

# Hazard Elimination Project Evaluation

Order # 41000004714

Hazard Elimination Project W-4818

## Evaluation of the Rumble Strip Installation on Sections of I-40, I-840, and US 220 in Guilford County

Documents Prepared By:

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6/3/2010

Date

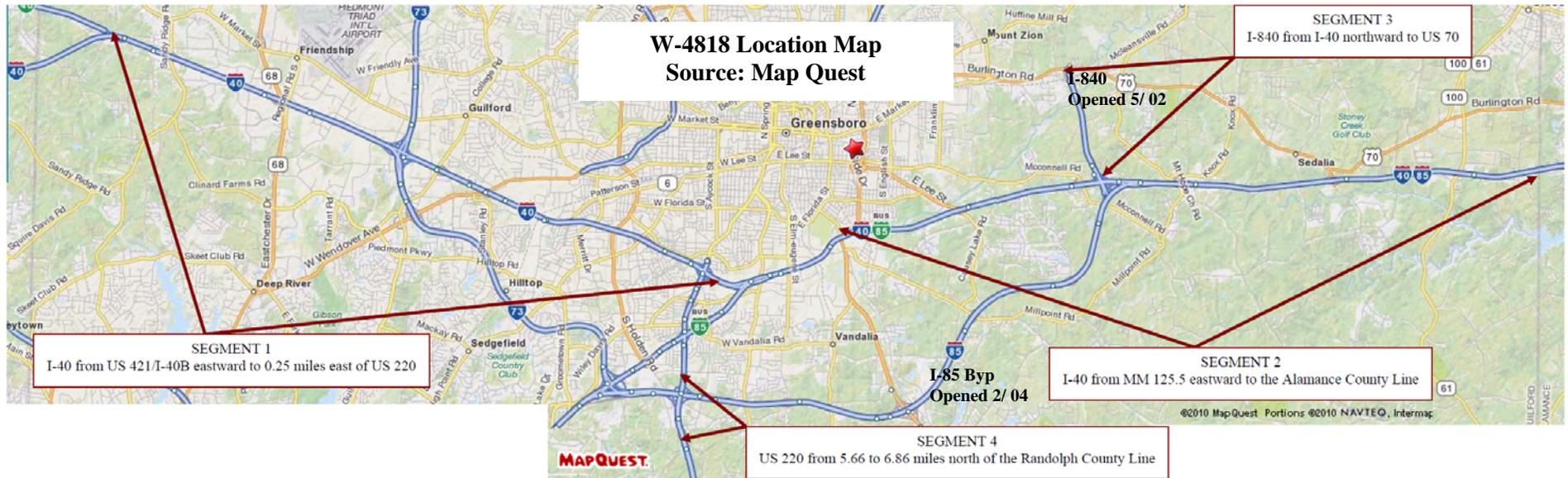
Traffic Safety Project Engineer

# Hazard Elimination Project Evaluation Documentation

## Subject Location

The treatment location includes four segments in Guilford County:

1. I-40 from US 421/I-40B eastward to 0.25 miles east of US 220
2. I-40 from MM 125.5 eastward to the Alamance County Line
3. I-840 from I-40 northward to US 70
4. US 220 from 5.66 to 6.86 miles north of the Randolph County Line



## Project Information and Background from the Project File Folder

The hazard elimination improvement countermeasure was the installation of shoulder rumble strips. The countermeasure was applied to both directions of travel lanes for approximately 25 miles of I-40, 2 miles of I-840, and 1 mile of US 220. I-40 varies from a 6 to 10-lane divided controlled access highway. I-840 and US-220 are 4-lane divided controlled access highways. The paved median and outside shoulder widths vary from 4 to 12 feet. Median barrier is provided. The posted speed limit varies from 55-65 mph. The intended purpose of the improvement was to alleviate the frequency of run-off-road (drift-off) crashes. The initial crash analysis was completed from August 1, 2000 to July 31, 2003 with 2,504 total reported crashes, 526 of which were deemed correctable Ran-Off-Road crashes. The improvement was completed on June 30, 2005 with a total cost of \$175,000. The projected B/C Ratio was 166:1.

