

# North Carolina Project Development Crash Reduction Factor (CRF) Information



North Carolina Department of Transportation  
Traffic Safety Unit

## North Carolina Project Development Crash Reduction Factor (CRF) Information

### Introduction

The North Carolina Project Development Crash Reduction Factor (CRF) Information document is a directory with common CRFs applicable to North Carolina.

Many safety professionals use the term Crash Modification Factor (CMF), which is a multiplicative factor that indicates the proportion of crashes that would be expected after implementing a countermeasure. A CRF is another way of representing the expected effect of a countermeasure in terms of the percentage decrease in crashes. A CRF is equal to  $100 \times (1 - \text{CMF})^a$ . The CRF is used in this document because it is an easy way for practitioners to communicate safety improvements.

The purpose of the document is to provide the expected crash reductions for specific countermeasure types used in the project development process. These CRFs are used by the NCDOT to evaluate and compare the cost-effectiveness of alternatives for safety improvements. Research is reviewed at the State and National level to determine which CRFs are most appropriate and applicable for North Carolina roadways.

<sup>a</sup> Source: [http://www.cmfclearinghouse.org/userguide\\_CMF.cfm](http://www.cmfclearinghouse.org/userguide_CMF.cfm)

### Safety Treatment Categories

There are currently 10 categories of safety treatments in the North Carolina CRF list: (1) **Traffic Signals**, (2) **Reduce Conflicts**, (3) **Turn Lanes & Ramps**, (4) **Roadway Improvements**, (5) **Roadside Improvements**, (6) **Alignment & Sight Distance**, (7) **Signing, Delineation & Illumination**, (8) **Pedestrian & Bicycle**, (9) **Railroad Crossing**, and (10) **Work Zones**.

### CRF Sources

The Crash Modification Factors Clearinghouse and individual research documents were reviewed to determine which CRFs were the highest quality and most applicable for each countermeasure. The Crash Modification Factors Clearinghouse, which serves as a central, web-based repository of CMFs from across the world, provides star ratings that were taken into consideration. Generally, the higher the rating, the more robust the study. <http://www.cmfclearinghouse.org/>

The Crash Modification Factors Clearinghouse was last downloaded in December 2021. The Clearinghouse rating values are reflective of the Clearinghouse's transition to the CMF rating criteria developed as part of the NCHRP 17-72 project for the 2nd edition of the Highway Safety Manual.

## North Carolina Project Development Crash Reduction Factor (CRF) Information

### CRF Approvals

Approval must be obtained from the CRF Committee if CRFs are identified from sources other than this sheet. The CRF Committee is comprised of all NCDOT Regional Traffic Engineers and the NCDOT Safety Evaluation Engineer.

### Definitions and Helpful Information

**NCDOT Reference Number** is provided for each CRF in the first column.

- If a Reference Number is followed by a Letter (i.e. 1.1.1A and 1.1.1B), the CRFs should be used together. To aid in the identification of CRFs that should be used together, "A", "B" and "C" labels have been added adjacent to the CRF values that go together.

**Countermeasure Location Type** is provided to help users identify where the countermeasure is typically applied.

**Countermeasure Target Crash** is provided to guide users on the crash type(s) that the countermeasure is typically installed to treat and target.

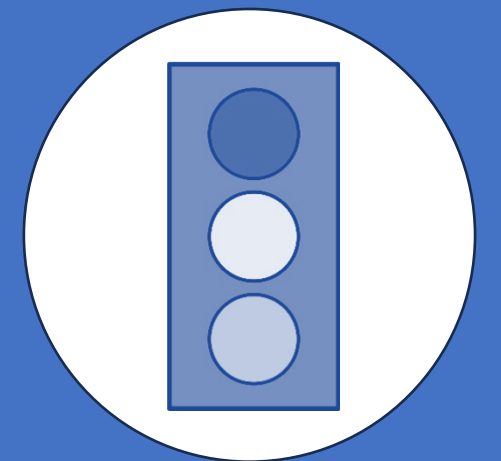
Refer to the **CRF Site Specifications**, **CRF Crash Pattern Affected** and **CRF Context** for information on where and how to apply a specific CRF. Research reports were reviewed to provide context where possible. Context is provided for many but not all CRFs.

