of trees will vary greatly depending on location, site, species, quality and relationship to differing land uses. Generally of greatest concern are residential, park, historical, and landscape areas of unique interest.

Feasibility—Feasible along all roads.

Effectiveness—An effective treatment for all road types.

Cost—Low.

GUARDRAILS

Description—Guardrails can prevent run-off-road vehicles from striking trees as well as other roadside obstructions. A properly designed and installed guardrail, conforming to guidelines documented by AASHTO,[9] can effectively dissipate the vehicle energy before contact is made with the tree(s) or can channel the vehicle away from the tree(s). Guardrails should only be used when the severity of striking a roadside object is greater than striking the guardrail; this is usually the case with mature trees. Any nontraversable obstacle (like trees) that warrants shielding by a barrier, should be considered for removal. If this is not practical, a barrier may be provided. Using a section of guardrail horizontally longer than the width of the tree, however, may create a greater problem than leaving the tree unprotected.

Installation—Guardrail installation can be done by regular maintenance crews using power equipment and hand tools.

Environmental Impacts—The installation of guardrail, as a spot treatment, affects the environment minimally. It may reduce visual quality in some areas, such as near historical or aesthetically sensitive locations. Grading and augering may result in soil erosion. The effects of traffic flow alterations during installation are minimal.

Feasibility—Feasible along all road conditions.

Effectiveness—Guardrails have proven effective in reducing the severity of impacts with fixed objects such as bridge piers and abutments, street posts, and trees. They may actually increase the number of accidents, however, particularly when the guardrail protects a narrow object such as a tree.

Cost—Moderate. (Consider maintenance cost to repair when hit.)

REGRADING DITCH SECTIONS

Description—All too frequently, roadside ditch maintenance results in ditch lines that are constructed extremely close to existing trees. Typically, trees are left on the backside of ditch slopes, but within impact range of a channelized vehicle. Field observations of accident sites have indicated that the vehicle leaves the traveled portion of the roadway, becomes trapped in the ditch, and is channeled directly into the tree(s). Relocation or regarding of ditches can eliminate this problem.

The vehicle/tree accident risk of trees along ditch lines is often obscured by other vegetation. In most cases where this risk exists, removal or alteration of the fixed object is often preferable. Regrading may be impractical if it is likely to adversely effect the roots of trees to be saved. Also, the benefits of preserving one higher risk tree may be negated if other trees must be removed that do not represent a risk.

Installation—The work can be done as part of a routine maintenance operation with graders, backhoe equipment, or other specialized ditching machines.

Environmental Impacts—Since the amount of regrading required to direct vehicles away from higher risk trees varies with each situation, the extent of potential impacts also varies. Some effects on drainage can be anticipated, and excessive drainage might occur in special situations. The primary environmental impact may be soil erosion and sedimentation during and after construction. If additional right-of-way is required, the effects on adjacent land use may be important.

Feasibility—Feasible for rural U.S./State roads; feasible with limitations for rural local roads.

Effectiveness—Effective in eliminating the problem of vehicles becoming channelized in ditches.

Cost—Moderate.

SLOPE ALTERATIONS

Description—Front slopes of road embankments or backslopes of ditch sections frequently lead directly to trees. In some cases, it is possible to regrade the slope to direct run-off-road vehicles away from the trees or provide additional space to permit the driver to regain control of the vehicle. The effect of the slope alteration on the vigor of the tree(s) is an essential consideration before treatment is initiated. The operation may be limited by the horizontal distance between the shoulder edge and the tree.

Installation—Slope alterations can be done with graders, front-end loaders, small earthmovers, or specialized ditching machines, and can be included in routine maintenance work.

Environmental Impacts—Environmental concerns with this treatment are similar to those of ditch regrading—soil erosion, sedimentation, and drainage.

Feasibility—Feasible along rural U.S./State roads; feasible with limitations along rural local roads.

Effectiveness—An effective treatment for all road types.

Cost—Moderate.

PROTECTIVE PLANTINGS

Descriptions—Protective plantings of dense shrubs can be used to shield trees from run-off-road vehicles. Care must be taken to select shrubs which are indigenous to the area, require little continuing maintenance, and can be planted with a high degree of growth success. The plants will not form an effective barrier until 5 to 10 years after planting.

Installation—Shrubs can be planted by maintenance crews, and do not require heavy equipment. Little continuing maintenance should be required.

Environmental Impacts—The functional role of vegetation is generally associated with positive environmental effects (e.g., aesthetics, wildlife habitats, etc.). Use of natural barriers should not obscure other higher risk objects or reduce sight distance.

Feasibility—Feasible with limitations along rural U.S./State roads and rural local roads. Plantings along some roads are considered impractical because the right-of-way area may be insufficient to provide the area required for planting.

Effectiveness—Plantings of dense shrubs have been effectively used to protect bridge piers located too close to the traveled portion of the roadway. These plantings could be especially effective on curves where woodlots exist. Protective plants may be placed in cleared areas up to the right-of-way line, providing attenuation against impacts with objects beyond the right-of-way. Due to the aesthetic nature of these plantings in some situations, use of protective plantings may be a suitable aesthetic replacement following tree removal. It may take several years before plants have matured enough to become effective buffers.

Cost—Moderate.

ROAD RELOCATION/REALIGNMENT

Description—Road relocation/realignment is particularly effective when roads are being reconstructed and improved. During the realignment of the new road, curves can be flattened and relocated to increase distance from the roadside trees. Design and space requirements are essential factors to be considered. Construction activities should be planned so that preserved trees are not effected. The total impact of realignment should not be greater than removal of the higher risk tree(s). Realignment could adversely effect other land uses such as, agricultural and/or wetland areas.

Installation—Road realignment requires the use of heavy equipment and trained personnel; it is usually done during road reconstruction and improvements.

Environmental Impacts—This treatment entails more extensive cost and environmental impact considerations. Significant short-term impacts will occur. Long-term impacts will be site-specific. Projects which require additional rights-of-way to place the roadway further from trees will have the most environmental impact. An extended period of traffic detouring will disrupt local travel patterns and shift the associated impacts to other roads for the period of reconstruction.

Road relocation may mean direct habitat loss of vegetation and wildlife. Indirect effects may be disruptive to habitat continuity and travel lanes for wildlife. An environmental assessment is often required before this method can be constructed. Such activity should not occur without a proper cultural resource review of the projected impact area by the State Historic Preservation Officer (SHPO) or other designated state authority.

Feasibility—Feasible for all road conditions.

Effectiveness—This method is effective; but it may create different hazards. Road relocation has been effectively applied to "S" curves; accidents other than those involving trees may also be reduced in number and severity.

Cost—High.

ENVIRONMENTAL CONSIDERATIONS

The aesthetic and functional relationship of trees to the roadway and to adjacent property should be considered prior to recommending removal, particularly if the tree is located off the road right-of-way.[7][8] Ornamental or aesthetic relationships of trees may be particularly significant when removal will radically alter the landscape character. Functional aspects of trees may be of real significance for shade, wind breaks, visual buffer, and even physical protection from run-off-road vehicles.

Alternative treatments associated within the roadway and shoulder should first be considered to reduce the risk of run-off-road vehicles. Following consideration and/or application of these alternatives, it may then be appropriate to reduce the risk of vehicle/tree accidents through tree removal and/or grading and slope changes, etc. If tree removal is an appropriate alternative to reduce the risk, before a final decision is made or action is taken, other environmental factors need to be considered. Consideration should include issues associated with ownership, endangered and threatened species, unique habitats, tree species size, historic vegetation, erosion and sedimentation, and safety.

