

# Hazard Elimination Project Evaluation

Order # 41000011168

Hazard Elimination Project W-4828

**Evaluation of the Rumble Strip Installation on US 421 from  
SR 2113 (Sam Fields Rd / S. Chatham Ave) to NC 49 (S. Fayetteville St)  
Chatham & Randolph Counties**

Documents Prepared By:

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

**Principal Investigator**



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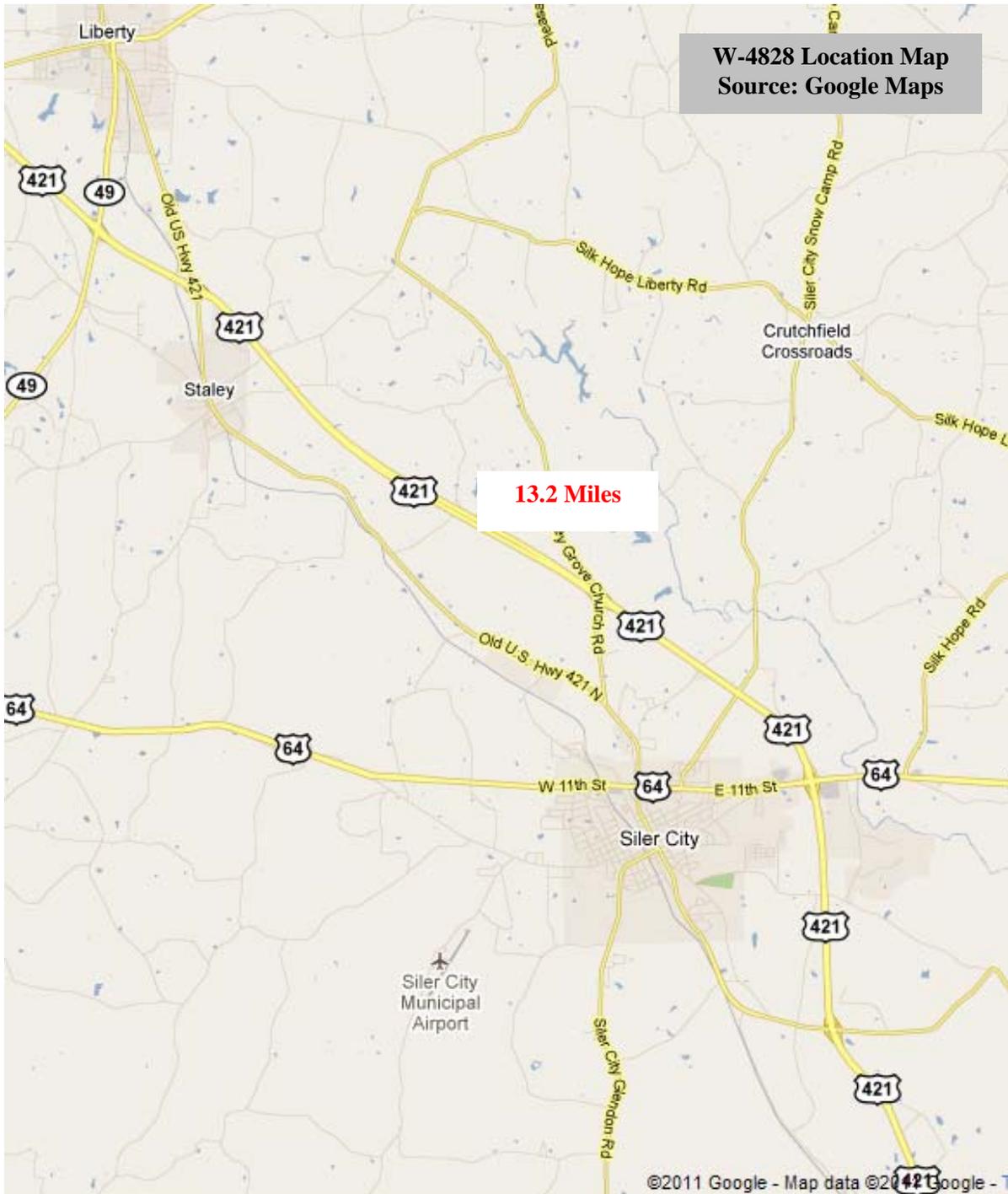
Carrie L. Simpson, PE

12/21/2011

Date

Traffic Safety Project Engineer

## *Hazard Elimination Project Evaluation Documentation*



### **Subject Location**

The treatment location includes US 421 from SR 2113 (Sam Fields Rd/S. Chatham Ave) to NC 49 (S. Fayetteville St) in Chatham & Randolph Counties. US 421 is a four lane divided facility. Median cable guardrail has been provided since 2003.

