

# Hazard Elimination Project Evaluation

Order # 41000018627

Hazard Elimination Project W-4813

**Evaluation of the Rumble Strip Installation on the Northern Section of I-440 (I-40 to I-40) and  
SR 1728 (Wade Ave) from I-40 to I-440  
Wake County**

Documents Prepared By:

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7/6/2012

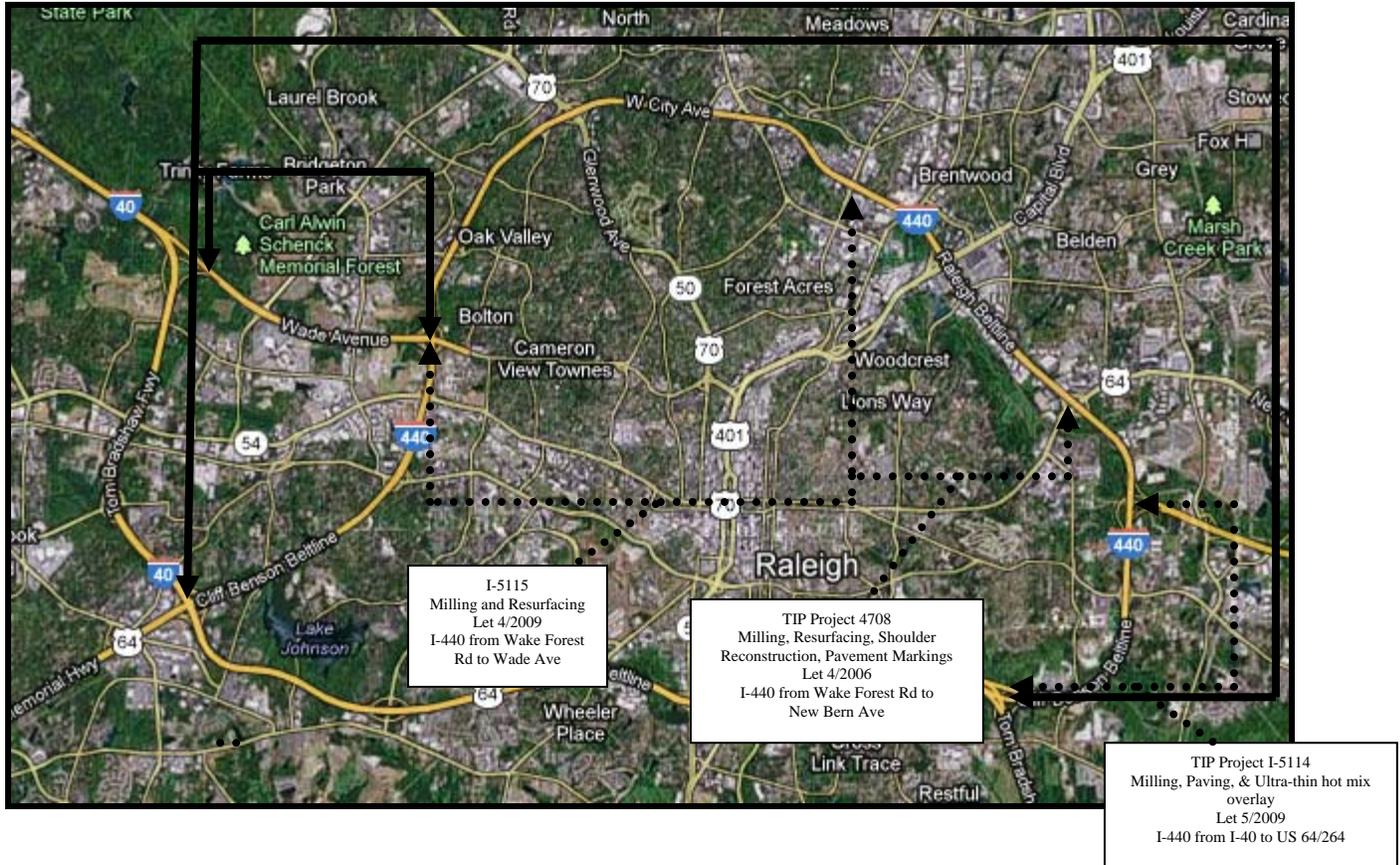
Date

Traffic Safety Project Engineer

# Hazard Elimination Project Evaluation Documentation

## Subject Location

Hazard Elimination Project W-4813 included two sections of roadway. The first was the northern section of I-440, from I-40 to I-40, a distance of approximately 16.5 miles. The second section was SR 1728 (Wade Ave) from I-40 to I-440, a distance of approximately 3.1 miles. Three TIP projects were completed on the I-440 section of roadway during the analysis period for this evaluation. They are noted in the location map for your reference but are not accounted for in this evaluation.



