

Hazard Elimination Project Evaluation

Project Log # 200608063

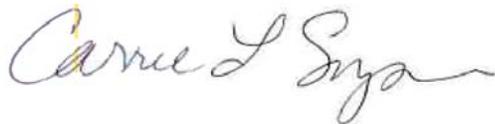
Hazard Elimination Project W-2963

**Evaluation of Shoulder Guardrail Installation on US 64-74 from the
Henderson County Line to SR 1008 in Rutherford County**

Documents Prepared By:

Safety Evaluation Group
Traffic Safety Systems Management Section
Transportation Mobility and Safety Division
North Carolina Department of Transportation

Principal Investigator



Carrie L. Simpson, PE

11/24/2008
Date

Traffic Safety Project Engineer

Hazard Elimination Project Evaluation Documentation

Subject Location

Evaluation of Hazard Elimination Project W-2963 – Installation of shoulder guardrail on US 64-74 from the Henderson County Line to SR 1008 in Rutherford County

Project Information and Background from the Project File Folder

The safety countermeasure chosen for the subject location was the installation of shoulder guardrail at select locations. There were 28,564 linear feet of guardrail and 22 BCT-1 guardrail end treatments installed. US 64-74 is a two-lane highway that passes through a heavily developed residential and commercial area. The majority of this section is speed zoned at 35 mph along the 9.54 mile study area. According to the project file, the shoulder width varies from 3 to 12 feet.

The initial crash analysis for this location was completed from January 1, 1989 through December 31, 1991 with a total of 32 reported crashes. The most prevalent crash pattern at the location was Ran-Off-Road Crashes, which made up 50 percent of the total crashes. The guardrail was installed to reduce the severity of the pattern of ran off road crashes. The project was completed on June 19, 2002 at an estimated cost of \$480,000.

Naive Before and After Analysis

After reviewing the project file folder along with all the crashes at the subject location, the crash data omitted from this analysis to consider for an adequate construction period was from October 1, 2001 through July 31, 2002. The before period consisted of reported crashes from November 1, 1995 through September 30, 2001 (5.92 Years) and the after period consisted of reported crashes from August 1, 2002 through June 30, 2008 (5.92 Years). The ending date for this analysis was determined by the available crash data at the time the crash analysis was completed.

The treatment data consisted of all crashes on US 64-74 from the Henderson County Line (MP 0.0) to SR 1008 (MP 9.54), excluding the section through the Village of Chimney Rock without guardrail (MP 1.67-3.01). A 0 feet y-line was used. Please see the attached *Location Map* for further detail.

The following tables depict the Naive Before and After Analysis for the Total Crashes, Target Crashes, and Influenced Crashes at the treatment location. Target Crashes are Ran-Off-Road Crashes. Crash reports were reviewed to include all crashes where at least one vehicle ran off the road. The Target Crashes were reviewed and further broken down into Influenced Crashes, crashes where guardrail was struck.

It should be noted that there was no specific information in the project file as to exactly where each run of guardrail was placed in this project. Therefore specific crash information for each run of guardrail could not be analyzed. The site visit confirmed where guardrail exists along the segment today, but there was no way to determine where guardrail existed before the project.

Table 1. Treatment Information

	Before Period	After Period	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	132	107	-18.9
Total Severity Index	11.44	11.04	-3.5
Target Crashes (Ran-Off-Road Crashes)	80	73	-8.8
Target Severity Index	12.58	12.42	-1.3
Influenced Crashes (Guardrail Struck Crashes)	10	15	50.0
Influenced Severity Index	12.28	10.99	-10.5
Volume	3900	2300	-41.0

Table 2. Target Crash Information

	Before Period	After Period	Percent Reduction (-)/ Percent Increase (+)
<i>Target Crashes- Injuries</i>			
Fatal Injury Crashes	2	2	0.0
KAB Injury Crashes	26	28	7.7
Injury Crashes	42	48	14.3
<i>Target Crashes-Contributing Factors</i>			
Night Crashes	31	15	-51.6
Wet Crashes	14	21	50.0
Alcohol/ Drug Crashes	23	11	-52.2
<i>Target Crashes- Crash Types</i>			
Ran Off Road	54	20	-63.0
Fixed Object	13	29	123.1
Head On	7	7	0.0
Overturn / Rollover	2	9	350.0
Sideswipe, Same Direction	2	1	-50.0
Sideswipe, Opposite Direction	2	7	250.0