**Location Photographs**  
**Segment 1 (I-40):**



**Segment 2 (I-40):**



**Segment 3 (I-840):**



**Segment 4 (US-220):**



All of the segments experienced changes during the before and/or after period due to projects other than the hazard elimination project. Segment 3, the two-mile section of I-840 east of Greensboro was opened in May 2002. I-85 Bypass was opened to traffic in February 2004, diverting some traffic from I-40/I-85 in Greensboro and impacting traffic on the US 220 segment surrounding the I-85 Bypass. In February 2008, the southwest portion of the Greensboro loop was opened to traffic, creating a complete southern bypass of Greensboro and again diverting traffic. Consequently, in February 2008, I-40 was re-routed to run with I-85 Bypass and I-73 along this southern loop. In September 2008, I-40 was changed back to its original route designation. All of these changes resulted in fluctuating traffic volumes on I-40.

Per the project file (dated April 2004), the western half of I-40 was under construction dating back to 1993 (I-2201) and a portion of the eastern half of I-40 at I-840 was under construction dating back to 1997 (I-2402D). Multiple other projects were completed on these sections of roadway both before and after the completion of W-4818. Known TIP projects are listed below for your reference but are not accounted for in this evaluation due to their number and duration:

#### I-40 Segments TIP Project Listing

Let 4/2002 - Project I-4414 (Milling & Resurfacing on I-40 from Rock Creek Dairy Rd eastward into Alamance Co.)

Let 7/2002 - Project I-2201S (ITS on I-40 from Holden Rd westward into Forsyth County)

Let 9/2003 - Project M-351 (ITS on I-40/I-85 corridor in Guilford and Alamance Counties)

Let 1/2007 - Project I-4907 - (Pavement Rehabilitation on I-40/85 from MM 131 to west of NC 61)

Let 10/2007 - Project I-4715 (Milling & Resurfacing on I-40/85 from I-85Byp to High Point Rd)

Let 7/2008 - Project B-4534 (Grading, Drainage, Paving, & Structure on I-40 over I-85 SBL)

Let 5/2009 - Project I-5118 (Milling & Resurfacing on I-40/85 from east of Rock Creek Dairy Rd to west of University Dr )

#### US 220 Segment TIP Project Listing

Let 10/2001 - Milling & Resurfacing on US 220 from Randolph County Line to I-85

### **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 January 1, 2005 through June 30, 2005. The time periods varied by segment. The ending date was determined by the date of available crash data at the time of analysis. The analysis was completed with a zero (0) foot y-line. Target crashes are lane departure crash types.

**Segment 1 (I-40 from US 421/I-40B eastward to 0.25 miles east of US 220 – 12.1 Miles)**

Segment 1 consists of all mainline crashes on I-40 from US 421/I-40B eastward to 0.25 miles east of US 220. The before period consists of reported crashes from May 1, 2000 through December 31, 2004 (4.67 years); and the after period consists of reported crashes from July 1, 2005 through February 28, 2010 (4.67 years). The before period ADT year is 2002 and the after period ADT year is 2007.

<b><u>Segment 1 Treatment Information</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes – Both Directions	1829	1266	-30.8%
Total Severity Index	4.81	4.61	-4.2%
Lane Departure Crashes – Both Directions	785	765	-2.5%
Lane Departure Severity Index	4.84	4.52	-6.6%
Volume	91,500	116,100	26.9%

The following tables divide the Segment 1 crash data by direction of travel:

<b><u>Segment 1 Westbound Treatment Info</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes	899	577	-35.8%
Total Severity Index	4.78	4.96	3.8%
Lane Departure Crashes	393	361	-8.1%

