

# **Hazard Elimination Project Evaluation**

Order # 41000011782

Hazard Elimination Project W-4849

## **Evaluation of the Concrete Median Barrier Installation US 158 (Caratoke Highway) at the Coinjock Bridge Currituck County**

Documents Prepared By:

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

**Principal Investigator**



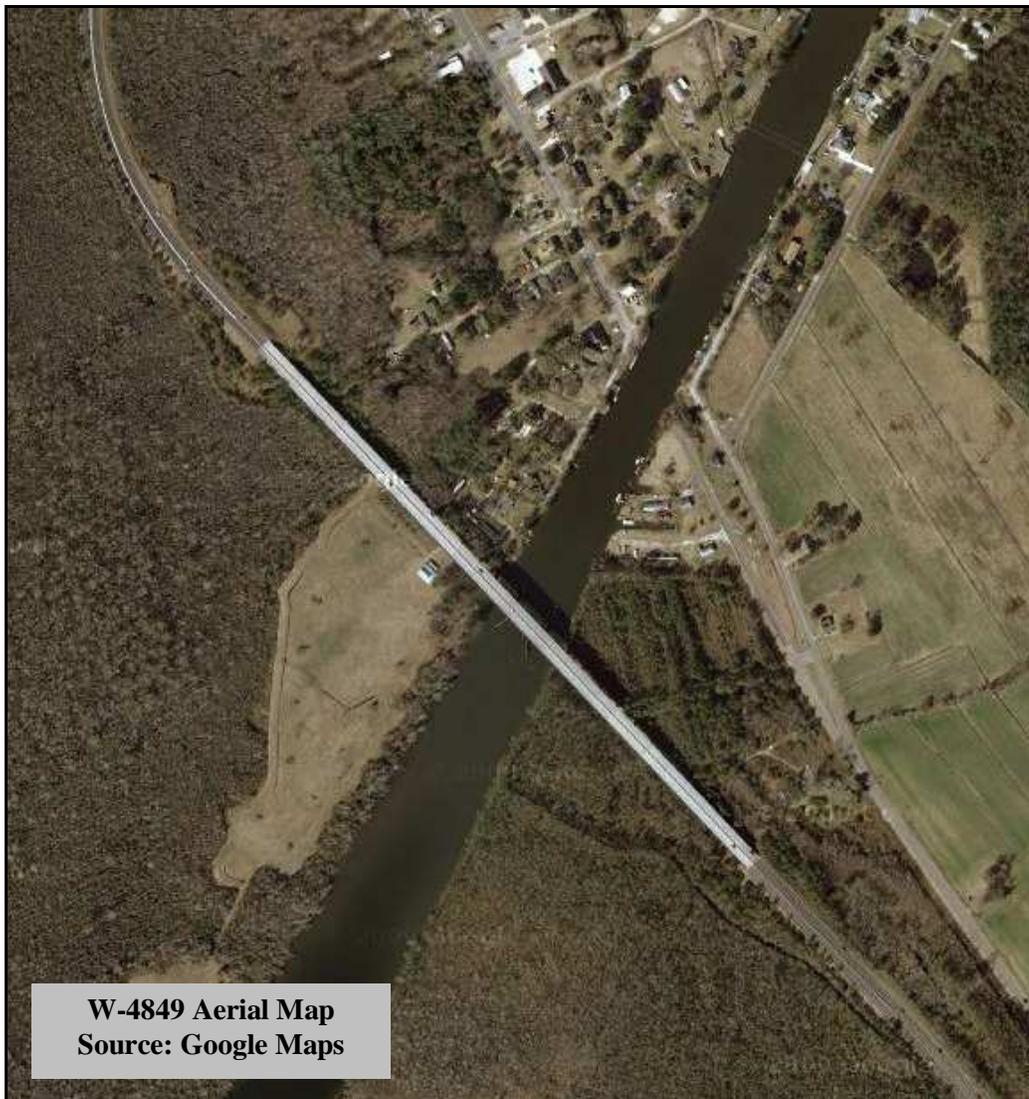
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Jason B. Schronce

3-22-2011  
Date

Traffic Safety Project Engineer





### **Subject Location**

The treatment location includes the US 158 (Caratoke Highway) segment as shown above. The study begins 0.1 mile south of SR 1143 (Worth Guard Road - MP 11.232) and continues to 0.1 mile north of the SR 1405 (Waterlily Road - MP 12.422). The total segment length is 1.19 miles which consists of the Coinjock Bridge over the Intercoastal Waterway. US 158 has a typical 5-lane cross section but the high-rise bridge consists of four-lanes with a four (4) foot painted median in the before period. The speed limit along this roadway is 55-mph.