OWNERSHIP

Ownership of rural U.S./State and local road rights-of-way may vary considerably from one State or county to another. Even along the same road, the right-of-way may include statutory, easement, and fee ownership situations along a rural local road in Michigan for example. Hence, the authority of a local or state highway agency to perform various maintenance treatments, such as tree removal, along a road right-of-way will also vary.

Many rural local roads are statutory rights-of-way. In Michigan, for example, they originally consisted of a 66 foot right-of-way centered along township section lines for the purpose of providing local access. The road right-of-way is actually owned by the adjacent property owners. Over the years, only the center portion of the original 66 foot right-of-way may actually have been used and maintained for the roadway; adjacent property owners have included the remaining portions of the right-of-way along with other adjacent land uses. Thus, the maintained portion of many statutory rights-of-way may be quite narrow, often little wider than the roadway itself.

Other locations may include easement rights-of-way. Based on the conditions of the easement, the road authority's right to maintain the road right-of-way is established. This authority may also vary from easement to easement, as does the actual easement width.

U.S./State road rights-of-way are more generally owned in fee (fee sample) by the road agency. Here, the authority of the highway department to perform maintenance work within the established right-of-way is more clearly established by ownership, established policies, safety and environmental laws and regulations.

Therefore, because of the variability of ownership conditions that may exist along any rural local and rural U.S./State roads, care must be taken to determine ownership as part of any treatment program.

In addition, laws have been established in many states to protect "natural rivers"([10]) and "scenic roads". The importance of roadside trees for aesthetics and tourism (summer beauty and fall color tours, etc.) should not be underemphasized, especially with regard to designated scenic roads.

State and some local road authorities may keep up to date records of their rights-of-way, and various ownership conditions. This greatly facilitates both road improvement and maintenance operations. However, if there is any question concerning right-of-way ownership, this needs to be established before roadside maintenance work, like tree removal, should or can be performed.

Determining ownership requires that deeds, land contracts, or other documents be located and interpreted. This interpretation as well as the exercise of judgment that might be required in unusual cases, can best be done by someone experienced in this area.

In the case of vacant land, the owner(s) should be identified by a search of the records of the county or local registrar of deeds. If the property has a building on it, the results of the search should be checked against the identity of the persons actually occupying the property. If there is a discrepancy, consult the occupants. It is not sufficient when the property is occupied to rely on the records of the registry of deeds. It is common, for example, for land contracts not to be recorded.

Once right-of-way ownership is verified, appropriate notification and/or request for permission to perform treatments, like tree removal, can be made (chapter 5, "Letters of Notification and Permission To Apply Treatment"). As discussed in chapter 5, it is important that property owners and adjacent property owners be contacted concerning a proposed treatment, even notice to an adjacent property owner is recommended to maintain a climate of cooperation and to avoid potential environmental conflicts.

ENDANGERED/THREATENED SPECIES AND UNIQUE HABITATS

For situations in which an endangered and threatened plant or animal species or their habitat will be effected by tree cutting, removal, or maintenance, other treatments need to be considered. These plants and animals are protected by law.[11] Actions which may jeopardize these species must withstand a detailed review.[7][8] State and Federal laws and regulations controlling water pollution, fill and dredge, coastal zone management, natural rivers, highway construction, and land use planning, can be used to varying degrees on both public and private lands to protect the habitats of these plants and animals.

Prior to any tree cutting or removal program, contact the State Department of Natural Resources (DNR), the U.S. Department of Interior (Fish and Wildlife Service), or other designated authority to verify the known existence of endangered and threatened plant or animal species and critical habitats along the road rights-of-way that are being considered for treatment. Written documentation from the DNR (for example) as to the existence, suspected existence or absence of endangered and threatened species that would include each potential site should be received prior to the selection of the treatment. This may easily be done as a one-time blanket review for a county or local area, and revised as appropriate by contacting the designated state agency.

If, based on appropriate review, higher risk sites are not identified as critical habitats or do not include endangered and threatened plant or animal species, appropriate action may proceed.

If an endangered and threatened plant or animal species or its critical habitat is identified in the area selected for treatment, and the proposed treatment will adversely effect the species or habitat as determined by the designated authority, suitable alternative measures need to be evaluated. If no alternative can be identified, additional negotiations or legal proceedings may be required to resolve the issue.

TREE SPECIES SIZE

Species designated as champion trees in your state or included in the **National Register of Big Trees**[12] require special consideration because their location, life expectancy, and possible historic value may be extraordinary and worth preserving (see "Historic Vegetation").

Based on field verification and consultation of available registers of champion and big trees, determine which trees have been formally designated either state champion trees or national big trees, or are in the process of being designated. Accurate identification of tree species is important for identifying champion trees. To determine if a champion tree is effected, a qualified forester, botanist, horticulturist, or landscape architect should be consulted. The national champion Michigan Holly, for example, is 8 cm in diameter. Reliance on "large size" may not be adequate.

If a tree has been registered, measures other than cutting or removal need to be considered. If no other suitable means to reduce accident risk at the site can be identified, resolution may need to be made with local, state, and federal agencies and commissions, or organizations associated with "big tree" or champion tree designations.

If, during field verification, a tree is identified as having exceptional size for its species, consult the **National Register of Big Trees**(12) for initial verification of a potential champion. If the tree meets or nearly meets "big tree" qualifications, contact the appropriate agency before taking any further action which might adversely affect the tree. If the tree is verified as a "big tree," measures other than removing or cutting need to be considered.

Even if the tree appears to be exceptionally large, consultation with a qualified forester, botanist, or landscape architect should be made to verify this species, size, and condition. If the tree is not a champion, but is still exceptionally large, professional opinion and/or contact with the appropriate natural resource protection agency should be sought to determine uniqueness and consideration for preservation. Establishing the value of the tree based on a number of factors, including its location and setting relative to adjacent land use, is likely to be an important consideration. To determine tree values, consultation with a professional forester is recommended.

HISTORIC VEGETATION

Trees and other roadside vegetation may have historic or cultural significance in two ways. They may form an important part of the setting or landscaping for an historic structure or an historic district consisting of a concentration of older buildings. The other way is that a particular tree may possess historic significance through a direct association with an event important in history.

Roadside trees and other vegetation can form an important part of the setting for an historic structure or district. Roadside trees and vegetation often contribute strongly to the historic character as well as visual appeal of an historic structure or district. Roadside trees often help to screen historic structures from traffic congestion and headlight glare, for example, that would otherwise reduce its usefulness for residential or other appropriate uses. Thus, the removal of roadside trees and vegetation directly associated with historic properties can have an adverse effect on the historic properties themselves.

Certain individual trees or plants may possess historical significance through a direct association with historical persons or events. Documented "witness trees" used by early surveyors to mark corner points of sections; trees or groves, under or in which important artistic or literary works were created, or which were the subject of such works; trees or groves under or within which discussions or meetings which set in motion important events were held; trees or groves which serve as memorials to important persons, groups, or events where there exists a direct historic link between the trees and the persons; and trees or plants directly descended from such trees or plants may possess historic significance. For example, the book by Michael D. Moore and William B. Botti, **Michigan's Famous and Historic Trees,** published by the Michigan Forest Association in 1976, describes a number of such trees and their historical association.

