

# **Hazard Elimination Project Evaluation**

Order # 41000018269

Hazard Elimination Project W-4843

**Evaluation of the Rumble Strip Installation  
I-40 from the Buncombe County Line to 0.4 mile east of SR 1760  
McDowell County**

Documents Prepared By:

Safety Evaluation Group  
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6-13-2012  
Date

# *Hazard Elimination Project Evaluation Documentation*

## **Subject Location**

Evaluation of Hazard Elimination Project Number W-4843 located along Interstate 40 from the Buncombe/McDowell County Line (Milepost 0.00) to 0.4 mile east of SR 1760, Harmony Grove Road (Milepost 23.467) in McDowell County, including the Cities of Old Fort and Marion.



## Project Information and Background from the Project File Folder

The hazard elimination project improvement chosen for the subject locations were the installation of milled rumble strips along the inside and outside shoulders of this freeway segment.

I-40 is mostly a four-lane median divided facility with 4-foot paved median shoulders and 10-foot paved outside shoulders. The median maintains protection with three-strand cable, W-beam guardrail, or a concrete barrier wall along the entire route. The speed limit varies between 55-mph and 70-mph. This roadway acts as the main connector access to the mountains of North Carolina from the Piedmont Region. The total segment length is 23.467 miles.

The original statement of problem mentioned that vehicles were running off the road resulting in fatalities, serious injuries, and property damage. Casual factors for vehicles leaving the roadway include driver fatigue and/or inattention. Rumble strips provide both noise and vibration as a warning to motorists that they are leaving the travel lane.

The initial crash analysis was completed from June 1, 2000 to June 30, 2003 with 554 reported crashes, with 324 crashes considered correctable Ran-Off Road collisions. The correctable collisions resulted in one (1) Fatal/A-injury crash. The improvement was completed on October 5, 2007 with a total cost of \$168,000. The projected B/C Ratio was 44.51

## Naive Before and After Analysis

After reviewing the project file folder along with all the crashes along the subject segment, the crash data omitted from this analysis to consider for an adequate construction period were the months of June through October 2007. The before period consisted of reported crashes from March 1, 2003 through May 31, 2007 (4 years, 3 months); and the after period consisted of reported crashes from November 1, 2007 through January 31, 2012 (4 years, 3 months). The ending date for this analysis was determined by the date of available crash data at the time of analysis.

The treatment data consisted of all crashes along I-40 with a zero (0) foot y-line (No Ramps).  
*Please see attached location map for further details.*

The following data table depicts the Naive Before and After Analysis for the treatment location. Please note that Interstate Lane Departure Crashes were the target crashes for the applied countermeasure. The Freeway Lane Departure Crash types considered are as follows: Angle; Fixed Object; Head-On; Jackknife; Overturn/Rollover; Parked Motor Vehicle; Ran-Off Roadway (Right, Left, Straight); and Sideswipe (Same and Opposite Direction).

<b><u>Treatment Information</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes – Both Directions	647	836	29.2 %
Total Severity Index	3.81	3.94	3.4 %
LD Crashes – Both Directions	504	626	24.2 %
Lane Departure Severity Index	3.91	4.31	10.2 %

<b><u>I-40 McDowell (MP 0.00 – 23.467)</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Volume (2005, 2009)	27,200	26,900	- 1.1 %
Total Crash Rate (100 Million Vehicle Miles)	65.27	85.28	30.7 %
<b>Injury Crashes</b>			
Fatal Injury Crashes	4	4	0.0 %
Class-A Injury Crashes	3	6	100.0 %
Class-B Injury Crashes	57	69	21.1 %
Class-C Injury Crashes	117	161	37.6 %
Property Damage Only Crashes	466	596	27.9 %
<b>Contributing Factors</b>			
Night Crashes	175	239	36.6 %
Wet Road Crashes (Codes 2, 3)	189	332	75.7 %
Ice/Snow Crashes (Codes 4, 5, 6)	54	91	68.5 %
Alcohol Related	26	23	- 11.5 %
<b>Lane Departure Crash Types</b>			
Angle	6	7	16.7 %
Fixed Object	373	439	17.7 %
Head On	1	5	400.0 %
Jackknife	2	3	50.0 %
Overturn / Rollover	15	28	86.7 %
Parked Motor Vehicle	14	10	- 28.6 %
Ran Off Road (Left)	5	24	380.0 %
Ran Off Road (Right)	6	19	216.7 %
Sideswipe, Opposite Direction	0	2	200.0 %
Sideswipe, Same Direction	82	89	8.5 %

<b><u>I-40 McDowell Eastbound Only</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
EB Total Crashes	344	436	26.7 %
EB Total Severity Index	3.93	3.60	- 8.4 %
<b>Lane Departure Crashes</b>			
EB Lane Departure Crashes	274	330	20.4 %
EB Lane Departure Severity Index	3.89	3.98	2.3 %

<b><u>I-40 McDowell Westbound Only</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
WB Total Crashes	303	400	32.0 %
WB Total Severity Index	3.67	4.32	17.7 %
<b>Lane Departure Crashes</b>			
WB Lane Departure Crashes	230	296	28.7 %
WB Lane Departure Severity Index	3.94	4.68	21.8 %

Due to the crash increase throughout the analysis, the Safety Evaluation Group also examined Segment Weather Data to further identify contributing factors since “wet road” collisions increased by 76 percent. The weather data was obtained from the State Climate Office of North Carolina for the Marion 2 NW Station (315340) with the parameters of precipitation, temperature, and snowfall.