This same study area was additionally improved with a resurfacing project that was completed in December 2002. The resurfacing project installed open-graded asphalt friction course pavement, profile edgelines along centerlines, enhanced the painted median, and added rumble strips. The evaluation of the concrete median barrier installed under W-4849 was limited by the completion of this previous resurfacing project. The Safety Evaluation Group did not identify any other improvements along this roadway segment.

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

The hazard elimination project improvement chosen was the installation of approximately one-mile of concrete median barrier leading up to and across the Coinjock Intercoastal Waterway Bridge. This section of US 158 had experienced numerous cross median (centerline) crashes resulting in fatalities, serious injury, and property damage. The intended purpose of the improvement was to enhance roadway safety by preventing vehicles from crossing the centerline into on-coming traffic and reducing severe injury collisions.

From June 1999 through December 2004, this roadway segment has experienced five (5) fatal crashes resulting in six (6) individual deaths. These five collisions included three (3) head-on crashes and two (2) that lost control and ran-off the road after hitting sand / debris on the roadway.

The initial crash analysis was completed from March 1, 2000 to February 28, 2003 with six (6) correctable crashes. The improvement was completed on March 25, 2006 with a total cost of \$500,000. The projected B/C Ratio was 25.25:1.

## **Location Photographs**



### Traveling South on US-158 at Bridge Entrance



#### 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 the months of January through May 2006. The before period consisted of reported crashes from January 1, 2003 through December 31, 2005 (3 years); and the after period consisted of reported crashes from June 1, 2006 through May 31, 2009 (3 years). The ending date for this analysis was limited by the resurfacing project completed in December 2002. The before period ADT year was 2004 and the after period ADT year was 2008.

The treatment data consisted of all mainline US-158 crashes with a 0' y-line. Target crashes are cross median crash types in the before period which translate to concrete median barrier hits in the after period. The Target Crashes were individually reviewed per selection (see collision diagram) and include the following crash types: Head-On; Fixed Object; Ran-Off Road (Right, Left); and Sideswipe-Opposite Direction.

**US-158: Currituck County, 1.19 Miles**

| <b><u>US-158 Both Directions</u></b>      | <b>Before</b> | <b>After</b> | <b>Percent Reduction (-)/<br/>Percent Increase (+)</b> |
|---|---------------|--------------|--|
| Total Crashes – Both Directions           | 26            | 11           | - 57.7 %   |
| Total Severity Index                      | 7.68          | 4.36         | - 43.2 %   |
|   |               |              |  |
| Cross Median / Median Barrier Hit Crashes | 7             | 4            | - 42.9 %   |
| Target (Cross Median) Severity Index      | 11.83         | 6.55         | - 44.6 %   |
|   |               |              |  |
| Total Lane Departure Crashes              | 17            | 8            | - 52.9 %   |
| Total Lane Departure Severity Index       | 5.89          | 5.63         | - 4.4 %  |
|   |               |              |  |
| Volume (2004, 2008)                       | 15,000        | 14,000       | - 6.7 %  |

| <b><u>US-158 over Coinjock Bridge</u></b> | <b>Before</b> | <b>After</b> | <b>Percent Reduction (-)/<br/>Percent Increase (+)</b> |
|---|---------------|--------------|--|
|   |               |              |  |
| <b>Injuries</b>                           |               |              |  |
| Fatal Injury Crashes                      | 2             | 0            | - 100.0 %  |
| Class-A Injury Crashes                    | 0             | 0            | 0.0 %  |
| Class-B Injury Crashes                    | 1             | 4            | 100+ %   |
| Class-C Injury Crashes                    | 2             | 1            | - 50.0 %   |
| Property Damage Only Crashes              | 21            | 6            | - 71.4 %   |
|   |               |              |  |
| <b>Contributing Factors</b>               |               |              |  |
| Night Crashes                             | 11            | 6            | - 45.5 %   |
| Wet Road Crashes                          | 6             | 1            | - 83.3 %   |
| Alcohol Related                           | 0             | 4            | 100+ %   |

The naive before and after analysis for US 158 in Currituck County resulted in an overall 58 percent decrease in Total Crashes and an 43 percent decrease in the Total Severity Index. There was also a 43 percent decrease in Target Cross Median Crashes but a 44 percent decrease in the Target Severity Index.

