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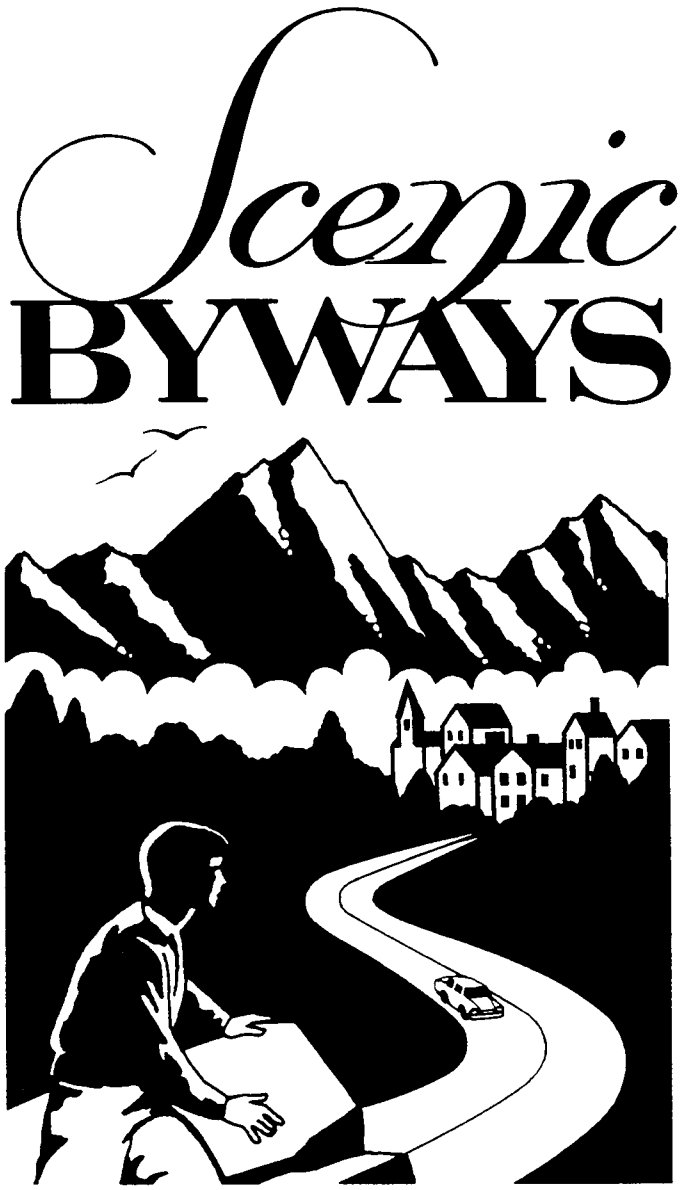
Final Case Study for the National Scenic Byways Study

A Study of the Highway Safety Aspects of the Blue Ridge Parkway



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Final Case Study

for the

National Scenic Byways Study

A STUDY of the HIGHWAY SAFETY ASPECTS of the BLUE RIDGE PARKWAY

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ABSTRACT

The objectives of the study were to : 1) identify and document the highway safety and operational consequences associated with travel on the Blue Ridge Parkway, and 2) determine the design features and operational characteristics of scenic and recreational roads that are most likely to have the greatest impact on highway safety.

During a recent four year period, there were 1,499 accidents on the Blue Ridge Parkway. The accidents rates for this period were : total accident rate = 2.5 accidents/MVMT;injury accident rate = 76.8 accidents/100 MVMT; and the fatal accident rate = 4.0/100 MVMT. When comparing these statistics to rates based on data from other national parks service roads and other roads, the Blue Ridge Parkway fatal accident rate was higher. Single vehicle accidents accounted for 78.6 percent of all accidents. Motorcycles were overrepresented in the accident statistics.

The following road features were found to have the greatest impact on highway safety: a) road geometrics- curves and downgrades in combination, and curves alone (adverse impact), b) roadside maintenance-improving sight distance and signing, and replacing wood guardrail with steel backed, wood guardrail (positive impact), and c) environmental features- fixed objects such as earth embankments, trees, guardrail, and rock outcropping, and points of entry and exit to the Parkway (adverse impact).