Table 3. Influenced Crash Information

	Before Period	After Period	Percent Reduction (-)/ Percent Increase (+)
<i>Influenced Crashes- Injuries</i>			
Fatal Injury Crashes	1	0	-100.0
KAB Injury Crashes	2	5	150.0
Injury Crashes	6	11	83.3
<i>Influenced Crashes-Contributing Factors</i>			
Night Crashes	4	4	0.0
Wet Crashes	0	5	n/a
Alcohol/ Drug Crashes	2	4	100.0

Results and Discussion

The naïve before and after analysis involving the comparison of treatment actual before data versus treatment actual after data resulted in a 19 percent decrease in Total Crashes and a 9 percent decrease in Target Crashes. Further investigation shows that the Severity Index of Total Crashes and Target Crashes appear to have decreased 4 and 1 percent respectively using naïve methodologies. The Average Daily Traffic (ADT) at this site has decreased substantially by 41 percent. The before period ADT year was 1998 and the after period ADT year was 2005.

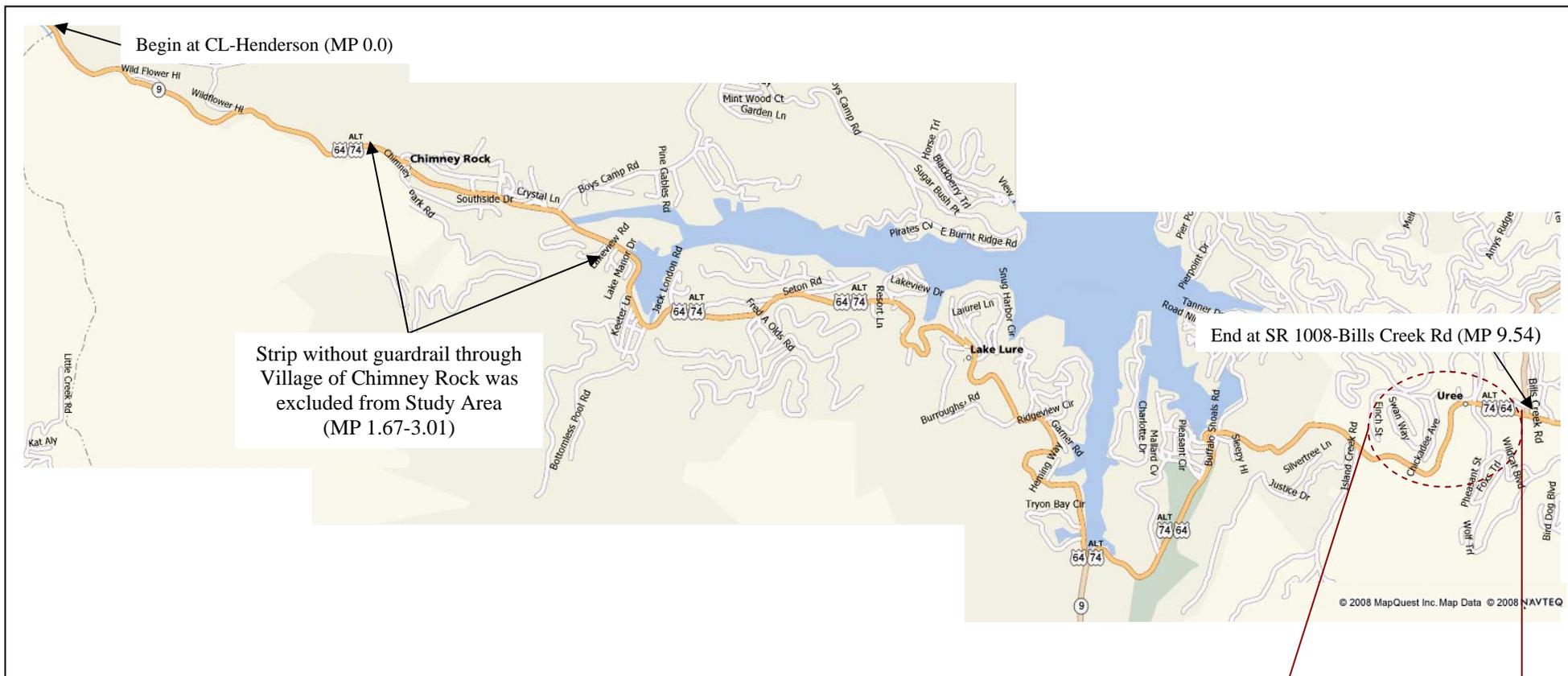
The calculated benefit to cost ratio for this project is 5.76 considering total crashes. The benefit to cost ratio considering only target crashes is 2.55. The benefits are calculated using the change in annual crash costs from the before to the after period. Operational and other benefits related to the project are not considered in this analysis. The costs of the project include the actual constructions costs as well as the increase in annual maintenance and utility costs.