Multiple additional projects were completed on this section of roadway both before and after the completion of W-4828. The following let dates for TIP projects are noted for your reference but not accounted for in this evaluation.

2/02	1 Section of US 421 & Various Other Roads in Chatham Co - Milling & Resurfacing
12/02	R-4007, US 421 from SR 2210 in Chatham Co to SR 2434 in Randolph Co – Median Guardrail
12/02	US 421 from US 64 to End of Divided Highway in Chatham Co – Shoulder Reconstruction, Milling & Resurfacing
1/06	Sections of US 421N & Various Other Roads in Randolph Co – Widening, Resurfacing, Shoulder Reconstruction & Pavement Markings
2/07	Shoulder of US 421 SBL and Various Other Roads in Randolph Co – Reconstruction & Resurfacing
7/08	R-4425, Division-wide Guardrail Rehabilitation of National Highway System

### **Project Information and Background from the Project File Folder**

The hazard elimination project improvement chosen was the installation of milled rumble strips on the median and outside shoulders of US 421. Run-Off-Road crashes were the predominant type of crash along the section. The pattern was attributed to drift-off-road crashes, which may be caused by driver drowsiness, inattention, or distraction and which may be prevented with the installation of rumble strips. The initial crash analysis was completed from August 1, 2000 through July 31, 2003 with 94 Total Crashes, including 51 Run-Off-Road Crashes. The improvement was completed on August 4, 2006 with a total cost of \$125,000. The projected B/C Ratio was 27.42:1.

### **Location Photographs**





### 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, 2006 through August 31, 2006. The before period consisted of reported crashes from July 1, 2001 through December 31, 2005 (4.5 years); and the after period consisted of reported crashes from September 1, 2006 through February 28, 2011 (4.5 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 2008.

For the purposes of this evaluation, we assumed that there were no rumble strips present in the before period and continuous rumble strips present for the duration of the after period. Note that we are unable to account for construction periods associated with other projects completed in the before and after periods.

The treatment data consisted of all mainline crashes with a 0' y-line. Target crashes are lane departure crash types.

	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – Both Directions	239	201	-15.9%
Total Severity Index	3.38	2.71	-19.8%
Lane Departure Crashes – Both Directions	151	99	-34.4%
Lane Departure Severity Index	3.52	3.11	-11.6%
Volume	10,400	9,700	-6.7%

	Before	After	Percent Reduction (-)/ Percent Increase (+)
<b>Injuries</b>			
Fatal Injury Crashes	2	0	-100.0%
Class-A Injury Crashes	2	2	0.0%
Class-B Injury Crashes	8	12	50.0%
Class-C Injury Crashes	28	14	-50.0%
Property Damage Only Crashes	199	173	-13.1%
<b>Contributing Factors</b>			
Night Crashes	109	116	6.4%
Wet Road Crashes	78	37	-52.6%
Alcohol Related	8	4	-50.0%
<b>Lane Departure Crash Types</b>			
Angle	1	1	0.0%
Fixed Object	71	82	15.5%
Head On	1	0	-100.0%
Movable Object	5	1	-80.0%
Overturn / Rollover	4	6	50.0%
Parked Motor Vehicle	0	1	N/A
Ran Off Road (Left)	27	1	-96.3%
Ran Off Road (Right)	31	2	-93.5%
Sideswipe, Same Direction	11	5	-54.5%

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

<b>Northbound</b>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	116	103	-11.2%
Total Severity Index	3.39	2.81	-17.1%
Lane Departure Crashes	73	48	-34.2%

<b>Southbound</b>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	123	98	-20.3%
Total Severity Index	3.38	2.6	-23.1%
Lane Departure Crashes	78	51	-34.6%

## Results and Discussion

Using naïve before and after analysis, the number of Total and Target Crashes decreased on the section of US 421 installed with rumble strips under project W-4828. The results were consistent in both directions of travel. The Severity Indexes of Total and Target Crashes decreased as well. There were no Fatal Injury crashes during the 4.5-year after period.