Refer to the **Status** to see if a CRF is denoted as "Subjective" or "Interim".

- "Subjective" CRFs are determined when no data is available and the committee has agreed upon a subjective value.
- "Interim" CRFs are determined when limited data is available but a robust study has not been performed or the study from past research summaries could not be found.
- Both "Subjective" and "Interim" CRFs may be used until a more statistically reliable CRF becomes available.
- Items with a Status note in **RED** are revisions or new additions from the prior version of the CRF Sheet.

Information used to perform a benefit cost analysis are provided in the last columns for each CRF, which includes **Service Life**, **Annual Maintenance**, **Utility Costs**, **Crash Costs F+A**, **Crash Costs B+C**, and **Crash Costs PDO**. The Crash Costs are specific to the CRF crash pattern affected and use 2022 values.

# 1 - Traffic Signals



North Carolina Project Development Crash Reduction Factor Information  
 LAST UPDATED: 6/28/2023

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**1 - Traffic Signals**

NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
<b>1.1 - New Traffic Signal</b>															
1.1.1 A	Intersection	Frontal Impact	New Traffic Signal	3-leg Urban Intersection	Angle Injury Crashes	Include All Angle Crashes in Intersection: May include Angle, LTDR and RTDR Crash Types. Injury includes fatality and injury crashes. Use 1.1.1A and 1.1.1B together. Apply 50 yr service life if metal poles/mast arms used.	A 34		10	\$ 2,700	\$ 475	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.1.1 B	Intersection	Frontal Impact	New Traffic Signal	3-leg Urban Intersection	Rear End Injury Crashes	Injury includes fatality and injury crashes. Use 1.1.1A and 1.1.1B together. Apply 50 yr service life if metal poles/mast arms used.	B -50		10	\$ 2,700	\$ 475	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
1.1.2 A	Intersection	Frontal Impact	New Traffic Signal	4-leg Urban Intersection	Angle Injury Crashes	Include All Angle Crashes in Intersection: May include Angle, LTDR and RTDR Crash Types. Injury includes fatality and injury crashes. Use 1.1.2A and 1.1.2B together. Apply 50 yr service life if metal poles/mast arms used.	A 67		10	\$ 2,700	\$ 475	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.1.2 B	Intersection	Frontal Impact	New Traffic Signal	4-leg Urban Intersection	Rear End Injury Crashes	Injury includes fatality and injury crashes. Use 1.1.2A and 1.1.2B together. Apply 50 yr service life if metal poles/mast arms used.	B -38		10	\$ 2,700	\$ 475	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
1.1.3 A	Intersection	Frontal Impact	New Traffic Signal Without Addition of New Left Turn Lanes	3-Leg and 4-Leg Rural Intersection	Angle and Left Turn Crashes	Include All Angle and Left Turn Crashes in Intersection: May include Angle, LTSR, LTDR, and RTDR Crash Types. Use 1.1.3A and 1.1.3B together. Apply 50 yr service life if metal poles/mast arms used.	A 58		10	\$ 2,700	\$ 475	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.1.3 B	Intersection	Frontal Impact	New Traffic Signal Without Addition of New Left Turn Lanes	3-Leg and 4-Leg Rural Intersection	Rear End Crashes	Include all Rear End Crashes in Intersection. Use 1.1.3A and 1.1.3B together. Apply 50 yr service life if metal poles/mast arms used.	B -43		10	\$ 2,700	\$ 475	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