Typically, one would expect guardrail installation projects to result in an increased number of Ran-Off-Road Crashes and a decrease in the severity of Ran-Off-Road Crashes. The increase in Ran-Off-Road Crashes is expected due to the placement of a fixed object (guardrail) near the travel way. The decrease in the severity of Ran-Off-Road Crashes is expected due to the guardrail being more forgiving than the object it is protecting. The results from this project don't seem to be in concurrence with the expected results. There was a slight decrease in the number of Ran-Off-Road Crashes and although the severity index of Ran-Off-Road Crashes decreased slightly, the number of Ran-Off-Road Injury Crashes and Ran-Off-Road KAB Crashes increased.

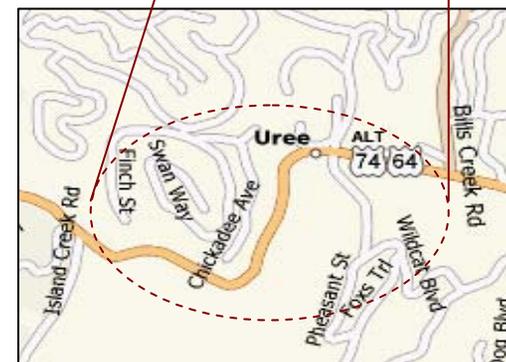
Ran-Off-Road Target Crashes do not provide a completely precise method in which to measure the effectiveness of the guardrail installed under this project. While Target Crashes provide a good picture of what is happening along the entire section of roadway, they fail to provide data specific to the actual treatment locations. The Influenced Crashes (crashes where guardrail was struck) provide a better measure of effectiveness that is more closely related to the objective of the treatment being evaluated. They provide a more meaningful measure of the degree to which the real objective has been achieved. The number of the Guardrail Struck Crashes increased by 50 percent, which may be attributed to the increase in crashes where guardrail was struck under Wet roadway conditions. Note that this includes all guardrail hits along this section of roadway and is not exclusive to the treatment guardrail only.

Over 50 percent of the after period guardrail hits occurred in a one-mile segment between SR 1185 and SR 1008 near the eastern project limits (MP 8.54-9.54). Please see the attached *Location Map* and the *Treatment Site Photos* for additional visual information. As the Safety Evaluation Group completes additional reviews for this type of countermeasure, we will be able to provide more objective and definite information regarding actual crash reduction factors.