Historic trees and vegetation should be considered a public asset whose loss might be irreplaceable. Some may be associated with properties listed on the National Register of Historic Places, the State Register of Historic Sites, or local historical registries. State historical agencies and/or local historical societies and commissions are the best sources of information. Use of Federal-aid funds to remove historic vegetation may conflict with section 4(f) of the Federal-aid Highway Act.

In most cases, historically significant vegetation consists of mature trees and/or are part of manmade landscape features. The age of a tree alone is rarely enough to make a tree significant; the tree should be directly associated with specific historic events or contribute to the character of a historic property or historic district.

The State Historic Preservation Officer (SHPO) should be notified of a vegetation control project if:

1. Vegetation known to be historic lies within 100 feet of the project.
2. The project is on or adjacent to properties with buildings or other structures which appear to be more than 50 years old or significant open areas such as parks and cemeteries are effected.
3. The project will effect large, mature trees within 50 feet of a section corner (possible witness trees).
4. Local sources such as historical societies, historical commissions, or persons knowledgeable about local history feel the vegetation is historically significant or constitutes a local landmark.

If the SHPO or other appropriately designed state authority determines that a vegetation control project would affect historic values, its staff can suggest alternatives which would minimize the possible damage to historic properties while meeting safety concerns.

EROSION/SEDIMENTATION

Sediment degrades water quality, and destroys natural plant growth. When deposited in new locations it can interfere with land uses. Additionally, sediment may carry or contain chemical pollutants. Careful consideration is needed prior to tree cutting or removal to insure that such actions, even when combined with erosion and sedimentation controls, will not seriously affect surrounding land and water uses.([7])([8]) Special care should be taken in areas of high erosion potential, such as steep slopes, drainageways, and stream banks. In Michigan, for example, the Michigan Soil Erosion and Sedimentation Control Law (Act 347) was enacted to protect Michigan's land and water resources. Several situations may necessitate contact with the State's Department of Natural Resources or other designated authority concerning the need for mitigative procedures:

- If there is a steep slope and/or highly erodible soils.
- If the trees to be cut or removed are the main vegetative binding of the soil.
- If the site is adjacent to an existing water course, wetland, or lake.
- If tree cutting or removal will cause degradation of water quality either through increased exposure to the sun or increased potential for soil erosion and sedimentation.

If degradation of water quality is likely to occur, alternative measures and/or mitigation will need to be evaluated. If no suitable alternative is found, negotiations or legal action may need to be pursued.

SAFETY ISSUES

Prior to cutting or removing higher risk accident trees, additional consideration should be given to situations that would expose residents, occupants of other buildings, or pedestrians to run-off-road vehicles or provide an unimpeded approach for run-off-road vehicles to go over a cliff or into a lake or river, or to hit other obstacles. Consideration of these situations might avoid creation of a new set of injury risks. Treatments other than tree removal, such as a guardrail, may be a more suitable alternative.

MITIGATING ENVIRONMENTAL IMPACTS

Measures that may be used to mitigate environmental impacts of tree removal are encouraged, and expected. Where the number of potential viewers is high, various measures may help minimize aesthetic impacts. Mitigative measures are particularly useful and necessary for areas in which landscapes are associated with high scenic values and concerned viewers (tourists) are important, especially where landmarks and high traffic volumes exist. In some instances, however, environmental impacts may be inevitable.

Minimize Disturbance—In all instances, the disturbed area should be limited as much as possible. Vegetative cover may need to be reestablished; tree(s) may be replaced from nursery stock. Even the color contrast of freshly cut stumps (even cut flush with ground level) can be reduced if they are treated. Painting, or even a shovel full of dirt on top of the stump provides a short-term solution. Stumps of deciduous trees should be chemically treated to reduce sprout growth.

For areas where soils have been disturbed and soil stabilization is required, specific soil erosion and sedimentation mitigation is needed. Specialized manuals should be referred to, such as the **Michigan Soil Erosion and Sedimentation Control Guidebook.**

Plant Trees—Where the functional and/or aesthetic loss of trees is significant (such as sun filtration, windbreaks, noise abatement, visual buffer, or even physical buffer), consider planting replacement trees outside the clear zone. Consultation with a professional forester and/or landscape architect is recommended to determine when a tree may warrant replacement to help mitigate an aesthetic or functional loss. Where trees requiring removal are located outside the right-of-way particularly in viewer sensitive areas such as residential uses or intensively used parks or recreational areas, plantings should be considered.

When Disturbance to the Environment is Unavoidable—For some treatments, such as road relocation or new construction, disturbance to the environment is unavoidable. However, opportunities to employ site-specific mitigation measures may exist. When Federal and/or State funding is involved with a project, specific legislative requirements must be met concerning impacted areas. Laws mitigating impacts associated with wetlands, floodplains, endangered species (plant and animal species and habitat), cultural resources, agricultural land, and public and recreation land, are very specific, and must be followed. If professional staff are not available in-house to address these issues, consultants may be required to address appropriate laws and obtain necessary environmental clearances permitting construction of projects, especially relocation or realignment of roads. For example, Federal-aid highway projects are to be reviewed by the State Historic Preservation Officer (SHPO). Consultation will determine the effect of the proposed project on prehistoric or historic cultural resources (see "Historic Vegetation"). If the proposed project affects a site eligible for or listed on the National Register of Historic Places, further negotiations under section 106 of the National Historic Preservation Act and possibly section 4(f) of the Department of Transportation Act are necessary. Certain States and local jurisdictions may also have historic preservation requirements.

Mitigation may require alteration of the project landscaping, moving of vegetation, replacement of vegetation, or other appropriate measures.

One should note that mitigation of an environmental impact does not necessarily mean replacing one impact with another. Using road relocation as an example, loss of a particular land use may be mitigated if the former location of the road right-of-way can be returned to the same land use lost by road relocation, or enhanced to a higher or better quality. Loss of a wetland or wildlife habitat can be mitigated to a limited extent by providing a more diversified habitat. Although mitigation might be achieved in the long run, considerable environmental impacts may occur in the short run.

MAINTENANCE

Once the higher risk roadsides in the particular jurisdictional area have been treated, the responsibility for maintaining these as clear zones shifts to the maintenance unit of the responsible road authority. Supervisors and crews different from those that evaluated the higher risk roadside environments will likely be responsible for maintaining the risk reducing treatment.

Maintenance of these higher risk roadsides as clear zones is necessary, to avoid future safety problems and increasing vehicle/tree accident risk as vegetation naturally reestablishes itself along the roadside. Without a maintenance program, a much more costly tree removal and/or treatment program would again have to be implemented. This is why it is important to emphasize the need for maintaining the roadside once cleared or treated. Brush and tree maintenance programs developed from this guide should be integrated into the responsible department's overall maintenance program. Whenever possible, existing personnel and equipment, standard crews and work schedules should be used.

Because each higher risk roadside was evaluated independently, information is available for each area that must be maintained, explaining the factors associated with it, including the location and distance from the road edge that should be maintained. (item No. 22, field verification form, appendix A.)