<b><u>Segment 1 Westbound Crash Details</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Injuries</b>			
Fatal Injury Crashes	6	4	-33.3%
Non-Fatal Injury Crashes	342	194	-43.3%
Property Damage Only Crashes	551	379	-31.2%
<b>Contributing Factors</b>			
Night Crashes	227	202	-11.0%
Wet Road Crashes	203	174	-14.3%
Alcohol Related	20	19	-5.0%
<b>Lane Departure Crash Types</b>			
Angle	59	54	-8.5%
Fixed Object	90	51	-43.3%
Head On	2	1	-50.0%
Jackknife	2	0	-100.0%
Movable Object	26	21	-19.2%
Overturn / Rollover	4	4	0.0%
Parked Motor Vehicle	3	2	-33.3%
Ran Off Road (Right & Left)	72	119	65.3%
Sideswipe, Opposite Direction	2	0	-100.0%
Sideswipe, Same Direction	133	109	-18.0%

<b>Segment 1 Eastbound Treatment Info</b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes	930	689	-25.9%
Total Severity Index	4.85	4.31	-11.1%
Lane Departure Crashes	392	404	3.1%

<b>Segment 1 Eastbound Crash Details</b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Injuries</b>			
Fatal Injury Crashes	2	1	-50.0%
Non-Fatal Injury Crashes	371	233	-37.2%
Property Damage Only Crashes	557	455	-18.3%
<b>Contributing Factors</b>			
Night Crashes	260	206	-20.8%
Wet Road Crashes	179	250	39.7%
Alcohol Related	21	15	-28.6%
<b>Lane Departure Crash Types</b>			
Angle	43	36	-16.3%
Fixed Object	85	73	-14.1%
Head On	1	1	0.0%
Jackknife	3	0	-100.0%
Movable Object	17	20	17.6%
Overturn / Rollover	5	4	-20.0%
Parked Motor Vehicle	5	4	-20.0%
Ran Off Road (Right & Left)	76	151	98.7%
Sideswipe, Opposite Direction	1	0	-100.0%
Sideswipe, Same Direction	156	115	-26.3%

The naive before and after analysis for Segment 1 on I-40 resulted in an overall 31 percent decrease in Total Crashes and a 4 percent decrease in the Total Severity Index. There was also a 3 percent decrease in Target Crashes and a 7 percent decrease in the Target Severity Index.

Eastbound Wet Road Crashes increased by 40 percent from the before to the after period, and comprised 36 percent of all after period eastbound crashes. Both directions of Segment 1 experienced reductions in Night Crashes.

**Segment 2 (I-40 from MM 125.5 eastward to the Alamance County Line – 13.3 Miles)**

Segment 2 treatment data consists of all mainline crashes on I-40 from MM 125.5 eastward to the Alamance County Line. The before period consists of reported crashes from May 1, 2000 through December 31, 2004 (4.67 years); and the after period consisted of reported crashes from July 1, 2005 through February 28, 2010 (4.67 years). The before period ADT year is 2002 and the after period ADT year is 2007.

<b><u>Segment 2 Treatment Information</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes – Both Directions	1548	977	-36.9%
Total Severity Index	4.62	4.26	-7.8%
Lane Departure Crashes – Both Directions	936	701	-25.1%
Lane Departure Severity Index	4.60	4.41	-4.1%
Volume	81,400	86,300	6.0%

The following tables divide the Segment 2 crash data by direction of travel:

<b><u>Segment 2 Westbound Treatment Info</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes	869	558	-35.8%
Total Severity Index	4.67	4.31	-7.7%
Lane Departure Crashes	489	397	-18.8%

<b><u>Segment 2 Westbound Crash Details</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Injuries</b>			
Fatal Injury Crashes	6	4	-33.3%
Non-Fatal Injury Crashes	295	172	-41.7%
Property Damage Only Crashes	568	382	-32.7%
<b>Contributing Factors</b>			
Night Crashes	247	203	-17.8%
Wet Road Crashes	332	190	-42.8%
Alcohol Related	20	21	5.0%
<b>Lane Departure Crash Types</b>			
Angle	24	15	-37.5%
Fixed Object	223	186	-16.6%
Head On	2	1	-50.0%
Jackknife	4	2	-50.0%
Movable Object	35	32	-8.6%
Overturn / Rollover	13	3	-76.9%
Parked Motor Vehicle	12	8	-33.3%
Ran Off Road (Right & Left)	40	32	-20.0%
Sideswipe, Opposite Direction	1	0	-100.0%
Sideswipe, Same Direction	135	118	-12.6%