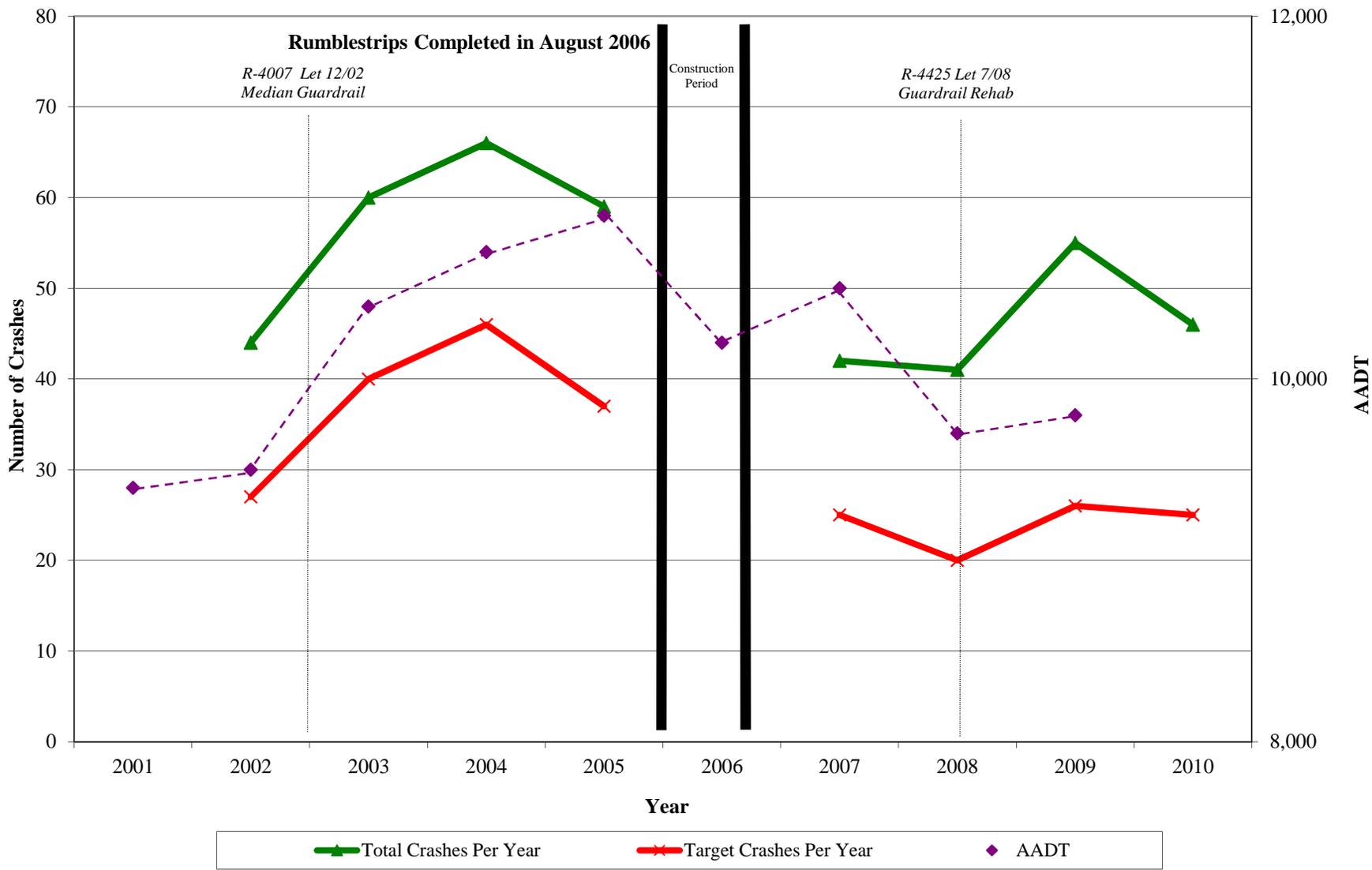
The calculated benefit to cost ratio for W-4828 is 16.36 considering Total Crashes. The benefit to cost ratio considering only Target Crashes is 12.57. Benefits are calculated using the change in annual crash costs from the before to the after period. Operational and other benefits related to the project 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 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 generally follow the volume trends during the study period. Note that the AADT along this section is on a slightly downward trend during the after period. Due to the number of other projects that likely influenced crashes during the study period, the change in crashes cannot be attributed solely to the rumble strip installations.