## Project Information and Background from the Project File Folder

The hazard elimination project improvements chosen for the subject locations were the installation of rumble strips along both the inside and outside shoulders of the roadway.

I-440 and SR 1728 (Wade Ave) are multi-lane divided facilities. I-440 has a concrete median barrier and SR 1728 has cable median barrier. The speed limit is 60 mph on the majority of the northern section of I-440 and 55 mph on SR 1728. The majority of I-440 has a varying inside paved shoulder width of 4-6 ft and an outside shoulder width of 10 ft. SR 1728 has an inside paved shoulder width of 2 ft and an outside shoulder width of 10 ft.

The improvement was completed on April 1, 2006 with a total cost of \$290,000. The projected B/C Ratio was 65.43.

## 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 were from February 1, 2006 through April 30, 2006. The before period consisted of reported crashes from May 1, 2000 through January 31, 2006 (5.75 years); and the after period consisted of reported crashes from May 1, 2006 through January 31, 2012 (5.75 years). The ending date for this analysis was determined by the date of available crash data at the time of analysis. The before period ADT year was 2003 and the after period ADT year was 2009.

This evaluation analyzed the crashes on I-440 and SR 1728 (Wade Ave) separately. The first segment consisted of all mainline crashes on the northern section of I-440 from 0.3 miles northeast of I-40/US 64 (western interchange) to 1 mile northeast of I-40 (eastern interchange). These distances were used due to the difficulty of placing crashes referencing the various ramps and bridges at the I-40/I-440 interchanges. The second segment consisted of all mainline crashes on SR 1728 from I-40 to I-440. Both analyses were completed with a 0' y-line.

The following data tables depict the Naïve Before and After Analysis for the treatment locations. Please note that lane departure crashes were the target crashes for the applied countermeasure. The freeway lane departure crash types are considered as follows: Angle, Fixed Object, Head-On, Jackknife, Overturn/Rollover, Parked Motor Vehicle, Ran-Off Roadway (Right, Left, and Straight), and Sideswipe (Same and Opposite Direction).

<b><u>Treatment Information – I440</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes – Both Directions	4,103	4,693	14.4
Total Severity Index	3.62	3.03	-16.3
Lane Departure Crashes – Both Directions	1,779	2,120	19.2
Lane Departure Severity Index	3.92	3.2	-18.4
Volume (2003, 2009)	100,800	95,500	-5.3
Total Crash Rate (100 Million Vehicle Miles)	125.28	150.76	20.3

<b><u>I-440 Target Crashes Both Directions</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Injury Crashes</b>			
Fatal Injury Crashes	7	5	-28.6
Class-A Injury Crashes	16	6	-62.5
Class-B Injury Crashes	155	145	-6.5
Class-C Injury Crashes	312	373	19.6
Property Damage Only Crashes	1,289	1,591	23.4
<b>Contributing Factors</b>			
Night Crashes	510	574	12.5
Wet Road Crashes	581	891	53.4
Alcohol Related	95	90	-5.3
<b>Lane Departure Crash Types</b>			
Angle	137	182	32.8
Fixed Object	448	417	-6.9
Head On	13	24	84.6
Jackknife	2	4	100.0
Overturn / Rollover	24	33	37.5
Parked Motor Vehicle	37	19	-48.6
Ran Off Road	414	633	52.9
Sideswipe, Opposite Direction	9	4	-55.6
Sideswipe, Same Direction	695	804	15.7

<b><u>I-440 Eastbound Only</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
EB Total Crashes	2,027	2,210	9.0
EB Total Severity Index	3.70	3.17	-14.3
<b>EB Lane Departure Crashes</b>			
EB Lane Departure Crashes	843	984	16.7
EB Lane Departure Severity Index	3.75	3.49	-6.9

<b><u>I-440 Westbound Only</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
WB Total Crashes	2,076	2,483	19.6
WB Total Severity Index	3.54	2.91	-17.8
<b>WB Lane Departure Crashes</b>			
WB Lane Departure Crashes	936	1,136	21.4
WB Lane Departure Severity Index	4.08	2.95	-27.7

Both total crashes and lane departure crashes increased on this section of I-440 from the before to the after period, although the severity indices decreased. The increases occurred for both directions of travel. It should be noted that lane departure crashes that occurred during wet road conditions experienced a 53 percent increase.