Because of local variations in weather, topography, etc., a single maintenance method cannot be applied to occurrences of similar roadside environments throughout any State. Rather, several methods or combinations of methods must be employed to achieve the desired maintenance goal. Selection of a method or methods must be based on the site-specific conditions encountered, including environmental concerns,[7][8] and documented on the field verification form.

Four basic maintenance methods or responsibilities are generally involved in maintaining clear zones:

1. Mowing.
2. Tree trimming, thinning, removal.
3. Herbicide application.
4. Maintaining constructed items (signs, guardrail, shoulders, ditches, etc.).

Property owners affected by roadside trimming, thinning, or removal operations on or off the road right-of-way should be notified of the proposed work. This is particularly important in locations adjacent to residences, nature areas, plant preserves, parks or landscaped areas.

This should be done not only to promote good public relations, but to facilitate implementation of maintenance programs by helping to identify or avoid locations particularly sensitive environmentally, or of a controversial nature. Where the adjoining landowner is not in agreement with the proposed treatment, procedures outlined in chapter 3 should be used to satisfactorily resolve issues.

CHAPTER 5 TREATMENT PROGRAMS AND PUBLIC RELATIONS

Whether potential impacts of a treatment program (including tree removal) are major or minor, long-term or short-term, the choices being made affect people. They need to be informed if they are to constructively participate in the program.[13]

FIELD INTERVIEWS

The community is an important source of information. For locations that have been identified as having a higher vehicle/tree accident risk, discussing the location with people who live near it, can be helpful in establishing a suitable treatment. Contact with people who live nearby may also clarify local opinions concerning treatment. This may be very important, not only to promote good public relations, and educate the public concerning a safety program, but help identify locations particularly sensitive environmentally, or of a controversial nature.

Interviews during the field verification process are considered public relations. Here are some guidelines to follow:

1. Introduce yourself and show an identification card.
2. Briefly explain what the agency is doing and what is desired of the individual:

   "We are checking the risk of vehicle/tree accidents along roads in this area. We would like to ask some questions concerning your road."
3. Ask about trees that have been singled out as being a higher risk because they bear accident scars, were identified on an accident report, etc. "We found some scars on these trees that indicate they have been hit by a vehicle. Is that true? Are there any other trees in this area that you know have been hit by vehicles?" Identify the specific trees, and ask the respondent to identify the trees.
4. Discuss the conditions that may necessitate a treatment other than removal; e.g., "big trees", historic trees, sedimentation/erosion or safety problems; presence of wetlands/streams/rivers/lakes, endangered/threatened species.
5. Ask if there are any other factors that should be known, for instance, particular cultural importance of the area, etc.
6. Ask them what they think should be done to reduce the risk of run-off-road accidents.
7. Obtain the person's name, address, and phone number.
8. Thank them and tell them that they may be contacted again regarding treatment of dangerous trees on their property or on adjacent property.

LETTERS OF NOTIFICATION AND PERMISSION-TO-APPLY TREATMENT

Permission from adjacent property owners to remove trees is not generally required for rights-of-way owned in fee by the road authority. Nor is permission typically required from property owners for easements allowing the road authority to perform maintenance or safety improvements. But in these situations, it is recommended that adjacent property owners be notified before treatments, (such as tree removal), are to be performed. The adjacent property owners should be notified in writing (appendix D, figure 19). But typically, contact with the adjacent property owners in person, and a record of verbal agreement is sufficient. It is important that adjacent property owners be contacted, not only as a courtesy, but because specific environmental considerations may have relevance to removal, and might not be realized otherwise.

For statutory rights-of-way, some easements and private land that may be effected outside of the right-of-way, permission from the land owner to perform treatments, like tree removal, is needed. The landowner needs to be contacted before the selected treatment is to be performed. Notification should preferably be in writing, and may be by certified mail (appendix D, figure 18). The letter should identify the land parcel, and specify the tree(s) involved. For trees off the right-of-way, the letter should offer the owner(s) the opportunity to make separate arrangements, to cut and/or transplant the tree(s) themselves. The letter can be prepared in such a way that the landowner(s) need merely sign it and return it to indicate consent. It should include a grant of the right to enter the owner(s) land, to cut the tree(s) and remove the wood, if appropriate. Sufficient time must be given to the property owner(s) to perform the treatment or make other arrangements.

If a landowner refuses to grant permission to cut trees on property not under jurisdiction of the road authority, and if negotiations fail, it may be necessary to take legal action to obtain authority to cut trees. There are two ways in which this might be accomplished. First, the power of eminent domain (condemnation) might be used. Second, the road authority might treat the trees as a public nuisance and sue to require the owner to "abate the nuisance" by removing the trees. There is authority that trees are a nuisance when they "endanger the safety of travelers".([14])

PUBLIC HEARINGS

For many Federal projects, public hearings are required by law. Some States also have hearing requirements. Consequently, a road agency will be holding hearings from time to time. A road agency may choose to hold additional hearings.

Public hearings are a chance for people to make their views known; a chance for people to hear the views of others expressed and explained. Communication at formal hearings is typically limited to brief question and answer periods and to making statements. Many people are uncomfortable because of the size of the meeting or its formality and will not speak out or will not even attend. An informal meeting or "open house" may be a good way to solicit feedback from the public concerning a treatment program.

Legally, the road agency must announce the hearing in some way (usually via newspaper) to inform groups or individuals that are affected. The agency should make sure that the public is well informed about the issues weeks in advance, so that concerned groups and individuals have adequate time to prepare their presentations.

Prior to the hearing, all information should be made available to the public for their review, usually at the agency office or at city or, county hall. If an environmental clearance (document) is required, it must be circulated prior to the hearing.

In essence, you are organizing an information campaign aimed at educating the public about the risk reduction program. Basically, the methods that can be used include:

Newspaper—Use the local papers. Try to get the newspapers to write about the issues as part of their community coverage. If the papers are uninterested, as a last resort, the agency should run paid advertisements announcing the time, date, and location of the hearing.

Displays—Understanding of issues is increased by using specific examples. Make every effort to familiarize the public with the issues through displays in municipal buildings, schools, etc.

Brochures—Short, printed pieces on specific issues should also be made available. These brief, simple brochures should detail the problems of vehicle/tree accidents and efforts underway to reduce risk.

Posters, Signs—To use these media, the message must be short; a graphic representation of the message is even more appropriate. These posters and signs should be placed anywhere there are people—on buses, in grocery stores, at the laundromat.

News Releases—Periodically the agency should report to the public about the progress of the program. A news release should be short and factual; the first two paragraphs should contain the who, what, where, when, and why of the message. Since a news release is used to announce something that has occurred or will occur, it should be written in past or future tense. Any statement of opinion must be attributed to a real person and should be put in quotation marks. News releases should be sent to the city editor of the local papers, and to radio and television stations at least 10 days to 2 weeks before the event being announced will occur.

Letters to the Editor—Many people read this section of the newspaper. The agency may wish to write letters to the editor announcing the program or explaining specific points of the program. Letters to the editor give the road agency an opportunity to explain exactly those items needed to be dealt with in an informal way, from the agency's point of view.

Existing Community Programs—Perhaps the most important method to use to get the message out are programs that already exist in the community. Most organizations, such as service clubs, have regular meetings. Ask if they would like someone from the road agency office to come and speak to them and answer their questions about the program. Make sure a representative; who is a good speaker and knowledgeable about the program is sent; prepare a slide show and bring along brochures. Distribute information material through their office. Ask if the road agency can put a notice or an article in their newsletter.