See the attached *GIS Collision Diagrams* for more information regarding the location of Total and Target Crashes by direction of travel along the section. Note that due to the recurrent synchronization of TEAAS and LRS, some mileposts may be off by a tenth of a mile or more.

As the Safety Evaluation Group completes additional 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.

# US 421 Chatham & Randolph County Crashes Per Year



**BENEFIT-COST ANALYSIS WORKSHEET**

LOCATION: US 421  
 COUNTY: CHATHAM & RANDOLPH  
 FILE NO.: W-4828  
 TOTAL CRASHES

BY: CLS  
 DATE: 5/18/2011

DETAILED COST: TYPE IMPROVEMENT - Rumblestrips

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$125,000	10	0.149	\$18,629
		0	0.000	\$0
		0	0.000	\$0
<b>TOTALS</b>	<b>\$125,000</b>	<b>10</b>	<b>0.149</b>	<b>\$18,629</b>

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$0  
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0  
 TOTAL ANNUAL COST= \$18,629  
 TOTAL COST OF PROJECT= \$125,000

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	4.50	4	0.89	36	8.00	199	44.22	\$910,156
AFTER	4.50	2	0.44	36	8.00	173	38.44	\$605,311

Annual Benefits from Crash Cost Savings \$304,844

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$286,216  
 BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 16.36

TOTAL COST OF PROJECT - \$125,000 COMPREHENSIVE B/C RATIO - 16.36

**BENEFIT-COST ANALYSIS WORKSHEET**

LOCATION: US 421  
 COUNTY: CHATHAM & RANDOLPH  
 FILE NO.: W-4828  
 TARGET CRASHES

BY: CLS  
 DATE: 5/18/2011

DETAILED COST: TYPE IMPROVEMENT - Rumblestrips

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$125,000	10	0.149	\$18,629
		0	0.000	\$0
		0	0.000	\$0
<b>TOTALS</b>	<b>\$125,000</b>	<b>10</b>	<b>0.149</b>	<b>\$18,629</b>

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$0  
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0  
 TOTAL ANNUAL COST= \$18,629  
 TOTAL COST OF PROJECT= \$125,000

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	4.50	2	0.44	31	6.89	118	26.22	\$530,533
AFTER	4.50	1	0.22	18	4.00	80	17.78	\$296,444