<b>Treatment Information – SR 1728</b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes – Both Directions	392	507	29.3
Total Severity Index	3.27	2.66	-18.7
Lane Departure Crashes – Both Directions	107	139	29.9
Lane Departure Severity Index	2.88	2.77	-3.8
Volume (2003, 2009)	55,600	58,700	5.6
Total Crash Rate (100 Million Vehicle Miles)	113.08	133.80	18.3

<b>SR 1728 Target Crashes Both Directions</b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Injury Crashes</b>			
Fatal Injury Crashes	0	0	N/A
Class-A Injury Crashes	1	1	0.0
Class-B Injury Crashes	9	9	0.0
Class-C Injury Crashes	8	14	75.0
Property Damage Only Crashes	89	115	29.2
<b>Contributing Factors</b>			
Night Crashes	33	36	9.1
Wet Road Crashes	30	46	53.3
Alcohol Related	4	7	75.0
<b>Lane Departure Crash Types</b>			
Angle	5	7	40.0
Fixed Object	31	23	-25.8
Head On	1	0	-100.0
Jackknife	1	0	-100.0
Overturn / Rollover	3	0	-100.0
Parked Motor Vehicle	0	0	N/A
Ran Off Road	42	54	28.6
Sideswipe, Opposite Direction	0	0	N/A
Sideswipe, Same Direction	24	55	129.2

<b><u>SR 1728 Eastbound Only</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
EB Total Crashes	242	310	28.1
EB Total Severity Index	2.90	2.82	-2.8
EB Lane Departure Crashes	49	69	40.8
EB Lane Departure Severity Index	1.76	3.17	80.1

<b><u>SR 1728 Westbound Only</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
WB Total Crashes	150	197	31.3
WB Total Severity Index	3.89	2.4	-38.3
WB Lane Departure Crashes	58	70	20.7
WB Lane Departure Severity Index	3.84	2.37	-38.3

Like the I-440 segment, this segment of SR 1728 experienced increases in both total and target crashes and decreases in the severity indices. Both directions of travel experienced crash increases, with eastbound experiencing a more dramatic increase along with an increase in the target crash severity. Wet road target crashes experienced a 53 percent increase from the before to the after period.

## **Results and Discussion**

On I-440, total crashes increased by 14 percent and target crashes increased by 19 percent. On SR 1728 (Wade Ave), total crashes increased by 29 percent and target crashes increased by 30 percent.

As noted in the previous section, wet road target crashes experienced a 53% increase on both I-440 and on SR 1728 from the before to the after periods. The following table summarizes the weather data for the area during the two time periods. The weather data was obtained from the State Climate Office of North Carolina from the Raleigh State University Station (317079).

<b>Weather Data</b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Weather Event Days	479	415	-13.4
Total Rainfall (Inches)	258.54	276.51	7.0
Average Rainfall per Event (Inches)	0.54	0.67	24.1