The following table summarizes the weather data. The data was only available through 12/31/2011; therefore a month was eliminated from both the before and after periods.

<b><u>Segment Weather Data</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Weather Event Days	474	469	- 1.1 %
Total Rainfall (Inches)	231.60	211.97	- 8.5%
Average Rainfall per Event (Inches)	0.49	0.45	- 8.2 %
Total Snowfall (inches)	13.4	24.9	85.8 %

Since the weather data chart indicates a decrease in rainfall total but the roadway experienced such an increase in wet road crashes, the segment was analyzed in smaller sections (5 mile segments) to highlight potential problem areas:

<b><u>Wet Road Analysis (Codes 2 &amp; 3)</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Milepost Range 0.00 – 4.99</b>			
Total Crashes	65	113	73.8 %
Lane Departure Crashes	51	94	84.3 %
<b>Milepost Range 5.00 – 9.99</b>			
Total Crashes	25	50	100.0 %
Lane Departure Crashes	20	44	120.0 %
<b>Milepost Range 10.00 – 14.99</b>			
Total Crashes	37	75	102.7 %
Lane Departure Crashes	31	70	125.8 %
<b>Milepost Range 15.00 – 19.99</b>			
Total Crashes	36	75	108.3 %
Lane Departure Crashes	30	69	130.0 %
<b>Milepost Range 20.00 – 23.467</b>			
Total Crashes	26	19	- 26.9 %
Lane Departure Crashes	23	17	- 26.1 %

From the Wet Road Analysis table, it appears that the After Period increase in wet road collisions (both total and lane departure) is a county wide issue versus an isolated segment.

## **Results and Discussion**

Reviewing the tables above, the overall segment increased crashes by 29 percent with a 24 percent increase in Lane Departure collisions from the before to the after period. Along with that severe injury crashes (Fatal and A-injury) increased from eight (8) to ten (10).

From further evaluation, both directions appeared to experience a crash increase above 25 percent. There was a 37 percent increase in Night Collisions and a 76 percent increase in “Wet Road” crashes. From examining the weather data, the average rainfall per event decreased slightly but the after period experienced nearly double the snowfall total.

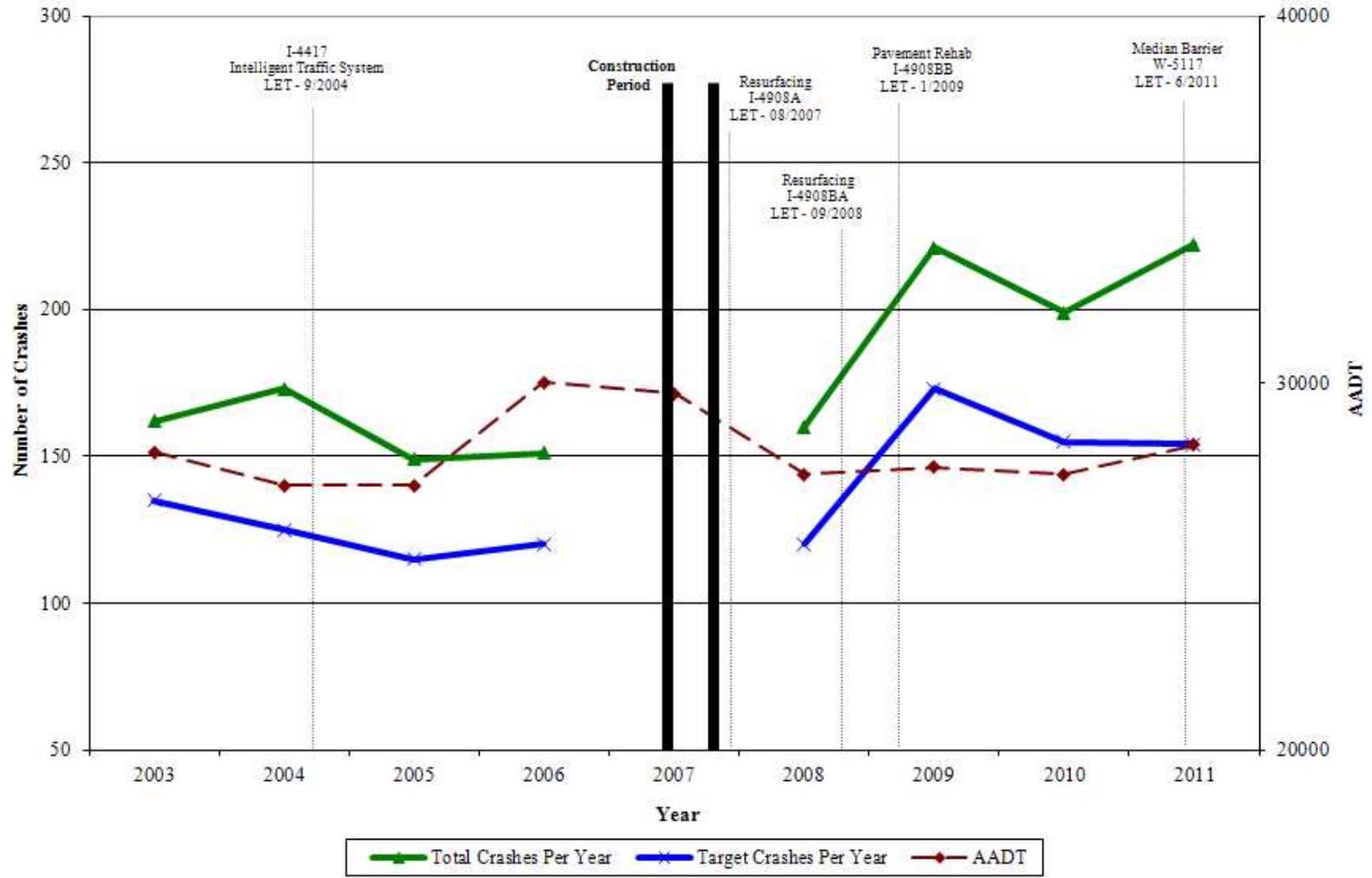
The calculated benefit to cost ratio for this project is **(-33.54) considering total crashes**. The benefit to cost ratio **considering only target crashes is (-30.10)**. The benefits are calculated using the change in annual crash costs from the before to the after period. Operational and other benefits related to the project are not considered in this analysis. The costs of the project include the actual construction costs as well as the increase in annual maintenance and utility costs.