A STUDY OF THE HIGHWAY SAFETY ASPECTS OF THE BLUE RIDGE PARKWAY

B. H. Cottrell Jr.

INTRODUCTION

Study Objectives

This study was developed as a case study of the 1990 National Scenic Byways Study. The objectives of the study were to :

1. Identify and document the highway safety and operational consequences associated with travel on the Blue Ridge Parkway. (BRP)

2. Determine the design features and operational characteristics of scenic and recreational roads that are most likely to have the greatest impact on highway safety.

Blue Ridge Parkway

The Blue Ridge Parkway extends 469 miles in Virginia and North Carolina. The parkway links the Shenandoah and Great Smokey Mountains national parks and extends along the crests of the Southern Appalachian Mountains. The typical main line road structure of this two-lane, two-way, undivided roadway is a 21-foot wide roadway width with a minimum 4.5-foot wide, stabilized, turf shoulders (1). The average width of the right-of-way corridor is 1,000 feet.

METHODOLOGY

The study methodology consisted of four tasks.

Task 1. Traffic and Accident Data Analysis

The first and most critical step in this task was to obtain the available traffic and accident data. The initial inquiry with the Blue Ridge Parkway revealed that this may be a difficult step to accomplish. Initially, it was planned that copies of each accident report (300-400 per year) during the desired time period 1987-1989 would be reviewed at the parkway headquarters in Asheville, North Carolina. Also, average daily traffic (ADT) counts were not available, only the annual number of vehicles entering the park. The revised plan was to examine two years of accident data and possibly eliminate ADT because it was not available.

In later conversations with Blue Ridge Parkway officials, it was learned that a traffic safety analysis was conducted for the National Park Service by a consultant. (1) A copy of the report was received from the BRP office. Subsequently, the consultant who prepared the report made available the computerized accident file that was developed during the study for the years 1984-1987.

The decision was made to use the 4-year data base because of the advantages of 4-years of data over 2 years and the

available computer database over the accident report file. Also, the traffic safety study effort collected traffic counts at 12 locations on the parkway to supplement the permanent counts at the endpoints of the parkway.

The traffic and accident data were analyzed to develop the accident rates and severity of accidents.

Task 2. Analysis of Relationships Between the Accident Data and Road Geometrics, Roadside Maintenance, and Environmental Features

In this task the key aspect was the capability of the computerized accident database to determine these relationships with some supplemental data. It was learned that the road design plans were available but to use them would be a time consuming, labor intensive process. Because the accident database included road characteristics and the traffic safety study provided some supplemental data, it was decided that a review of the road design plans would be omitted. Except for a mowing policy, there was no documentation of roadside maintenance. However, information on roadside maintenance was obtained through the BRP headquarters.

The relationships were analyzed with the available data. Highway design and operational features that impact traffic safety the greatest were identified.

Task 3. Comparison of Blue Ridge Parkway Accident Statistics with Other Scenic and Recreational Roads

Accident studies and statistics of scenic and recreational roads, and other classes of roads were identified and compared to the findings in tasks 1 and 2.

Task 4. Report Preparation

In the final task, the data, analysis, and findings of the previous tasks were documented in the final report. The report is divided into four sections:

1. Traffic and Accident Data Analysis
2. Comparison of Accident Data
3. Relationships between Accidents and Roadway Geometry, Roadside Maintenance and Environmental Features
4. Conclusions

TRAFFIC AND ACCIDENT DATA ANALYSIS

Traffic Data Analysis

The traffic volumes were examined for 14 sections. The sections length, average daily traffic (ADT), daily vehicle miles traveled (DVMT), and annual vehicle miles of travel (AVMT) are shown in Table 1. Commuter traffic uses the Blue Ridge Parkway in the two sections with the highest volumes: section 11 in the Asheville, NC area and section 4 near Roanoke, VA. (1) Sixty-two percent of the AMVT is in North Carolina while 38 percent is in Virginia. The AMVT based on these 1988 traffic counts were adjusted to obtain a total VMT for the study period, calendar

years 1984-1987, of 598.78 (1).

Table 1

Average Daily Traffic by Section

SECTION	MP BEGIN	MP END	LENGTH	ADT	DVMT	AMVMT
1	0	27	27	667	17676	6,452
2	27	48	21	333	7026	2,565
3	48	108	60	422	25404	9,273
4	108	122	14	2220	31968	11,668
5	122	176	54	555	29859	10,899
6	176	200	24	990	23661	8,636
7	200	218	18	1111	19554	7,137
8	218	292	75	1000	74600	27,229
9	292	305	13	1555	20370	7,435
10	305	382	77	1890	145341	53,049
11	382	389	7	4500	29700	10,840
12	389	412	23	1777	41226	15,048
13	412	444	32	688	21741	7,935
14	444	469	26	866	22083	8,060

MP-milepost

MP 0-216.9 in VA

MP 216.9-469 in NC

Accident Data Analysis

Accident Data Summary

The accident data consisted of information from all reported accidents on the Parkway from January 1, 1984 through December 31, 1987. The accident data summary is shown by accident severity by year in Table 2.