EVALUATING THE INFORMATION PROGRAM

How does the agency determine whether the right people were reached? The agency should keep track of whether or not the news releases were used (either as a basis for a story or word-for-word). If they are not, ask the editor why. Or the number of people attending the hearing could be counted; but this method will not tell whether all the interests of the public were represented: To determine whether the agency information program was successful, the following should be asked of the agency:

1. Were all the people affected by the program allowed an equal opportunity to participate?
2. Were their contributions and preferences given due consideration?

LITIGATION

Occasionally the agency and the property owners involved will not be able to come to a satisfactory agreement on the risk reduction treatment to be applied. After reconsidering all possible alternatives and having all alternatives proposed to the property owners rejected, the agency may have to go to court and get a court order to perform the recommended treatment. There are two ways this might be accomplished. First, the power of eminent domain (condemnation) might be used. To have the tree(s) (property) condemned, the road agency will have to produce expert witnesses who can explain the risk involved in retaining the tree(s). Secondly, the agency might claim the tree(s) to be a public nuisance and sue to require the owner to "abate the nuisance" by removing the tree(s) or performing the treatment recommended. There is a precedent that trees are a nuisance when they "endanger the safety of travelers."([14])

Going to court cannot be taken lightly. This is a last resort when the road agency truly believes that the recommended treatment is the only way to insure the public safety. Coupled with the use of litigation, should be an information campaign explaining the decision to go to court, a public hearing if appropriate, and door-to-door direct contact with citizens if at all possible.

APPENDIX A: Field Verification Form

To vertify higher risk road sections for treatment, fill in or circle appropriate information:

GENERAL

1. Site Visit Date: ____/____/____
2. Form filled out by ______________________________ (name).
3. The road section is on ______________________ Road, beginning ______ (mile) (feet) **N S E W** of ______________________ Rd. intersection, and continuing ______ (mile) (feet) **N S E W.**
4. County ____________ Township ____________ City ____________

SPECIFIC ROAD SECTION

5. Road section type/conditions: ______ curve ______ straight__________ rural local road __________ rural U.S./State road.
6. Road section average daily traffic volume (ADT) ____________.
7. **Expected** vehicle/tree accidents per year (refer to appendix B table 4 of guide and/or your priority listing of road sections) ____________.
8. Site of Vehicle/Tree Accident(s) **No Yes** Number ____________.
9. If known, list accident report number(s) __________, __________, __________, __________, __________, __________, __________.
10. Vehicle/Tree accidents per year (average number of accidents over the data period) __________.
11. **Threshold** value (refer to appendix B, table 5 of guide) __________.
12. If threshold value **is** met (actual number of vehicle/tree accidents per year equal to or greater than threshold value), circle the actual number of vehicle/tree accidents per year in item 10 above).
13. If threshold value is not met, circle the expected number of vehicle/tree accidents in item 7 above.
14. Tree(s) on the **N S E W** side(s) of Road.
15. Existing tree(s) include: **lone tree, clump, planted row, cluster or grove, fence row, woodlot,** other ______________________________ (show location on field observation map of all potentially higher risk trees.)
16. Verify existence of following:

Yes	No	
☐	☐	exceptionally large or champion trees ("big trees")
☐	☐	endangered/threatened trees or other species and habitat
☐	☐	trees associated with historic structures or culturally significant site

☐ Refer to item No. 24 for additional comment.

17. Status of noteworthy tree(s) along road section (show location on field observation map):

Tree	Distance From Road Edge(ft)	Diameter	Accident	Dead, Diseased, etc.	Species
Tree 1					
Tree 2					
Tree 3					
Tree 4					
Tree 5					

☐ Refer to item No. 24 for additional comment.

18. Check the existing land uses most associated with characteristics present at the site/road section.

☐ Residential ☐ Industrial ☐ Wetland ☐ Wooded or Forest Land

☐ Agricultural ☐ Lake ☐ Open or Vacant ☐ Stream or Waterway

☐ Range Land ☐ Commercial, Services & Institutional

☐ Other (Describe) ______________________________

☐ Refer to item No. 24 for additional comment.

FIELD OBSERVATIONS

19. As appropriate, use the field observation (base) map to plot locations of existing trees (i.e., individually, rows, woodlots, etc.) relative to other road/roadside features such as ditches, signs, buildings, and including other items noted below:

Indicate presence and/or occurrence of items below:

Yes	No	
☐	☐	Site of frequent accidents
☐	☐	Speed limit ignored
☐	☐	Signs/signals obscured by trees/foilage/other object
☐	☐	Advisory speed sign present
☐	☐	Section has sharp curve
☐	☐	Allowed passing inconsistent with environmental conditions
☐	☐	Shoulder slope away from road
☐	☐	No-Passing signs/markings ignored
☐	☐	Narrow or no shoulder
☐	☐	Enforcement inadequate
☐	☐	Need for superelevation or improvement
☐	☐	Residents' complaints/requests to have safety improved
☐	☐	Unstable shoulder
☐	☐	Dropoff from pavement/shoulder

Yes	No	
☐	☐	Speed limit too high for conditions
☐	☐	Steep ditch slope
☐	☐	Approach alignment includes curves
☐	☐	Terrain beyond shoulder is downgrade or embankment
☐	☐	Roadside has ditch **with/without** trees
☐	☐	Trees are 20 feet (6.1 m) or more from road edge
☐	☐	Trees are close, 15 feet (4.6 m) or less from road edge
☐	☐	Narrow lanes
☐	☐	Potentially dangerous trees, exhibiting structural weakness, attack by insects, diseased, or lack wind firmness such as to jeopardize the safety of the motoring public
☐	☐	Signs, delineators and/or pavement markings are not standard (warn, damaged, etc.). If so, identify and comment in item No. 24.
☐	☐	Other higher risk fixed objects: _____

Measure and note the following:

Lane width ________, Roadway width ________, Shoulder width ________, Sight distance ________

☐ Refer to item No. 24 for additional comment.

CONDITIONS THAT MAY NECESSITATE ALTERNATIVE TREATMENT TO TREE REMOVAL

20. Check conditions that apply, then describe in detail below (see chapter 4, and sections on "Environmental Considerations").

- ☐ Ownership
- ☐ Trees associated with historic site
- ☐ Endangered/threatened/rare species
- ☐ Erosion/sedimentation wetlands, streams
- ☐ Unusually large or unique tree species size
- ☐ Safety concerns
- ☐ Other factors ______________________________
- ☐ Refer to item No. 24 for additional comment.

CONTACT WITH PROPERTY OWNER(S) AND ADJACENT OWNER(S)

21. Contact was made with property owners ☐ Yes ☐ No

Yes	No	
☐	☐	Confirm knowledge of previous vehicle/tree accidents.
☐	☐	Confirm knowledge of historic/big/endangered/threatened trees.
☐	☐	Identify any additional vehicle/tree accident sites.
☐	☐	Identify any additional considerations and concerns (see chapter 4 of guide).

☐ Refer to item No. 24 for additional comment.