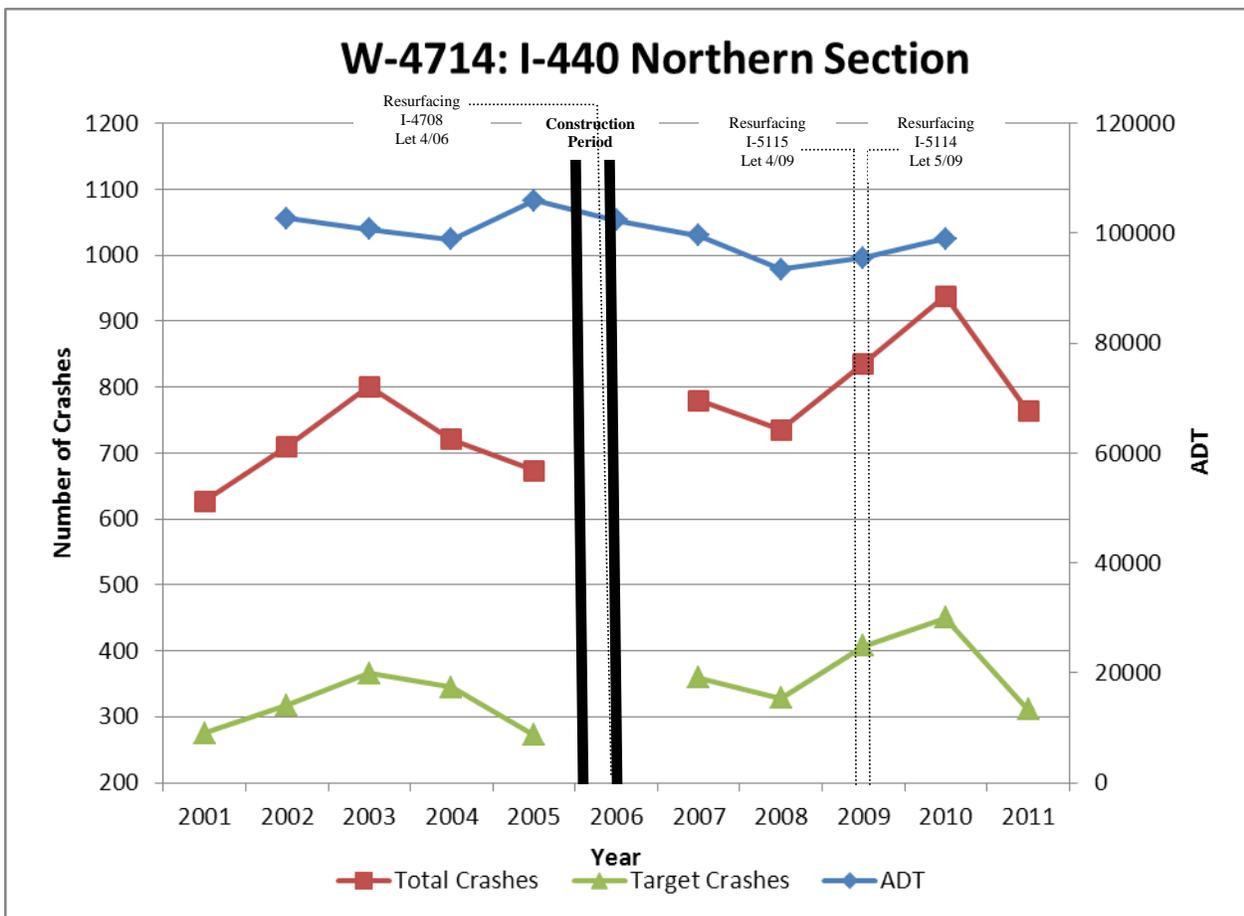
Although there were less total days with precipitation in the after period, the total rainfall and the average rainfall per event increased by seven and 24 percent, respectively. This increase in rainfall may have contributed to the increase in wet road target crashes.

In addition, there were three resurfacing TIP projects on the I-440, all let after the completion of construction on this project, which might have also influenced crashes. Refer to the map on the first page of this evaluation and the chart on the following page for information about these projects.