Table 2

Accident Severity Summary

	1984	1985	1986	1987	Total
Number of Accidents	337	330	395	437	1,499
Number of Fatality Accidents	7	5	9	3	24
Number of Fatalities	9	7	12	3	31
Number of Injuries in Fatality Accidents	5	2	4	7	18
Number of Injury Accidents	114	109	115	115	453
Number of Injuries	174	155	167	159	655
Property-Damage-Only Accidents	216	216	271	319	1,022

Source: Blue Ridge Parkway Traffic Safety Study North Carolina and Virginia

Accident Rates

The Blue Ridge Parkway experienced the following accidents rates during the 4 year study period:

Total Accident Rate= 2.50 accidents/MVMT
Injury Accident Rate= 76.81 accidents/100 MVMT
Fatal Accident Rate= 4.00 accidents/100 MVMT

Death Rate= 5.18 deaths/100 MVMT
Injury Rate= 112.39 injuries/100 MVMT

Accidents Off the Main Line

About 14 percent of the accidents, that is 214 accidents, occurred off the main line of the Parkway. In the accident reporting, the investigating officer identifies accidents off the mainline of the Parkway by the nearest point on the Parkway. Further description such as overlook-off or parking-off is also provided. The mainline and off accidents are summarized below.

	Mainline	Off
Total of Accidents	1285	214
No. of Fatal Accidents	22	2
No. of Injury Accidents	420	33
No. of PDO Accidents	843	179

Serious consideration was given to omitting the off line accidents in the analysis. The off line accidents were retained because they are within the Parkway though not on the main line. However, to address concerns on this issue accident rates are presented below for the main line of the Parkway.

Total Accident Rate = 2.15 acc/MVMT
Injury Accident Rate = 70.14 acc/100 MVMT
Fatal Accident Rate = 3.67 acc/100 MVMT

Death Rate = 4.84 acc/100 MVMT
Injury Rate = 105.21 acc/100 MVMT

Although these rates are slightly lower than the Parkway rates, the conclusion drawn in the comparison of rates in the next section are the same for main line rates as for Parkway rates.

Single Vehicle Accidents

Single vehicle accidents accounted for 78.6 percent or 1,178 of the accidents. Fixed objects off the road were hit in 657 or 43.8 percent of the accidents. A secondary collision with a fixed object occurred in an additional 34 accidents. There were 229 animal-vehicle accidents which represent 15.3 percent of all accidents.

Motorcycle Accidents

Although motorcycles represent about 1 percent of the vehicles on the Parkway, motorcycles were involved in 227

accidents or 15.1 percent of all accidents. Moreover, motorcycle accidents represented 25 percent (6 accidents) of the fatal accidents, and 35 percent (160) of property damage only accidents. Motorcycles are overrepresented in accidents in general, and more severe accidents in particular.

Weather Related Accidents

The percent of all accidents that occurred during various weather conditions are listed below.

	Percent of Accidents
Wet-Road	15.7
Snow/Icy-Road	15.7
Foggy Conditions	7.6
Total	39.1

These factors are represented in 39.1 percent of the accidents.

Alcohol/Drug Related Accidents

There were 110 accidents or 7.3 percent of all accidents that involved alcohol or drugs as a contributing factor. Alcohol and drugs were factors in 54 percent of the fatal accidents, 11 percent of all injury accidents and 4 percent of all property damage only accidents.

Motorcycles, Weather, and Drug/Alcohol Related Accidents

Motorcycles, weather, animals and drug/alcohol were involved in a substantial number of accidents as indicated below.

	Percent of Accidents
Motorcycles	15.1
Weather	39.1
Animals	15.3
Drug/Alcohol	7.3
Total	76.8

These factors contributed to 76.8 percent of all accidents. Some double counting is likely because more than one factor may be presented in an accident.