<b><u>Segment 2 Eastbound Treatment Info</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes	679	419	-38.3%
Total Severity Index	4.55	4.18	-8.1%
Lane Departure Crashes	447	304	-32.0%

<b><u>Segment 2 Eastbound Crash Details</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Injuries</b>			
Fatal Injury Crashes	5	3	-40.0%
Non-Fatal Injury Crashes	238	131	-45.0%
Property Damage Only Crashes	436	285	-34.6%
<b>Contributing Factors</b>			
Night Crashes	234	153	-34.6%
Wet Road Crashes	165	136	-17.6%
Alcohol Related	29	18	-37.9%
<b>Lane Departure Crash Types</b>			
Angle	25	11	-56.0%
Fixed Object	198	127	-35.9%
Head On	2	2	0.0%
Jackknife	3	2	-33.3%
Movable Object	36	29	-19.4%
Overturn / Rollover	11	6	-45.5%
Parked Motor Vehicle	11	4	-63.6%
Ran Off Road (Right & Left)	30	32	6.7%
Sideswipe, Opposite Direction	1	0	-100.0%
Sideswipe, Same Direction	130	91	-30.0%

The naive before and after analysis for Segment 2 on I-40 resulted in an overall 37 percent decrease in Total Crashes and an 8 percent decrease in the Total Severity Index. There was also a 25 percent decrease in Target Crashes and a 4 percent decrease in the Target Severity Index.

Both directions of Segment 2 experienced reductions in Night and Wet Road Crashes from the before to the after period.

**Segment 3 (I-840 from I-40 northward to US 70 – 2.2 Miles)**

Segment 3 treatment data consisted of all mainline crashes on I-840 from I-40 northward to US 70. The before period consisted of reported crashes from June 1, 2002 through December 31, 2004 (2.59 years); and the after period consisted of reported crashes from July 1, 2005 through February 28, 2010 (4.67 years). The before period ADT year was 2003 and the after period ADT year was 2007. (Note: ADT was not available in the before period.)

<b>Segment 3 Treatment Information</b>	<b>Before</b>		<b>After</b>		<b>Percent Reduction (-)/ Percent Increase (+)</b>
	<b>2.59 Yr</b>	<b>Crashes/ Yr</b>	<b>4.67 Yr</b>	<b>Crashes/ Yr</b>	
Total Crashes – Both Directions	16	6.2	28	6.0	-3.2%
Total Severity Index	6.20		3.38		-45.5%
Lane Departure Crashes – Both Directions	12	4.6	10	2.1	-54.3%
Lane Departure Severity Index	7.93		5.44		-31.4%
Volume	N/A		14,000		N/A

<b>Segment 3 Crash Details – Both Directions</b>	<b>Before</b>		<b>After</b>		<b>Percent Reduction (-)/ Percent Increase (+)</b>
	<b>2.59 Yr</b>	<b>Crashes/ Yr</b>	<b>4.67 Yr</b>	<b>Crashes/ Yr</b>	
<b>Injuries</b>					
Fatal Injury Crashes	0	0.0	0	0.0	N/A
Non-Fatal Injury Crashes	2	0.8	9	1.9	137.5%
Property Damage Only Crashes	14	5.4	19	4.1	-24.1%
<b>Contributing Factors</b>					
Night Crashes	8	3.1	22	4.7	51.6%
Wet Road Crashes	5	1.9	5	1.1	-42.1%
Alcohol Related	1	0.4	0	0.0	-100.0%
<b>Lane Departure Crash Types</b>					
Angle	0	0.0	0	0.0	N/A
Fixed Object	10	3.9	1	0.2	-94.9%
Head On	0	0.0	0	0.0	N/A
Jackknife	0	0.0	0	0.0	N/A
Movable Object	0	0.0	0	0.0	N/A
Overturn / Rollover	1	0.4	1	0.2	-50.0%
Parked Motor Vehicle	0	0.0	0	0.0	N/A
Ran Off Road (Right & Left)	0	0.0	6	1.3	N/A
Sideswipe, Opposite Direction	0	0.0	0	0.0	N/A
Sideswipe, Same Direction	1	0.4	2	0.4	0.0%

The naive before and after analysis for Segment 3 on I-840 resulted in an overall 3 percent decrease in Total Crashes and a 46 percent decrease in the Total Severity Index. There was also a 54 percent decrease in Target Crashes and a 31 percent decrease in the Target Severity Index.