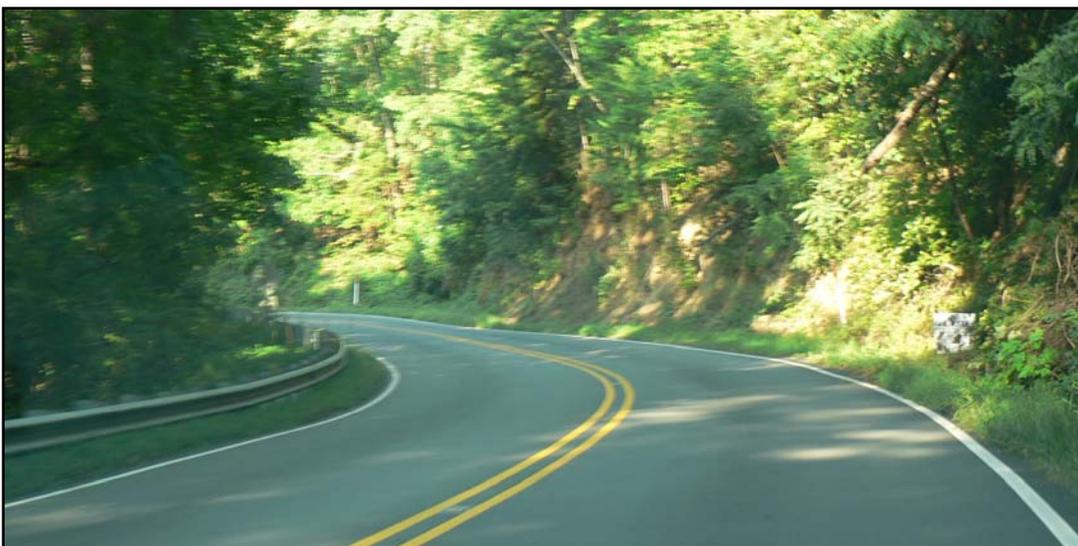
**Location Map: Hazard Elimination Project W-2963
Installation of Shoulder Guardrail on US 64-74 in Rutherford County**



Segment of Interest:
Over 50% of After-Period
Guardrail Hits Occurred in a One-
Mile Segment between SR 1185
and SR 1008 (MP 8.54-9.54)



Treatment Site Photos (Taken on September 18, 2008)



Traveling East on US 64-74

Treatment Site Photos (Taken on September 18, 2008)



Traveling East on US 64-74

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: US 64-74 from Henderson CL to SR 1008
 COUNTY: Rutherford
 FILE NO.: W-2963 Total Crashes

BY: Simpson
 DATE: 11/21/2008

DETAILED COST: TYPE IMPROVEMENT - Shoulder Guardrail

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$0	0	0.000	\$0
Right-of-Way	\$480,000	10	0.149	\$71,534
	\$0	0	0.000	\$0
TOTALS	\$480,000	10	0.149	\$71,534

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$4,932
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$76,466
 TOTAL COST OF PROJECT= \$480,000

COMPREHENSIVE COST REDUCTION:

ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES

TIME PERIOD	YEARS	ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES				PDO		ANNUAL COSTS
		K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	CRASHES	CRASHES PER YR	
BEFORE	5.92	13	2.20	53	8.95	66	11.15	\$1,609,324
AFTER	5.92	9	1.52	53	8.95	45	7.60	\$1,168,750

Annual Benefits from Crash Cost Savings \$440,574

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$364,108

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 5.76

TOTAL COST OF PROJECT - \$480,000 COMPREHENSIVE B/C RATIO - 5.76

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: US 64-74 from Henderson CL to SR 1008
 COUNTY: Rutherford
 FILE NO.: W-2963 Target Crashes

BY: Simpson
 DATE: 11/21/2008

DETAILED COST: TYPE IMPROVEMENT - Shoulder Guardrail

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$0	0	0.000	\$0
Right-of-Way	\$480,000	10	0.149	\$71,534
	\$0	0	0.000	\$0
TOTALS	\$480,000	10	0.149	\$71,534

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$4,932
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 TOTAL ANNUAL COST= \$76,466
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ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES

TIME PERIOD	YEARS	ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES				PDO		ANNUAL COSTS
		K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	CRASHES	CRASHES PER YR	
BEFORE	5.92	9	1.52	33	5.57	38	6.42	\$1,096,216
AFTER	5.92	7	1.18	41	6.93	25	4.22	\$901,182

Annual Benefits from Crash Cost Savings \$195,034

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$118,568

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 2.55

TOTAL COST OF PROJECT - \$480,000 COMPREHENSIVE B/C RATIO - 2.55