No Accident Sections

Although the focus in an accident analysis is on where and under what conditions accidents occurred, it was also of interest to examine where accidents did not occur. There were 356 sections of the Parkway that was one-half mile or longer where no accidents occurred. These sections represented 356.1 miles or 75.9 percent of the Parkway.

High Frequency Accident Locations

Locations with more than five accidents during the study period were arbitrarily designated as high accident locations. A list of the 16 locations represented 11.67 percent of all accidents. A sharp curve was present at 11 or 68.8 percent of the locations; a downgrade at 9 or 56.3 percent; and both a sharp curve and downgrade were present at 6 or 37 percent of the locations. There were only two locations (12.5 percent) where neither a sharp curve nor grade was present; one was an intersection and the other was a slight curve.

Table 3

High Frequency Accident Locations

MP	No. of Accidents	Road Characteristic
1.0	6	downgrade
6.9	6	sharp curve
37.4	8	sharp curve
85	21	downgrade
85.9	12	slight curve level
86.0	13	sharp curve downgrade
120.0	25	sharp curve downgrade
121.0	13	sharp curve
217.2	7	sharp curve level
287.0	10	sharp curve downgrade
316.0	9	sharp curve downgrade
382.0	12	intersection
384	15	sharp curve downgrade
384.7	6	sharp curve
385	12	sharp curve downgrade
388	16	sharp curve downgrade

COMPARISON OF ACCIDENT RATES

The Blue Ridge Parkway accident rates were compared with other roads in the National Park Service (NPS) system, four scenic byways in Virginia, and National, North Carolina, and Virginia statistics.

Comparison with Other NPS Roads

Blue Ridge Parkway accident rates were compared with rates based on a 10 park average, and three other parkways as shown in Tables 4 and 5.

Table 4

Accident Rates on NPS Road Systems

Location	Total Accident Rate (ACC/MVMT)	Injury Accident Rate (ACC/100 MVMT)	Fatality Rate Accident Rate (ACC/100 MVMT)
10 Park Average	3.33	68.18	3.17
Shenandoah National Park	7.64	64.69	2.94
Gr.Smoky Mt.National Park	3.51	67.95	2.56
Natchez Trace Parkway	1.22	32.20	3.58
Blue Ridge Parkway	2.50	76.61	4.00

Source: Blue Ridge Parkway Traffic Safety Study North Carolina and Virginia

Table 5

Accident Severity Rates on NPS Road Systems

	Death Rate (per 100 MVMT)	Injury Rate (per 100 MVMT)
Shenandoah National Park	2.94	144.07
Gr.Smoky Mt.National Park	2.56	112.51
Natchez Trace Parkway	4.03	48.06
Blue Ridge Parkway	5.18	112.39

Source: Blue Ridge Parkway Traffic Safety Study North Carolina and Virginia

The total accident rate is generally lower for Blue Ridge Parkway where as the injury accident rate, fatal accident rate, and death rate are higher. Therefore, although the total accident rate is lower the severity of the accidents are greater on the Blue Ridge Parkway. The injury rate is in the middle and is therefore neither higher nor lower.

Comparisons with the Shenandoah and Great Smokey Mountain National Parks are of particular interest because the Blue Ridge

Parkway links these two parks. The injury and fatality accident rates are higher for the Blue Ridge Parkway where as the total accident rate is lower.

Comparison with Other Roads and Road Systems

Accident and severity rates are shown in Table 6 for several roads and other systems.

Table 6

Accident and Severity Rates for Other Roads and Systems

Road or System	Total Accident Rate (accidents/MVMT)	Death Rate (deaths per 100 MVMT)	Injury Rate (injuries per 100 MVMT)
Nationwide (1986) (2)	0.95	2.57	95.72
N.C.- All Public Roads (1)	3.16		
Virginia (all systems)	2.05	2.1	119
Virginia-Interstate (3)	0.83	0.7	46
Virginia-Primary	2.07	2.6	129
VA.-Primary (two-lane) (1)	1.70	3.5	112
Virginia-Secondary (3)	3.89	3.0	213
Virginia Byways (3):			
Route 5	1.66	2.6	113
Route 6	1.66	1.3	95
Route 39	1.51	9.6	99
Route 151	1.73	5.6	98
Blue Ridge Parkway	2.50	5.18	112.39

The total accident rate and death rate on the Blue Ridge Parkway are higher than all of the comparison routes and systems except two (All North Carolina Roads and VA Secondary) for the total accident rate and two (Routes 39 and 151) for the death rate. The injury rate ranks in the middle of the comparison routes and systems. Therefore, the total accident rate and severity based on the death rate are higher for the Blue Ridge Parkway.