Annual Benefits from Crash Cost Savings \$234,089

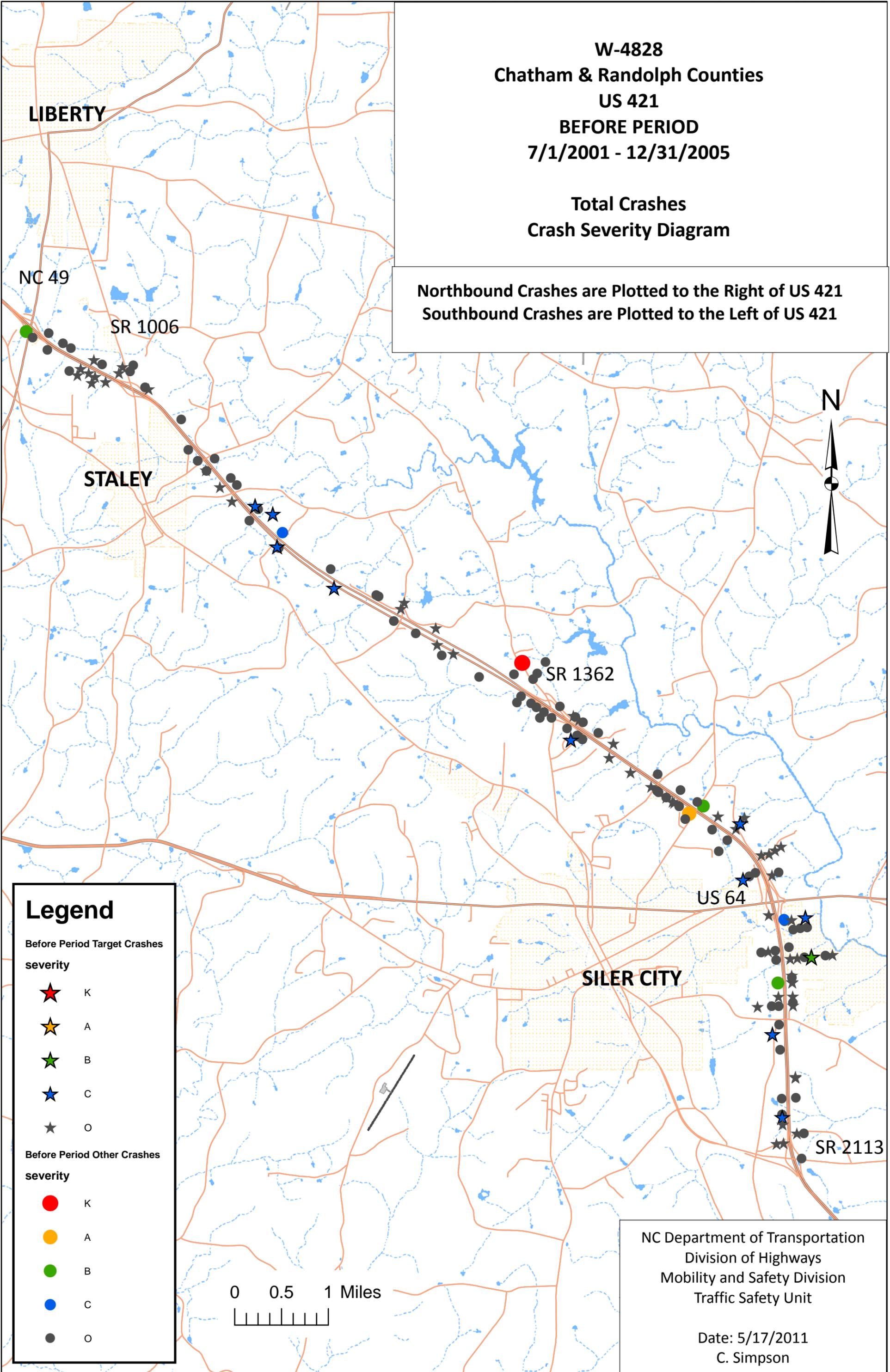
NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$215,460  
 BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 12.57

TOTAL COST OF PROJECT - \$125,000 COMPREHENSIVE B/C RATIO - 12.57

W-4828  
 Chatham & Randolph Counties  
 US 421  
 BEFORE PERIOD  
 7/1/2001 - 12/31/2005

Total Crashes  
 Crash Severity Diagram

Northbound Crashes are Plotted to the Right of US 421  
 Southbound Crashes are Plotted to the Left of US 421