The following chart depicts the number of Total and Target Crashes per year plotted in the before and after period, along with the AADT. Crashes per year appear to have increased dramatically with the Pavement Rehabilitation project in early 2009. Due to the number of other projects that likely influenced crashes during the study period, the increase change in crash values cannot be attributed solely to the rumble strip installations.

As the Safety Evaluation Group completes additional safety reviews for this type of countermeasure, we will be able to provide objective and definite information regarding actual crash reduction factors for this type of treatment.

# I-40 McDowell County - Crashes Per Year

Rumble Strips Completed 10/2007



**BENEFIT-COST ANALYSIS WORKSHEET - Total Crashes**

LOCATION: I-40		BY: JBS						
COUNTY: McDowell		DATE: 5/30/2012						
FILE NO.: W-4843								
DETAILED COST:	TYPE IMPROVEMENT -	Median & Outside Rumble						
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$168,000	10	0.149	\$25,037			
		\$0	0	0.000	\$0			
	Right-of-Way	\$0	0	0.000	\$0			
	TOTALS	\$168,000	10	0.149	\$25,037			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$0			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$25,037			
	TOTAL COST OF PROJECT=				\$168,000			
COMPREHENSIVE COST REDUCTION:								
ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES								
TIME PERIOD	YEARS	K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	ANNUAL COSTS
BEFORE	4.25	7	1.65	174	40.94	466	109.65	\$2,327,953
AFTER	4.25	10	2.35	230	54.12	596	140.24	\$3,167,718
Annual Benefits from Crash Cost Savings								(\$839,765)
NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST					=	(\$864,802)		
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST					=	-33.54		
TOTAL COST OF PROJECT		-	\$168,000	COMPREHENSIVE B/C RATIO		-	-33.54	

**BENEFIT-COST ANALYSIS WORKSHEET - Lane Departure Crashes**

LOCATION: I-40		BY: JBS						
COUNTY: McDowell		DATE: 5/30/2012						
FILE NO.: W-4843		Target Crashes - Lane Departure						
DETAILED COST:	TYPE IMPROVEMENT -	Median & Outside Rumble						
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$168,000	10	0.149	\$25,037			
		\$0	0	0.000	\$0			
	Right-of-Way	\$0	0	0.000	\$0			
	TOTALS	\$168,000	10	0.149	\$25,037			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$0			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$25,037			
	TOTAL COST OF PROJECT=				\$168,000			
COMPREHENSIVE COST REDUCTION:								
ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES								
TIME PERIOD	YEARS	K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	ANNUAL COSTS
BEFORE	4.25	6	1.41	137	32.24	361	84.94	\$1,899,365
AFTER	4.25	9	2.12	188	44.24	429	100.94	\$2,652,871
Annual Benefits from Crash Cost Savings								(\$753,506)
NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST					=	(\$778,543)		
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST					=	-30.10		
TOTAL COST OF PROJECT		-	\$168,000	COMPREHENSIVE B/C RATIO		-	-30.10	