RELATIONSHIPS BETWEEN ACCIDENTS AND ROADWAY GEOMETRY, ROADSIDE MAINTENANCE AND ENVIRONMENT FEATURES

Accidents and Roadway Geometry

The relationship between accidents and roadway geometry was examined using two information sources: the accident data base and the Blue Ridge Parkway Traffic Study (1).

Accident Database

The accident database included up to two characteristics identified by the investigating police officer for each accident record. The frequency of a particular road characteristic in the database is shown in Table 7.

Table 7

Single Road Characteristics and Accidents

Road Characteristic	Number of Accidents	Percent of Accidents
Downgrade	490	32.7
Sharp Curve	369	24.6
Slight Curve	333	22.2
Straight	291	19.4
Level	178	11.9
Upgrade	165	11.0
Intersection	139	9.3
Alley, driveway	24	1.6
Other	17	1.1
Bridge Tunnel	16	1.1
No Response	13	0.8
Circle	2	0.1
Merging Lane	0	0.0

Downgrade is the single characteristic most frequently mentioned in the accident reports. However, if the 2 curve characteristics are combined, curve was the most frequently mentioned

characteristic in 702 accidents or 48.6 percent of all accidents.

The frequency of the actual road characteristics for each accident record is presented in Table 8 for the 12 highest frequency characteristics.

Table 8

Actual Road Characteristics and Accidents

Road Characteristics	Number of Accidents	Percent of Accidents
Slight Curve Downgrade	214	14.3
Sharp Curve Downgrade	185	12.3
Slight Curve	84	5.6
Sharp Curve	79	5.3
Straight	71	4.7
Straight level	67	4.5
Slight curve upgrade	60	4.0
Straight downgrade	57	3.8
Slight curve level	48	3.2
Slight curve upgrade	47	3.1
Sharp curve level	44	2.9
Straight upgrade	44	2.9
		66.6

The combination of curves and downgrade were the two highest road characteristics. Moreover, curves were present in the four highest road characteristics. Consequently, it appears that the presence of curves and downgrades combined, and curves have the greatest adverse impact on traffic safety.

Curves and the Maximum Safe Speed

In the Blue Ridge Parkway Traffic Safety Study, the main line of the Parkway was evaluated to determine the maximum safe speed for curves using a ball bank indicator (1). A list of 135

curves that were unsigned or incorrectly signed was developed. An analysis of the list provided the information on the relationship between accidents and the maximum safe speed of curves shown in Table 9.

Table 9

Accidents and the Recommended Safe Speed of Curves

	Recommended Safe Speed, mph		
	25	30	35
No. of Curves without accidents	10	50	68
No. of curves with accidents	23	37	24
Percent of curves with accidents	69.7	42.5	26
No. of accidents/curves with accidents	1.96	1.62	1.25

Two conclusions can be drawn from Table 9 : 1) the percent of curves with accidents decreases as the recommended safe speed increases, and 2) the number of accidents per curve with accidents decreases as the recommended safe speed increases. In other words, the lower the recommended safe speed, the more adverse the impact on safety. The recommended safe speed is very likely to be inversely proportional to the degree of curvature or conversely, directly proportional to the radius of curvature.

Accidents and Roadside Maintenance

Information on roadside maintenance activities on the Blue Ridge Parkway was provided by the Chief of Maintenance and Engineering (4). Mowing is the major maintenance activity and the only activity with a written policy. Mowing is performed about weekly to maintain a maximum height of 4 to 6 inches. Some

mainline maintenance activities and their schedule is shown in Table 10.

Table 10

Maintenance Activities and Schedule

Activity	Schedule
Mowing	weekly
Drive through inspection by rangers and maintenance workers	daily
Ditch maintenance	6 months
Maintaining treee line at its limits	annually
Inspection of traffic signs	annually
Measuring sight distance	6 months
Painting of pavement markings	2 years
Replacing wood guardrail with steel backed, wood guardrail	replacement schedule

Since there is no item on the accident report relative to roadside maintenance, a space for explanations is the only space available for entering such data. There were no explanations related to roadside maintenance nor was the Chief of Maintenance and Engineering aware of any accidents where roadside maintenance was determined to be a contributing factor. In the Blue Ridge Parkway Traffic Safety Study, it was recommended that trees and shrubs be removed to improve sight distance at 11 of the 20 sites evaluated, and that shoulder repairs/improvements be made at 4 of the 20 sites (1).