### **Results and Discussion**

From the tables above, the overall crashes appear to have been positively impacted with the installation of the concrete median barrier with a reduction of 57 percent. By nature of the concrete median barrier installation, cross median crashes are immediately removed and the opposing vehicle interactions should be eliminated. For the after period, we examined and compared the vehicles striking the median barrier to the cross-median crashes in the before period and still experienced a reduction of 43 percent. There were no severe injury (Fatality or A-injury) crashes in the after period. This is especially significant since this location saw five (5) fatal crashes in a five-year period from November 1999 through December 2004.

The calculated benefit to cost ratio for W-4849 is **8.37 considering Total Crashes**. The benefit to cost ratio **considering only Target Crashes is 3.86**. 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.

As the Safety Evaluation Group completes additional hazard elimination 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.

### Analysis through Current Crash Data

Since our evaluation was limited in the after period by the resurfacing project completed in December 2002; the Safety Evaluation Group conducted a follow-up analysis showing the after period crash history through current crash data.

After 1 Period (from study): June 1, 2006 – May 31, 2009 (3 Years)

After 2 Period (current data): June 1, 2009 - January 31, 2011 (1 Year, 8 Months)

| <b><u>US-158 Both Directions</u></b>         | <b>Before<br/>3.0 Yrs</b> | <b>After<br/>1.67 Yrs</b> | <b>Percent Reduction (-)/<br/>Percent Increase (+)</b> |
|--|---------------------------|---------------------------|--|
| Total Crashes – Both Directions              | 11                        | 5                         | N/A  |
| <b>Total Crashes per Year</b>                | <b>3.67</b>               | <b>2.99</b>               | <b>- 18.5 %</b>  |
| Total Severity Index                         | 4.36                      | 2.48                      | - 43.1 %   |
|  |                           |                           |  |
| Cross Median / Median Barrier Hit Crashes    | 4                         | 1                         | N/A  |
| <b>Median Barrier Hits Crashes Per Year</b>  | <b>1.33</b>               | <b>0.60</b>               | <b>- 54.9 %</b>  |
| Target (Cross Median) Severity Index         | 6.55                      | 1.00                      | - 84.7 %   |
|  |                           |                           |  |
| Total Lane Departure Crashes                 | 8                         | 3                         | N/A  |
| <b>Total Lane Departure Crashes per Year</b> | <b>2.67</b>               | <b>1.80</b>               | <b>- 32.6 %</b>  |
| Total Lane Departure Severity Index          | 5.63                      | 1.00                      | - 82.2 %   |

As evident in the table above, this location is still experiencing enhanced crash reduction and safety with the installation of the concrete median barrier. The one year and eight months of current data additionally shows a 55 percent decrease in Median Barrier Strikes and a 32 percent decrease in Total Lane Departure Crashes along this US-158 segment.