1.1.4 A	Intersection	Frontal Impact	New Traffic Signal with New Left Turn Lane(s)	3-Leg and 4-Leg Rural Intersection	Angle and Left Turn Crashes	Include All Angle and Left Turn Crashes in Intersection: May include Angle, LTSR, LTDR, and RTDR Crash Types. Use 1.1.4A and 1.1.4B together. Apply 50 yr service life if metal poles/mast arms used.	A 61		10	\$ 2,700	\$ 475	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.1.4 B	Intersection	Frontal Impact	New Traffic Signal with New Left Turn Lane(s)	3-Leg and 4-Leg Rural Intersection	Rear End Crashes	Include all Rear End Crashes in Intersection. Use 1.1.4A and 1.1.4B together. Apply 50 yr service life if metal poles/mast arms used.	B 29		10	\$ 2,700	\$ 475	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
<b>1.2 - Upgrade Traffic Signal</b>															
1.2.1	Intersection	All	Upgrade Traffic Signal	All	Total Crashes	Only use if there is not a countermeasure available for your specific situation	14	Interim	10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>1.3 - Change to Protected Left Turn</b>															
1.3.1	Intersection	Left Turn	Change from Permitted or Permitted-Protected to Protected-Only Left Turn	Urban	Left Turn Same Roadway Crashes*	*Modified from Study. Include only LTSR crashes on treated approaches. For Time of Day applications, apply CRF during times it is in protected operation.	99		10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.3.2	Intersection	Left Turn	Change from Permitted or Permitted-Protected to Protected-Only Left Turn	Not Specified	Left Turn Same Roadway Crashes*	*Modified from Study. Include only LTSR crashes on treated approaches. For Time of Day applications, apply CRF during times it is in protected operation.	70	Interim	10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
<b>1.4 - Convert Signal to Mast Arm</b>															
1.4.1	Intersection	Frontal Impact	Convert Signal from Span Wire to Mast Arm	All	Angle Crashes	Include All Angle Crashes in Intersection: May include Angle, LTDR and RTDR Crash Types	5		50	\$ 400	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
<b>1.5 - Install Near Side Signal Head</b>															
1.5.1	Intersection	Frontal Impact	Install Near Side Signal Head	All	Target Frontal Impact Crashes	Target = Red Light Run Crashes on Treated Approaches	30	Interim	10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
<b>1.6 - Pretimed to Actuated Signal</b>															
1.6.1	Intersection	Frontal Impact	Pretimed to Actuated Signal	Not Specified	Angle Crashes	Include All Angle Crashes in Intersection: May include Angle, LTDR and RTDR Crash Types	10	Interim	10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
<b>1.7 - Closed Loop Signal System</b>															
1.7.1	Int / Section	All	Closed Loop Signal System	Not Specified	Total Crashes		15	Interim	10	\$1000 x # of signals in system	\$ 480	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>1.8 - Improve Signal Timing</b>															
1.8.1	Intersection	All	Improve Signal Timing	Not Specified	Total Crashes		15	Interim	10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>1.9 - Replace 8-inch Signal Heads with 12-inch Signal Heads</b>															
1.9.1	Intersection	Frontal Impact	Replace 8-inch Signal Heads with 12-inch Signal Heads	Urban	Angle Crashes	Include All Angle Crashes in Intersection: May include Angle, LTDR and RTDR Crash Types	42		10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400