FIELD RECOMMENDATION(S) FOR TREATMENT AND MAINTENANCE

22. Treatment(s) Recommended ☐ Yes ☐ No

COMMENTS: (reference specific items and explain):

____

____

____

____

____

Treatment at this time: ______________________________

Future maintenance to maintain treatment recommended: ______________________________

____

Maintenance schedule proposed to maintain treatment recommended:

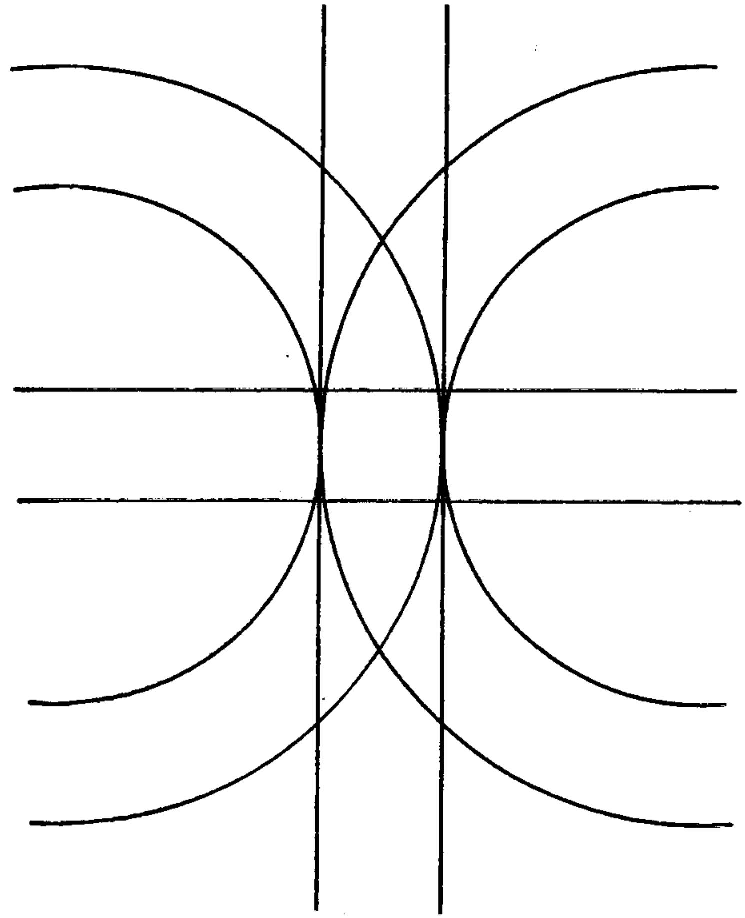
____

☐ Refer to item No. 24 for additional comment.

PHOTOGRAPHS TAKEN AT SITE/ROAD SECTION

23. Attach appropriate pictures (instant or Polaroid type) to this form for a complete record.

FIELD OBSERVATION MAP



List traffic control devices present and note location on preceding field observation map (e.g., signs, pavement and other markings, traffic signal controls):

ADDITIONAL COMMENTS

24. Use this space for making additional comments (add extra sheets if needed)

APPENDIX B: Priorities For Treatment Based on Both Expected and Existing Accident Occurrence

This guide uses the expected number of vehicle/tree accidents as a basis to determine priority treatment along roadsides (task 2). If vehicle/tree accident data is unknown or simply not available over the last 3 to 5 years for a specific road, table 4 may be used to identify the expected number of accidents. This may be used to rank order higher risk road sections for treatment.

If, however, vehicle/tree accident data is available over the last 3 to 5 years, this information may be used to more accurately identify higher risk roads for priority treatment. Use table 5 to identify those roads warranting priority treatment based on vehicle/tree accident frequency. If the threshold value or minimum number of vehicle/tree accidents per year (averaged over data period of from 3 to 5 years) occurs, then that road segment warrants consideration for priority treatment. The threshold value listed should be used to rank order higher risk sections first.

For road sections not having vehicle/tree accidents, or not meeting the threshold, table 4 should be used to identify the risk for that section by the expected number of vehicle/tree accidents. Treatment priority is then based on either expected or existing accident occurrence (using a combined list) whichever is most appropriate, by using tables 4 and 5.

TABLE 4. Expected number of vehicle/tree accidents per year by ADT for rural local and rural U.S./State roads, curved or straight sections.[1 2].

ADT	Rural U.S./State Road		Rural Local Road	
	Curved	Straight	Curved	Straight
100	0.01	<0.01	0.11	0.01
200	0.01	<0.01	0.18	0.01
300	0.01	<0.01	0.24	0.01
400	0.01	<0.01	0.30	0.01
500	0.01	<0.01	0.35	0.01
600	0.01	<0.01	0.40	0.01
700	0.01	<0.01	0.44	0.01
800	0.01	<0.01	0.49	0.01
900	0.02	0.01	0.53	0.02
1,000	0.02	0.01	0.57	0.02
1,100	0.02	0.01	0.61	0.02
1,200	0.02	0.01	0.64	0.02
1,300	0.02	0.01	0.68	0.02
1,400	0.02	0.01	0.72	0.02
1,500	0.02	0.01	0.75	0.02
1,600	0.02	0.01	0.79	0.02
1,700	0.02	0.01	0.82	0.02
1,800	0.02	0.01	0.86	0.02
1,900	0.03	0.01	0.89	0.03
2,000	0.03	0.01	0.92	0.03
2,100	0.03	0.01	0.95	0.03
2,200	0.03	0.01	0.98	0.03

TABLE 4. Expected number of vehicle/tree accidents per year by ADT for rural local and rural U.S./State roads, curved or straight sections (continued)[1 2].

ADT	Rural U.S./State Road		Rural Local Road	
	Curved	Straight	Curved	Straight
2,300	0.03	0.01	1.02	0.03
2,400	0.03	0.01	1.05	0.03
2,500	0.03	0.01	1.08	0.03
2,600	0.03	0.01	1.11	0.03
2,700	0.03	0.01	1.14	0.03
2,800	0.03	0.01	1.17	0.03
2,900	0.03	0.01	1.20	0.03
3,000	0.03	0.01	1.22	0.04
3,100	0.04	0.01	1.25	0.04
3,200	0.04	0.01	1.28	0.04
3,300	0.04	0.01	1.31	0.04
3,400	0.04	0.01	1.34	0.04
3,500	0.04	0.01	1.36	0.04
3,600	0.04	0.01	1.39	0.04
3,700	0.04	0.01	1.42	0.04
3,800	0.04	0.01	1.44	0.04
3,900	0.04	0.01	1.47	0.04
4,000	0.04	0.01	1.50	0.04
4,100	0.04	0.01	1.52	0.04
4,200	0.04	0.01	1.55	0.04
4,300	0.04	0.01	1.57	0.05
4,400	0.05	0.01	1.60	0.05
4,500	0.05	0.02	1.62	0.05
4,600	0.05	0.02	1.65	0.05
4,700	0.05	0.02	1.68	0.05
4,800	0.05	0.02	1.70	0.05
4,900	0.05	0.02	1.72	0.05
5,000	0.05	0.02	1.75	0.05
5,500	0.05	0.02	1.87	0.05
6,000	0.06	0.02	1.99	0.06
6,500	0.06	0.02	2.10	0.06
7,000	0.06	0.02	2.21	0.06
7,500	0.07	0.02	2.32	0.07
8,000	0.07	0.02	2.43	0.07
8,500	0.07	0.02	2.54	0.07
9,000	0.07	0.02	2.64	0.08
9,500	0.08	0.03	2.74	0.08
10,000	0.08	0.03	2.84	0.08
10,500	0.08	0.03	2.94	0.08
11,000	0.08	0.03	3.04	0.09
11,500	0.09	0.03	3.13	0.09
12,000	0.09	0.03	3.23	0.09

TABLE 4. Expected number of vehicle/tree accidents per year by ADT for rural local and rural U.S./State roads, curved or straight sections (continued)[1 2].