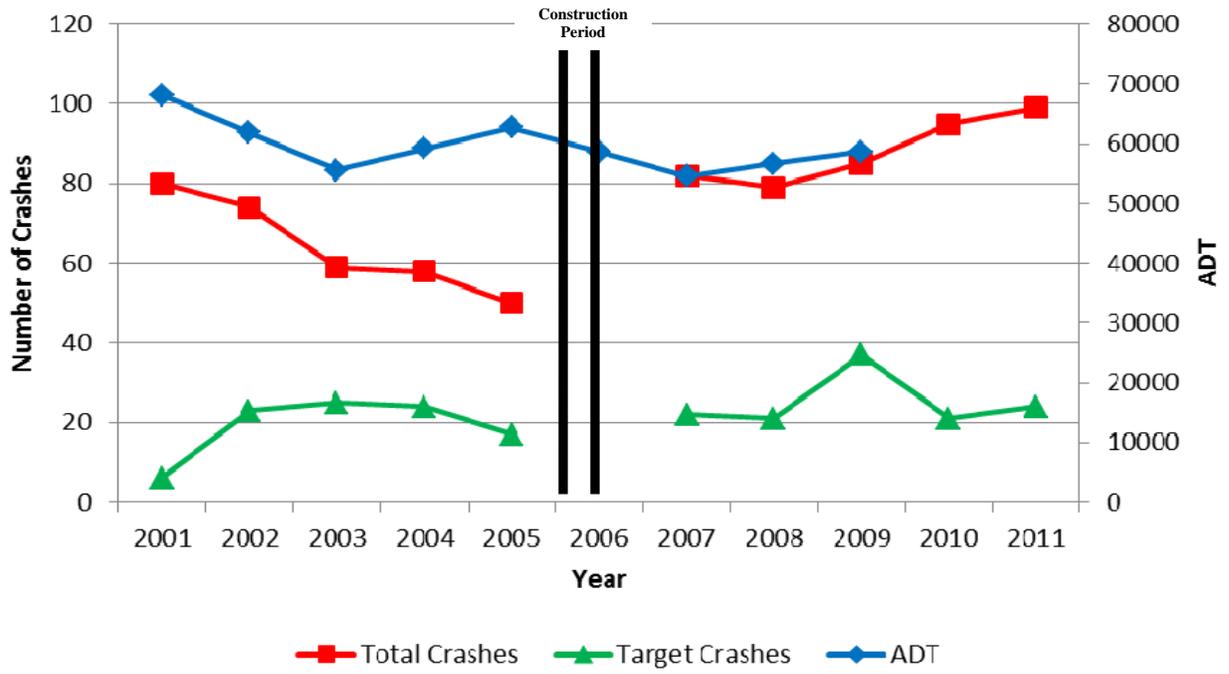
The calculated benefit to cost ratio for the project is **43.23** considering Total Crashes. The benefit to cost ratio considering only Target Crashes is **20.12**. The benefits are calculated using the change in annual crash costs from the before to the after period. Operational and other benefits related 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 costs when applicable.

The following charts depict the crash trends along these two segments of roadway. The number of Total and Target Crashes per year are plotted in the before and after periods, along with the ADT. The dates of known projects that may have influenced crashes are noted.

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.



# W-4714: SR 1728 Section



**BENEFIT-COST ANALYSIS WORKSHEET - TOTAL**

LOCATION: I-440 northern section and wade ave between I-40 and I-440		BY: bdr						
COUNTY: Wake		DATE: 4/27/2012						
FILE NO.: W-4813								
DETAILED COST:	TYPE IMPROVEMENT -	Rumble Strips						
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$0	0	0.000	\$0			
		\$290,000	10	0.149	\$43,219			
	Right-of-Way	\$0	0	0.000	\$0			
	TOTALS	\$290,000	10	0.149	\$43,219			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$0			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$43,219			
	TOTAL COST OF PROJECT=				\$290,000			
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	5.76	43	7.47	1130	196.18	3322	576.74	\$11,106,701
AFTER	5.76	19	3.30	1208	209.72	3973	689.76	\$9,238,524
							Annual Benefits from Crash Cost Savings	\$1,868,177
	NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST							\$1,824,959
	BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST							43.23
	TOTAL COST OF PROJECT	-	\$290,000		COMPREHENSIVE B/C RATIO	-		43.23

**BENEFIT-COST ANALYSIS WORKSHEET - TARGET**

LOCATION: I-440 northern section and wade ave between I-40 and I-440		BY: bdr						
COUNTY: Wake		DATE: 4/27/2012						
FILE NO.: W-4813								
DETAILED COST:	TYPE IMPROVEMENT -	Rumble Strips						
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$0	0	0.000	\$0			
		\$290,000	10	0.149	\$43,219			
	Right-of-Way	\$0	0	0.000	\$0			
	TOTALS	\$290,000	10	0.149	\$43,219			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$0			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$43,219			
	TOTAL COST OF PROJECT=				\$290,000			
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	5.76	24	4.17	484	84.03	1378	239.24	\$5,334,271
AFTER	5.76	12	2.08	541	93.92	1706	296.18	\$4,464,549
							Annual Benefits from Crash Cost Savings	\$869,722
	NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST							\$826,504
	BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST							20.12
	TOTAL COST OF PROJECT	-	\$290,000		COMPREHENSIVE B/C RATIO	-		20.12