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

|  |   |                                |                            |                         |                            |                  |                          |   |                  |
|--|---|--------------------------------|----------------------------|-------------------------|----------------------------|------------------|--------------------------|---|------------------|
| LOCATION: <b>US-158 at Coinjock Bridge</b> |   | BY: <b>JBS</b>                 |                            |                         |                            |                  |                          |   |                  |
| COUNTY: <b>Currituck</b>                   |   | DATE: <b>3/22/2011</b>         |                            |                         |                            |                  |                          |   |                  |
| FILE NO.: <b>W-4849</b>                    |   |                                |                            |                         |                            |                  |                          |   |                  |
| DETAILED COST:                             | TYPE IMPROVEMENT -  | <b>Concrete Median Barrier</b> |                            |                         |                            |                  |                          |   |                  |
|  | ITEMS   | TOTAL                          | SERVICE                    | CRF                     | ANNUAL COST                |                  |                          |   |                  |
|  | <b>Construction</b>   | <b>\$500,000</b>               | <b>20</b>                  | <b>0.102</b>            | <b>\$50,926</b>            |                  |                          |   |                  |
|  | <b>Right-of-Way</b>   | <b>\$0</b>                     | <b>0</b>                   | <b>0.000</b>            | <b>\$0</b>                 |                  |                          |   |                  |
|  | <b>TOTALS</b>   | <b>\$500,000</b>               | <b>20</b>                  | <b>0.102</b>            | <b>\$50,926</b>            |                  |                          |   |                  |
|  | ESTIMATED INCREASE IN ANNUAL MAINT. COST =                          |                                |                            |                         | <b>\$200</b>               |                  |                          |   |                  |
|  | ESTIMATED INCREASE IN ANNUAL UTILITY COST =                         |                                |                            |                         | <b>\$0</b>                 |                  |                          |   |                  |
|  | TOTAL ANNUAL COST=  |                                |                            |                         | <b>\$51,126</b>            |                  |                          |   |                  |
|  | TOTAL COST OF PROJECT=  |                                |                            |                         | <b>\$500,000</b>           |                  |                          |   |                  |
| COMPREHENSIVE COST REDUCTION:              |   |                                |                            |                         |                            |                  |                          |   |                  |
|  | ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES                       |                                |                            |                         |                            |                  |                          |   |                  |
| TIME PERIOD                                | YEARS   | K & A<br>CRASHES               | K & A<br>CRASHES<br>PER YR | B & C<br>CRASHES        | B & C<br>CRASHES<br>PER YR | PDO<br>CRASHES   | PDO<br>CRASHES<br>PER YR | ANNUAL<br>COSTS                         |                  |
| <b>BEFORE</b>                              | <b>3.00</b>   | <b>2</b>                       | <b>0.67</b>                | <b>3</b>                | <b>1.00</b>                | <b>21</b>        | <b>7.00</b>              | <b>\$470,100</b>                        |                  |
| <b>AFTER</b>                               | <b>3.00</b>   | <b>0</b>                       | <b>0.00</b>                | <b>5</b>                | <b>1.67</b>                | <b>6</b>         | <b>2.00</b>              | <b>\$41,933</b>                         |                  |
|  |   |                                |                            |                         |                            |                  |                          | Annual Benefits from Crash Cost Savings | <b>\$428,167</b> |
|  | NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST |                                |                            |                         | =                          | <b>\$377,041</b> |                          |   |                  |
|  | BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST          |                                |                            |                         | =                          | <b>8.37</b>      |                          |   |                  |
|  | TOTAL COST OF PROJECT   | -                              | <b>\$500,000</b>           | COMPREHENSIVE B/C RATIO | -                          |                  |                          | <b>8.37</b>                             |                  |

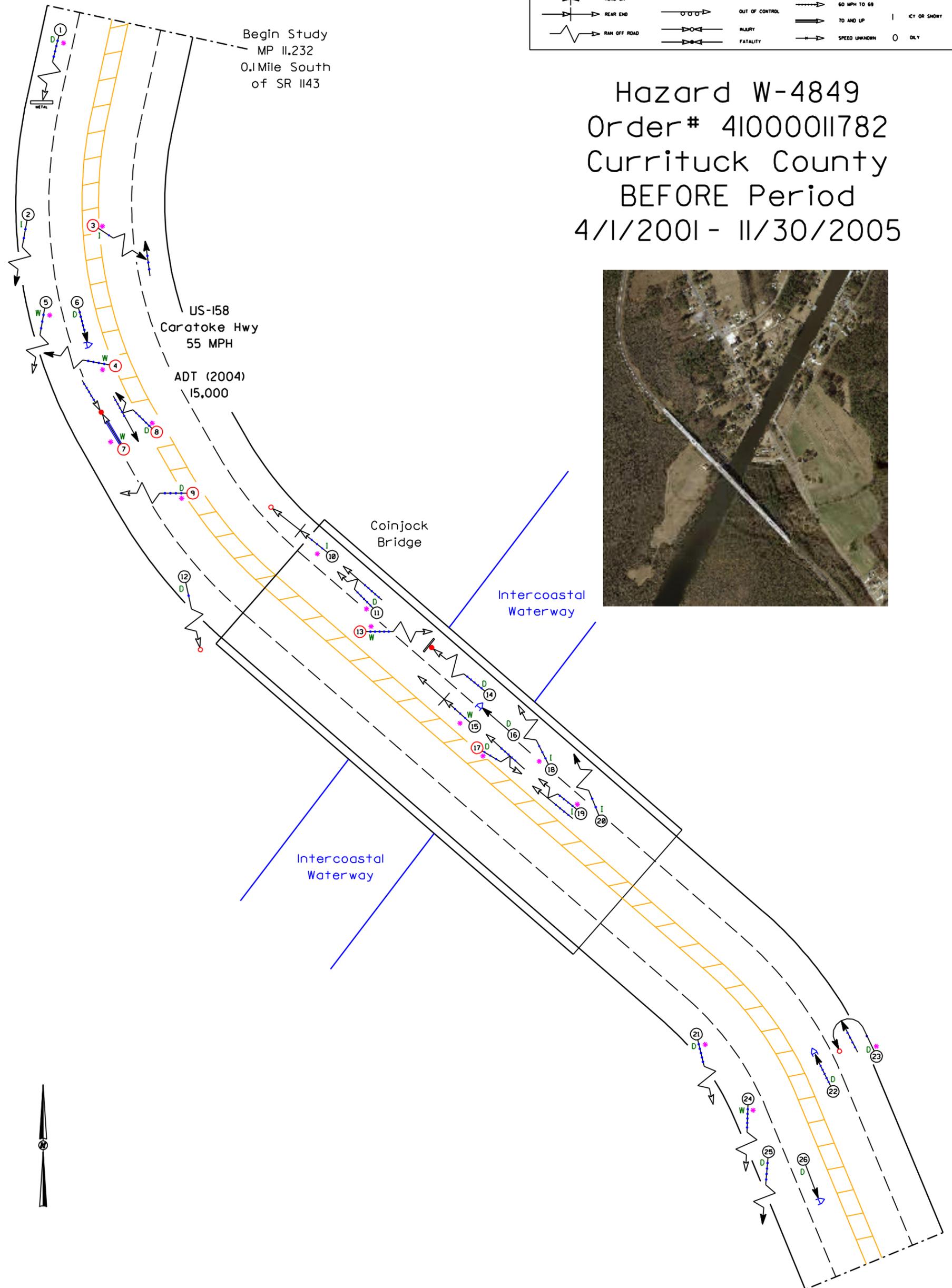
**BENEFIT-COST ANALYSIS WORKSHEET - Target Crashes**