In the after period, 79 percent of Total Crashes on I-840 occurred at night. There was a 52 percent increase in Night Crashes from the before to the after period.

**Segment 4 (US 220 from 5.66 to 6.86 miles north of the Randolph County Line – 1.2 Miles)**

Segment 4 treatment data consisted of all mainline crashes on US 220 from 5.66 to 6.86 miles north of the Randolph County Line. There was no before period due to the interchange of US 220 and I-85 Bypass construction until February 2004 (located in the middle of Segment 4, approx. 6 miles north of the Randolph County Line). The after period consisted of reported crashes from July 1, 2005 through February 28, 2010 (4.67 years). The after period ADT year was 2007.

<b><u>Segment 4 Treatment Information</u></b>	<b>After</b>	
	<b>4.67 Yrs</b>	<b>Crashes/Yr</b>
Total Crashes – Both Directions	53	11.3
Total Severity Index	5.82	
Lane Departure Crashes – Both Directions	31	6.6
Lane Departure Severity Index	8.28	
Volume	33,600	

<b><u>Segment 4 Crash Details – Both Directions</u></b>	<b>After</b>	
	<b>4.67 Yrs</b>	<b>Crashes/Yr</b>
<b>Injuries</b>		
Fatal Injury Crashes	1	0.2
Non-Fatal Injury Crashes	15	3.2
Property Damage Only Crashes	37	7.9
<b>Contributing Factors</b>		
Night Crashes	16	3.4
Wet Road Crashes	22	4.7
Alcohol Related	4	0.9
<b>Lane Departure Crash Types</b>		
Angle	2	0.4
Fixed Object	19	4.1
Head On	0	0.0
Jackknife	0	0.0
Movable Object	1	0.2
Overturn / Rollover	3	0.6
Parked Motor Vehicle	1	0.2
Ran Off Road (Right & Left)	3	0.6
Sideswipe, Opposite Direction	0	0.0
Sideswipe, Same Direction	2	0.4

The 4.67-year after period analysis for Segment 4 on US-220 resulted in 53 Total Crashes and 31 Target Crashes. The Total Severity Index was 5.82 and the Target Severity Index was 8.28.

## **Results and Discussion**

Using naïve before and after analysis, the number and severity of Total and Target Crashes decreased on all sections evaluated. The results are as follows:

Segment 1 experienced an overall 31 percent decrease in Total Crashes and a 4 percent decrease in the Total Severity Index. There was also a 3 percent decrease in Target Crashes and a 7 percent decrease in the Target Severity Index.

Segment 2 experienced an overall 37 percent decrease in Total Crashes and an 8 percent decrease in the Total Severity Index. There was also a 25 percent decrease in Target Crashes and a 4 percent decrease in the Target Severity Index.

Segment 3 experienced an overall 3 percent decrease in Total Crashes and a 46 percent decrease in the Total Severity Index. There was also a 54 percent decrease in Target Crashes and a 31 percent decrease in the Target Severity Index.