**Legend**

Before Period Target Crashes

severity

- ★ K
- ★ A
- ★ B
- ★ C
- ★ O

Before Period Other Crashes

severity

- K
- A
- B
- C
- O



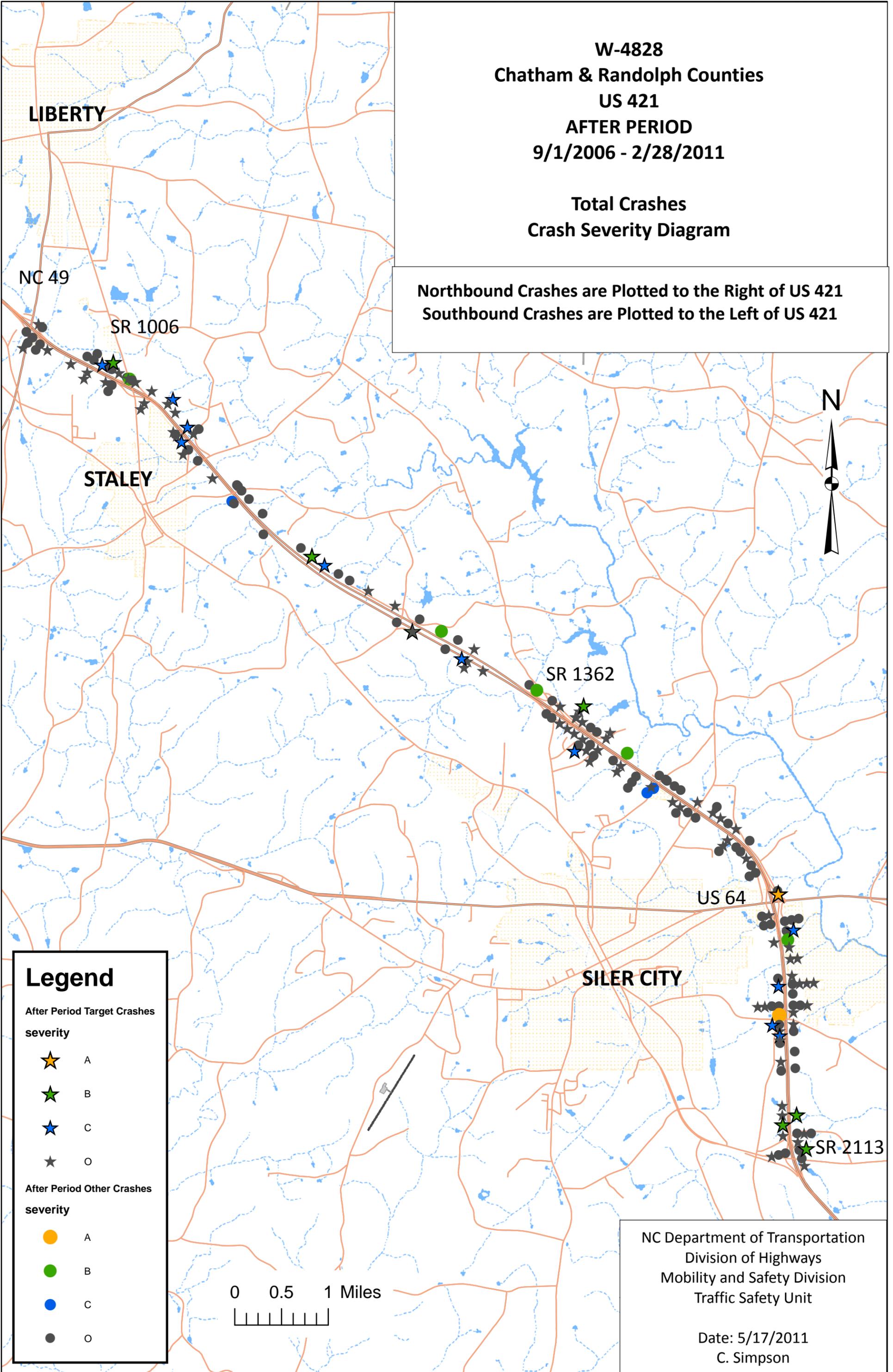
NC Department of Transportation  
 Division of Highways  
 Mobility and Safety Division  
 Traffic Safety Unit

Date: 5/17/2011  
 C. Simpson

W-4828  
Chatham & Randolph Counties  
US 421  
AFTER PERIOD  
9/1/2006 - 2/28/2011

Total Crashes  
Crash Severity Diagram

Northbound Crashes are Plotted to the Right of US 421  
Southbound Crashes are Plotted to the Left of US 421



**Legend**

After Period Target Crashes  
severity

- ★ A
- ★ B
- ★ C
- ★ O

After Period Other Crashes  
severity

- A
- B
- C
- O

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