|  |   |                                       |                            |                         |                            |                  |                          |   |                  |
|--|---|---------------------------------------|----------------------------|-------------------------|----------------------------|------------------|--------------------------|---|------------------|
| LOCATION: <b>US-158 at Coinjock Bridge</b> |   | BY: <b>JBS</b>                        |                            |                         |                            |                  |                          |   |                  |
| COUNTY: <b>Currituck</b>                   |   | DATE: <b>3/22/2011</b>                |                            |                         |                            |                  |                          |   |                  |
| FILE NO.: <b>W-4849</b>                    |   | Target Crashes - Cross Median Crashes |                            |                         |                            |                  |                          |   |                  |
| DETAILED COST:                             | TYPE IMPROVEMENT -  | <b>Concrete Median Barrier</b>        |                            |                         |                            |                  |                          |   |                  |
|  | ITEMS   | TOTAL                                 | SERVICE                    | CRF                     | ANNUAL COST                |                  |                          |   |                  |
|  | <b>Construction</b>   | <b>\$500,000</b>                      | <b>20</b>                  | <b>0.102</b>            | <b>\$50,926</b>            |                  |                          |   |                  |
|  | <b>Right-of-Way</b>   | <b>\$0</b>                            | <b>0</b>                   | <b>0.000</b>            | <b>\$0</b>                 |                  |                          |   |                  |
|  | <b>TOTALS</b>   | <b>\$500,000</b>                      | <b>20</b>                  | <b>0.102</b>            | <b>\$50,926</b>            |                  |                          |   |                  |
|  | ESTIMATED INCREASE IN ANNUAL MAINT. COST =                          |                                       |                            |                         | <b>\$200</b>               |                  |                          |   |                  |
|  | ESTIMATED INCREASE IN ANNUAL UTILITY COST =                         |                                       |                            |                         | <b>\$0</b>                 |                  |                          |   |                  |
|  | TOTAL ANNUAL COST=  |                                       |                            |                         | <b>\$51,126</b>            |                  |                          |   |                  |
|  | TOTAL COST OF PROJECT=  |                                       |                            |                         | <b>\$500,000</b>           |                  |                          |   |                  |
| COMPREHENSIVE COST REDUCTION:              |   |                                       |                            |                         |                            |                  |                          |   |                  |
|  | ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES                       |                                       |                            |                         |                            |                  |                          |   |                  |
| TIME PERIOD                                | YEARS   | K & A<br>CRASHES                      | K & A<br>CRASHES<br>PER YR | B & C<br>CRASHES        | B & C<br>CRASHES<br>PER YR | PDO<br>CRASHES   | PDO<br>CRASHES<br>PER YR | ANNUAL<br>COSTS                         |                  |
| <b>BEFORE</b>                              | <b>3.00</b>   | <b>1</b>                              | <b>0.33</b>                | <b>0</b>                | <b>0.00</b>                | <b>6</b>         | <b>2.00</b>              | <b>\$218,600</b>                        |                  |
| <b>AFTER</b>                               | <b>3.00</b>   | <b>0</b>                              | <b>0.00</b>                | <b>3</b>                | <b>1.00</b>                | <b>1</b>         | <b>0.33</b>              | <b>\$21,433</b>                         |                  |
|  |   |                                       |                            |                         |                            |                  |                          | Annual Benefits from Crash Cost Savings | <b>\$197,167</b> |
|  | NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST |                                       |                            |                         | =                          | <b>\$146,041</b> |                          |   |                  |
|  | BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST          |                                       |                            |                         | =                          | <b>3.86</b>      |                          |   |                  |
|  | TOTAL COST OF PROJECT   | -                                     | <b>\$500,000</b>           | COMPREHENSIVE B/C RATIO | -                          |                  |                          | <b>3.86</b>                             |                  |