ADT	Rural U.S./State Road		Rural Local Road	
	Curved	Straight	Curved	Straight
12,500	0.09	0.03	3.32	0.10
13,000	0.10	0.03	3.41	0.10
13,500	0.10	0.03	3.51	0.10
14,000	0.10	0.03	3.60	0.10
14,500	0.10	0.03	3.69	0.11
15,000	0.11	0.03	3.77	0.11
15,500	0.11	0.04	3.86	0.11
16,000	0.11	0.04	3.95	0.11
16,500	0.11	0.04	4.03	0.12
17,000	0.11	0.04	4.12	0.12
17,500	0.12	0.04	4.20	0.12
18,000	0.12	0.04	4.29	0.12
18,500	0.12	0.04	4.37	0.13
19,000	0.12	0.04	4.45	0.13
19,500	0.13	0.04	4.53	0.13
20,000	0.13	0.04	4.62	0.13

[1]O'Day, James. 1979. Identification of Sites With a High Risk of Run-off-Road Accident. Interim Report UM-HSRI-79-39. University of Michigan, Highway Safety Research Institute. 57 pp.

[2]Expected number of tree accidents per year were extended to 20,000 ADT for rural U.S./State (trunkline) and rural local (county) roads respectively (O'Day, 1979, pp. 25-27).

Although the expected number of vehicle/tree accidents per year could be converted to represent lengths other than 1/4-mile, for consistency and ease of use, 1/4-mile (0.4-km) sections are consistently used throughout this guide when referencing expected vehicle/tree accidents. This length represents a reasonable length from which to evaluate road sections.

TABLE 5. Accident threshold or minimum number of vehicle/tree accidents per year and 1/4-mile (0.4-km) road section, warranting priority consideration for field review and treatment.[1 2]

ADT	Number of vehicle/tree accidents per year.			
	Rural U.S./State Road		Rural Local Road	
	Curved	Straight	Curved	Straight
100	0.12	0.06	0.79	0.12
200	0.15	0.08	1.04	0.15
300	0.17	0.10	1.23	0.17
400	0.19	0.11	1.39	0.19
500	0.21	0.12	1.53	0.21
600	0.22	0.12	1.66	0.22
700	0.23	0.13	1.77	0.24
800	0.25	0.14	1.88	0.25
900	0.26	0.14	1.98	0.26
1,000	0.27	0.15	2.07	0.27
1,100	0.28	0.15	2.16	0.28
1,200	0.29	0.16	2.25	0.29
1,300	0.29	0.16	2.33	0.30
1,400	0.30	0.17	2.41	0.31
1,500	0.31	0.17	2.49	0.32
1,600	0.32	0.17	2.56	0.32
1,700	0.33	0.18	2.64	0.33
1,800	0.33	0.18	2.71	0.34
1,900	0.34	0.19	2.77	0.34
2,000	0.35	0.19	2.84	0.35
2,100	0.35	0.19	2.91	0.36
2,200	0.36	0.20	2.97	0.36
2,300	0.36	0.20	3.03	0.37
2,400	0.37	0.20	3.09	0.38
2,500	0.38	0.21	3.15	0.38
2,600	0.38	0.21	3.21	0.39
2,700	0.39	0.21	3.27	0.39
2,800	0.39	0.21	3.32	0.40
2,900	0.40	0.22	3.38	0.40
3,000	0.40	0.22	3.44	0.41
3,100	0.41	0.22	3.49	0.41
3,200	0.41	0.23	3.54	0.42
3,300	0.42	0.23	3.59	0.42
3,400	0.42	0.23	3.65	0.43
3,500	0.43	0.23	3.70	0.43
3,600	0.43	0.24	3.75	0.44
3,700	0.44	0.24	3.80	0.44
3,800	0.44	0.24	3.85	0.45
3,900	0.45	0.24	3.89	0.45
4,000	0.45	0.24	3.94	0.46

TABLE 5. *Accident threshold or minimum number of vehicle/tree accidents per year and 1/4-mile (0.4-km) road section, warranting priority consideration for field review and treatment (continued)*[1 2].

ADT	Number of vehicle/tree accidents per year.			
	Rural U.S./State Road		Rural Local Road	
	Curved	Straight	Curved	Straight
4,100	0.45	0.25	3.99	0.46
4,200	0.46	0.25	4.03	0.47
4,300	0.46	0.25	4.08	0.47
4,400	0.47	0.25	4.13	0.47
4,500	0.47	0.26	4.17	0.48
4,600	0.47	0.26	4.22	0.48
4,700	0.48	0.26	4.26	0.49
4,800	0.48	0.26	4.31	0.49
4,900	0.49	0.26	4.35	0.49
5,000	0.49	0.27	4.39	0.50
5,500	0.51	0.28	4.60	0.52
6,000	0.53	0.28	4.81	0.53
6,500	0.54	0.29	5.00	0.55
7,000	0.56	0.30	5.19	0.57
7,500	0.57	0.31	5.37	0.58
8,000	0.59	0.32	5.55	0.60
8,500	0.60	0.32	5.72	0.61
9,000	0.61	0.33	5.89	0.62
9,500	0.63	0.34	6.05	0.64
10,000	0.64	0.34	6.21	0.65
10,500	0.65	0.35	6.37	0.66
11,000	0.67	0.36	6.52	0.68
11,500	0.68	0.36	6.67	0.69
12,000	0.69	0.37	6.82	0.70
12,500	0.70	0.37	6.97	0.71
13,000	0.71	0.38	7.11	0.72
13,500	0.72	0.39	7.25	0.73
14,000	0.73	0.39	7.39	0.74
14,500	0.74	0.40	7.52	0.75
15,000	0.75	0.40	7.66	0.76
15,500	0.76	0.41	7.79	0.77
16,000	0.77	0.41	7.92	0.78
16,500	0.78	0.42	8.05	0.79
17,000	0.79	0.42	8.18	0.80
17,500	0.80	0.43	8.30	0.81
18,000	0.81	0.43	8.43	0.82
18,500	0.82	0.43	8.55	0.83
19,000	0.83	0.44	8.67	0.84
19,500	0.84	0.44	8.80	0.85
20,000	0.84	0.45	8.91	0.86

TABLE 5. Accident threshold or minimum number of vehicle/tree accidents per year and 1/4-mile (0.4-km) road section, warranting priority consideration for field review and treatment (continued)[1] [2].

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[1]O'Day, James. 1979. Identification of Sites With a High Risk of Run-off-Road Accident. Interim Report UM-HSRI-79-39. University of Michigan, Highway Safety Research Institute. 57 pp.

[2]The expected number of vehicle/tree accidents per 1/4-mile (0.4-km) road section has been adjusted using standard statistical quality control methods designed to trigger action on outliers. Assuming that the Poisson probability distribution applies to roadside accident (tree) occurrence, the square root of expected accidents per 1/4-mile (0.4-km) road section (O'Day, 1979, pp. 43-49) is used as a measure of variation (standard deviation). Twice this is considered an intolerable deviation from expectation. Thus, by adding twice the square root of accident expectation to the expected accidents per O'Day (above) for rural U.S./State (trunkline) curve all, rural U.S./State (trunkline) tangent all, rural local (county) curve all, and rural local (county) tangent all, we obtain "threshold" of action numbers. If the number of existing vehicle/tree accidents per year meet this accident threshold, that location should be a priority candidate for treatment.