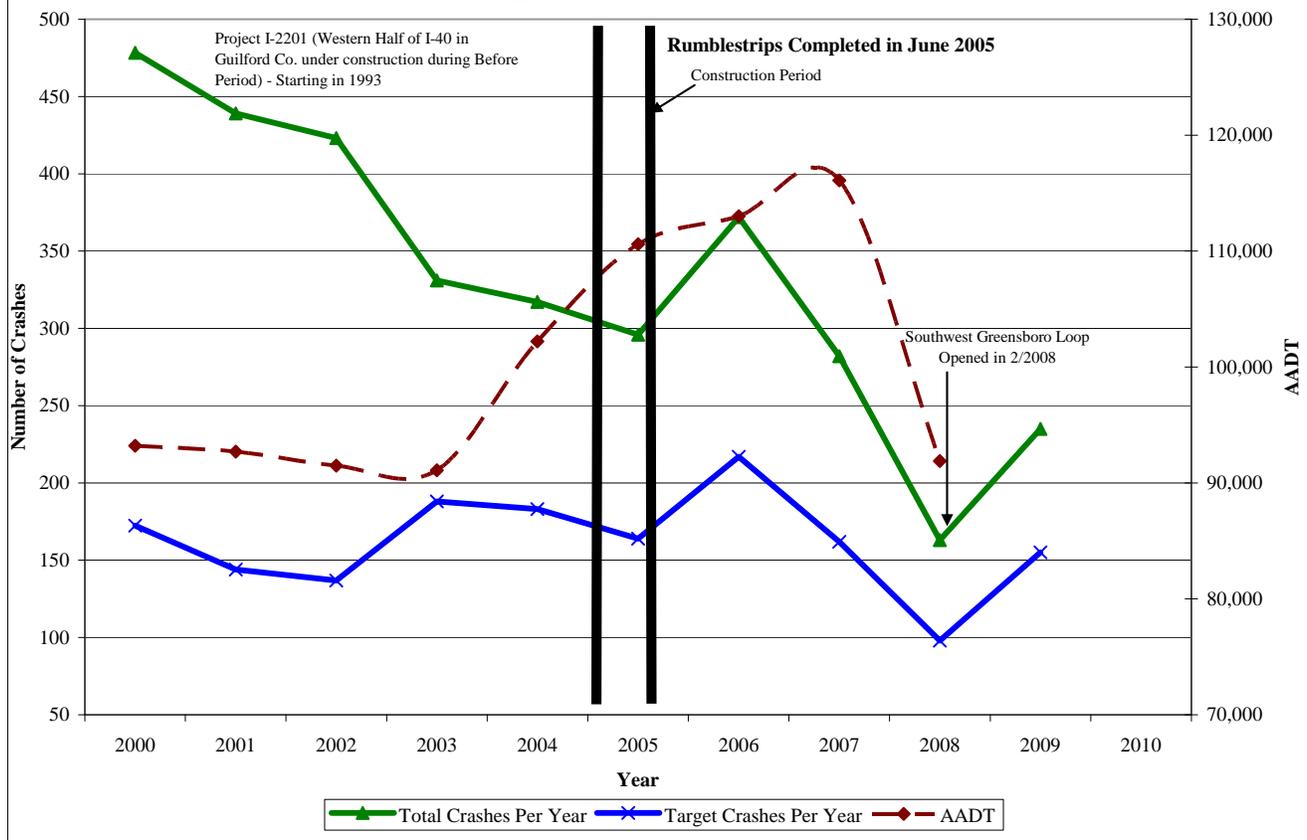
Segment 4, which was only evaluated in the after period, experienced 53 Total Crashes and 31 Target Crashes in the 4.67-year after period. The Total Severity Index was 5.82 and the Target Severity Index was 8.28.

Due to the number of other projects that may have influenced crashes in our before and after periods but that we are unable to account for in the analysis, the reductions cannot be attributed solely to the rumble strip installations. The impact of these other projects on crashes is not known. A benefit to cost ratio was not calculated for W-4818 due to the fact that there was no before period crash data for Segment 4 and the costs were not broken down per segment.

The following charts depict the crash trends along Segments 1 and 2 on I-40. The number of Total and Target Crashes per year are plotted in the before and after period, along with the AADT. It appears that the number of Total and Target Crashes per year has been on a downward trend since the before period. The dates of known projects that may have influenced crashes are noted.

As the Safety Evaluation Group completes additional spot 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 intersection.

### Segment 1: Crashes Per Year



### Segment 2: Crashes Per Year