**LEGEND**

|  |                 |  |                |  |               |  |                 |
|--|-----------------|--|----------------|--|---------------|--|-----------------|
|  | MOVING VEHICLE  |  | ANGLE          |  | 9 MPH OR LESS |  | PEDESTRIAN      |
|  | PEDESTRIAN      |  | TURNING        |  | 10 MPH TO 19  |  | TRAIN           |
|  | PARKED VEHICLE  |  | BACKING        |  | 20 MPH TO 29  |  | DRIVER AT FAULT |
|  | PARKING VEHICLE |  | SIDESWIPE      |  | 30 MPH TO 39  |  | DRY             |
|  | FIXED OBJECT    |  | OUT OF CONTROL |  | 40 MPH TO 49  |  | WET             |
|  | HEAD ON         |  | INJURY         |  | 50 MPH TO 59  |  | ICY OR SNOWY    |
|  | REAR END        |  | FATALITY       |  | 70 AND UP     |  | OILY            |
|  | RAN OFF ROAD    |  | SPEED UNKNOWN  |  |               |  |                 |

**Hazard W-4849**  
**Order# 41000011782**  
**Currituck County**  
**BEFORE Period**  
**4/1/2001 - 11/30/2005**



**N.C. DEPARTMENT of TRANSPORTATION**  
**DIVISION of HIGHWAYS**  
**TRANSPORTATION MOBILITY and**  
**SAFETY DIVISION**

**TRAFFIC SAFETY UNIT**

Date: 3-21-2011

Prepared By: J. Schronce

Cross Median  
Target Crashes

**LEGEND**

|  |                 |  |                |  |               |  |                 |
|--|-----------------|--|----------------|--|---------------|--|-----------------|
|  | MOVING VEHICLE  |  | ANGLE          |  | 9 MPH OR LESS |  | PEDESTRIAN      |
|  | PEDESTRIAN      |  | TURNING        |  | 10 MPH TO 19  |  | TRAIN           |
|  | PARKED VEHICLE  |  | BACKING        |  | 20 MPH TO 29  |  | DRIVER AT FAULT |
|  | PARKING VEHICLE |  | SIDESWIPE      |  | 30 MPH TO 39  |  | DRY             |
|  | FIXED OBJECT    |  | OUT OF CONTROL |  | 40 MPH TO 49  |  | WET             |
|  | HEAD ON         |  | INJURY         |  | 50 MPH TO 59  |  | ICY OR SNOWY    |
|  | REAR END        |  | FATALITY       |  | TO AND UP     |  | DILY            |
|  | RAN OFF ROAD    |  | SPEED UNKNOWN  |  |               |  |                 |



Begin Study  
MP 11.232  
0.1 Mile South  
of SR 1143

Hazard W-4849  
Order# 41000011782  
Currituck County  
AFTER Period  
6/1/2006 - 5/31/2009



Install Concrete Median  
Barrier along and leading  
upto the Coinjock Bridge

US-158  
Caratoke Hwy  
55 MPH  
ADT (2008)  
14,000

Coinjock  
Bridge

Intercoastal  
Waterway

Intercoastal  
Waterway

End Study  
MP 12.422  
0.1 Mile North  
of SR 1405

**N.C. DEPARTMENT of TRANSPORTATION**  
**DIVISION of HIGHWAYS**  
**TRANSPORTATION MOBILITY and**  
**SAFETY DIVISION**

**TRAFFIC SAFETY UNIT**

Date: 3-22-2011

Prepared By: J. Schronce

Cross Median  
Target Crashes