APPENDIX C: Methods To Be More Responsive To Actual Roadway Conditions and Tree Accident Frequencies

ROADWAY CONDITION AND TREE ACCIDENT FREQUENCIES

This guide uses the **expected** number of vehicle/tree accidents to determine priority treatment along roadsides (table 4). When vehicle/tree accident information is available, preferably over a 3 to 5 year period, priority treatment based on actual accident frequency should be determined by using table 5. This table was developed using standard statistical methods to discount random accident occurrence (see table 5, footnote 2). Yet both these tables were derived from a statewide sample of run-off-road accidents that occurred in Michigan for the years 1976 and 1977. This listing is expected to vary somewhat with other states, and counties, depending on local conditions.

To be more responsive to the actual conditions, any road authority can tailor the treatment program to its specific conditions and even update tables 4 and 5 over time as roadway and roadside conditions, driver, auto design, or other variables change. The tree "accident prediction equation" may be used to regenerate table 4.[1] Once table 4 regenerated, table 5 may also be regenerated (table 5, footnote 2). The Michigan Department of Transportation (MDOT) may also be of assistance in applying this equation.

A tree accident prediction formula may be constructed as follows:

1. Classify road tangents and curves in the county or State, for example, into ADT segments.
2. Obtain the mileage for each segment.
3. Obtain the total tree accidents for curves and tangents for a given year.
4. Compute the accident factor ($\propto_c$) as follows for curves and tangents:

$$\propto_c = \frac{\text{Total Accidents per year for curves (tangents)}}{(ADT_1)^{0.7} M_1 + (ADT_2)^{0.7} M_2 + \ldots + (ADT_n)^{0.7} M_n}$$

where ADT_i = the average daily traffic for segment (curve or tangent) i, and M_i = mileage for segment i.

The yearly expected vehicle/tree accidents for a given 1/4-mile (0.4-km) segment can then be calculated:

$$\widehat{ACC_j} = \propto_c \frac{(ADT_j)^{0.7}}{4}$$

where $\widehat{ACC_j}$ is the expected accident total per year for the 1/4-mile (0.4-km) segment_j.

[1]This equation differs from the one used in the original study (O'Day, 1979), and is used here to present a clearer understanding of how the expected number of accidents is computed.

CLASSIFICATION OF ROADWAYS

This guide identifies roadways by risk, based on vehicle/tree accident frequencies associated with specific roadway and off-roadway conditions. Higher risk roadways are differentiated between the following conditions:

1. Rural local roads vs. rural U.S./State roads.
2. Curved vs. straight (tangent, intersections, etc.) road sections.

Average daily traffic volumes (ADT's) are then used as a measure of exposure for higher risk roadways. The higher the ADT, the greater the exposure (probability) or risk of vehicle/tree accidents. Priority treatment of specific roadway locations having significant accident frequencies (thresholds) is a way of being more responsive to actual conditions in any jurisdiction. Treatment priority is based on higher risk locations first.

By necessity, higher risk conditions described above are generalizations. Although not always present at every accident site and/or location, other roadway and off-roadway variables are implicity included within the above broadly described conditions. For example, roadway characteristics (i.e., number of lanes, surface, gradient, lane and shoulder width, etc.) and off-roadway characteristics (i.e., density, size, and distance of trees in relation to edge of road, slopes ditches, etc.) are typically different on a statewide basis between Michigan rural local and rural U.S./State roads (chapter 2).

Because the conditions identified as higher risk in this guide may be somewhat less applicable in some states or counties; and it is likely that other site specific factors also play a role on an individual basis; it is more responsive to tailor a treatment program to conditions for the specific county or State as already indicated in this appendix.

However, another method to be more responsive to conditions for the specific jurisdiction, is to consider differences in roadway classification.

Classification of roadway and off-roadway conditions typically associated with rural U.S./State vs. rural local roads in Michigan may not necessarily be indicators of roadway and off-roadway conditions in other jurisdictions. For example, roads may not even be identified as rural local or rural U.S./State roads, but by functional classification(6) and/or ADT for new construction, safety, and/or maintenance work.

Therefore, if roads described in this guide (rural local vs. rural U.S./State) are not applicable, the method described earlier in this appendix will also allow the agency to more appropriately classify them. This can easily be done by first revising this guide's accident tables (tables 4 and 5, appendix B).

But instead of differentiating between rural local and rural U.S./State roads, group all roads under a single classification. Differentiation of roads simply by ADT (then by curved or straight sections) may more implicity reflect typical higher risk roadway and roadside conditions for each jurisdiction. Use of functional classifications based on AASHTO guidelines(6) may also be of additional benefit toward application of various treatments, or even classification of roads.

APPENDIX D: Sample Letters To Notify And/Or Request Permission From Property Owners Concerning Removal Of Trees

July 1, 1986

Dear Mr. and Mrs. Jones:

As part of its road safety program, the **Monaghan** County Road Commission is removing trees that present a higher vehicle/tree accident risk to passing motorists because of their location near the roadway. Our field investigation indicates that an **elm** tree located **fifteen** feet from the edge of the roadway near the **west end** of your property at **135 West River Road** is considered a higher risk, and should be removed.

Therefore, we request your permission to enter your property and cut and remove this tree at no expense to you. If you grant this permission, the Road Commission will repair any damage caused by cutting and removal of the tree.

Your willingness to grant permission now will be greatly appreciated, so we may be more responsive to improving roadway safety.

If you are willing to grant this permission, please do so by signing in the space indicated below, and return this letter in the enclosed envelope. If you prefer to have the wood from cut tree(s) left for your use, please indicate by noting this request on this letter. If you have any questions, or should you prefer to cut or remove the tree(s) yourself, please give me a call at **(517) 373-8350.**

Yours truly,

____

John Smith
Monaghan County Road Commission

I/We have read the above letter, understand it, and hereby grant permission to the Monaghan County Road Commission or its designee to enter our land and cut and remove the tree described above.

____

Thomas Jones

____

Elmira Jones

Figure 18. Sample letter requesting permission from property owner to remove tree(s).

July 1, 1986

Dear Mr. and Mrs. Jones:

As part of its road safety program, the **Monaghan** County Road Commission is removing trees that present a higher vehicle/tree accident risk to passing motorists because of their location near the roadway. Our field investigation indicates that an **elm** tree located **fifteen** feet from the edge of the roadway near the **west end** of your property at **135 West River Road** is considered a higher risk. Under State law, trees located on the right of way may be removed by the Road Commission when necessary for road purposes. Therefore, the tree described above will be cut and removed. If you prefer to have the wood from cut tree(s) left for your use, please indicate by returning this letter in the enclosed envelope, and noting your request. There will be no expense to you. The road commission will not cut the tree until after **August 1, 1986.**

If you have any questions regarding this, please give me a call at **(517) 373-8350.**

Yours truly,

____

John Smith
Monaghan County Road Commission

Figure 19. Sample letter to notify adjacent property owner of tree removal on the right-of-way.

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