Improving sight distance on curves and at intersections, adequate signing, especially on curves and at intersections and steel backed wood guardrails are probably the roadside maintenance features that are likely to impact traffic safety the

greatest.

Accidents and Environmental Features

Environmental features were defined as elements in the vicinity of the roadway, that is roadside features such as fixed objects, intersections, and developed areas such as overlooks and campgrounds. Accidents at or involving these features are listed below.

	No. of Accidents	Percent of Accidents
Fixed object	691	46.1
Intersection	197	13.1
Overlook	42	2.8
Parking	72	4.8
Campground	18	1.2
Other	61	4.1

Other includes accidents on service roads to maintenance buildings and other limited use development areas, and miscellaneous.

Fixed Objects

The fixed-objects most frequently hit are listed below:

Fixed Object	No. of Accidents	Percent of Fixed Object Accidents
Earth Embankment	250	36.2
Tree	142	20.5
Guardrail	71	10.3
Rock Outcropping	42	6.1
Drainage Ditch	25	3.6
Fence	22	3.2
Curb or Median	19	2.7
Rockwall	19	2.7
Total	590	85.7

These eight fixed objects were involved in 85.7 percent of all

rock outcropping are the four fixed objects that most adversely impact safety. Roadway geometry is a factor in fixed object accidents because 531 accidents or 76.8 percent of the fixed object accidents occurred along curves. The most commonly used method on the Parkway to address fixed object accidents is signing. In some cases, the fixed object is removed, for example trees are removed or slope of the embankment is cut. Also, the wood guardrail is being replaced by steel backed, wood guardrail.

Intersections, Overlook, Parking, Campground

These four elements are similar in that each create an entry/exit from the Parkway main line. A total of 21.9 percent of the accidents occur at one of these locations. Adequate sight distance and signing are important elements in safe entry and exit through these areas. Points of entry and exit from the mainline of the Parkway moderately impact safety.

CONCLUSION

The following conclusions were drawn from this study:

1. The Blue Ridge Parkway accident rates during 1984 through 1987 were:

   total accident rate = 2.5 acc/MVMT
   fatal accident rate = 4.0 acc/100 MVMT
   injury accident rate = 76.8 acc/100 MVMT
   death rate = 5.18 deaths/100 MVMT
   injury rate = 112.39 injuries/100 MVMT

Single vehicle accidents accounted for 78.6 percent of all accidents. Motorcycles were overrepresented in the accident statistics.

2. When comparing the Blue Ridge Parkway accident statistics with those of other National Park Service roads, it was found that although the total accident rate was lower for the Parkway, the fatal and injury accident rates were higher. Based on a comparison of National, North Carolina, Virginia, and scenic byways in Virginia accident statistics, the total accident rate and the death rate are higher for the Blue Ridge Parkway. The comparisons agree that the death rate is higher and the injury rate is in the middle. For example, when compared to the average rates of 10 National Park Service roads, the fatality, injury, and total accident rates were 26.2 percent higher,12.7 percent higher, and 24.9 percent lower, respectively, for the Blue Ridge Parkway. The Blue Ridge Parkway's death rate and injury rates were the third and fifth highest of the 11 roads and systems reviewed.

3. The road features that have the greatest impact on highway safety are presented for three groups.

a. roadway geometry. The combination of curves and downgrades, and curves alone have the greatest adverse impact. The sharper the curve the greater the impact. The combination of curve and downgrade was the actual road characteristic most frequently noted in the accident report, that is, 399 accidents or 26.6 percent of the accidents. Curve was the single road characteristic most frequently reported for accidents, that is for 702 accidents or 48.6 percent of the accidents.

b. roadside maintenance. Although roadside maintenance was not found to directly contribute to accidents, improving sight distance and signing, and replacing wood guardrails with steel backed wood guardrails are likely to have the greatest positive impact.

c. environmental features. Earth embankments, trees, guardrail and rock outcropping are the four fixed objects, in order of decreasing impact, that most adversely impact safety. These four fixed objects were involved in 505 accidents or 73.1 percent of all fixed object accidents. Points of entry and exit from the mainline of the Parkway provide a moderate adverse impact.

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