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1 - Traffic Signals															
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
1.10 - Add Long Vehicle Detection															
1.10.1	Intersection	Truck	Add Long Vehicle Detection	All	Total Crashes		10	Interim	10	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
1.11 - Add Advanced Dilemma Zone Detection															
1.11.1	Intersection	Frontal Impact	Add Advanced Dilemma Zone Detection	Rural High Speed Approaches - 4-Leg (Major ADT 10,900 to 43,300)	Injury Crashes	Injury includes fatality and injury crashes	39		10	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
1.12 - Add/Revise Signal Back Plates															
1.12.1	Intersection	Frontal Impact	Install New Signal Back Plates	Not Specified	Angle Crashes	Include All Angle Crashes on Approaches Addressed by Treatment: May include Angle, LTDR and RTDR Crash Types	20	Interim	10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.12.2	Intersection	Frontal Impact	Add 3-Inch Yellow Micro-prismatic Retroreflective Sheeting to Signal Back Plates	All	Total Crashes		15		10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
1.13 - Install Dual Red Signal Indication															
1.13.1	Intersection	Frontal Impact	Install Dual Red Signal Indication	Not Specified	Angle Crashes	May apply to T or stacked red display. Include All Angle Crashes on Approaches Addressed by Treatment: May include Angle, LTDR and RTDR Crash Types.	33	Interim	10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.14 - Flashing Yellow Arrow															
1.14.1	Intersection	Left Turn	Install FYA - Permissive Only to FYA Protected-Permitted	All	Left Turn Same Roadway Injury Crashes	Injury includes fatality and injury crashes. Include only LTSR crashes on approaches treated with FYA. CRF may be applied to revision from Permissive FYA (3-section) to Protected-Permitted FYA.	41		10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.14.2	Intersection	Left Turn	Install FYA - Protected Only to FYA Protected-Permitted	All	Left Turn Same Roadway Injury Crashes	Injury includes fatality and injury crashes. Include only LTSR crashes on approaches treated with FYA.	-378		10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.14.3	Intersection	Left Turn	Install FYA - Protected Only to FYA Protected-Permitted with TOD	All	Left Turn Same Roadway Injury Crashes	Injury includes fatality and injury crashes. Include only LTSR crashes on approaches treated with FYA.	-292	NEW	10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.14.4	Intersection	Left Turn	Install FYA - "Doghouse" Protected-Permitted to FYA Protected-Permitted	All	Left Turn Same Roadway Injury Crashes	Injury includes fatality and injury crashes. Include only LTSR crashes on approaches treated with FYA.	25		10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.14.5	Intersection	Left Turn	Install FYA - Permissive Only to FYA Permissive Only	All	Left Turn Same Roadway Injury Crashes	Injury includes fatality and injury crashes. Include only LTSR crashes on approaches treated with FYA.	65		10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.15 - Install Activated Advance Warning Flashers for Signal															
1.15.1 A	Intersection	Frontal Impact	Install Activated Advance Warning Flashers for Signal	All	Target Frontal Impact Crashes	Target = Red Light Run Crashes on treated approaches. Use 1.15.1A and 1.15.1B together.	A 30		10	\$ 500	\$ 100	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.15.1 B	Intersection	Frontal Impact	Install Activated Advance Warning Flashers for Signal	All	Target Rear-End Crashes	Target = Rear End Crashes approaching signal on treated approaches. Use 1.15.1A and 1.15.1B together.	B 22		10	\$ 500	\$ 100	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
1.16 - Install Left Turn Yield Blank Out Sign															
1.16.1	Intersection	Left Turn	Install Left Turn Yield Blank Out Sign	All	Total Crashes		15	Subjective	10	\$ 25	\$ 100	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
1.17 - Remove Unwarranted Signal															
1.17.1	Intersection	Rear End	Remove Unwarranted Signal and Replace with Minor Road Stop Control	All	Rear End Crashes	Include Only Rear Ends on Major Road approaches	90	Interim	20	\$ (2,700)	\$ (475)	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
1.17.2	Intersection	Frontal Impact	Remove Unwarranted Signal and Replace with All Way Stop Control	All	Frontal Impact Crashes		33	Interim	20	\$ (2,700)	\$ (475)	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.18 - Add Primary Signal Head															
1.18.1 A	Intersection	Frontal Impact	Add Primary Signal Head	Urban	Injury Crashes	Injury includes fatality and injury crashes. Use 1.18.1A and 1.18.1B together.	A 17		10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
1.18.1 B	Intersection	Frontal Impact	Add Primary Signal Head	Urban	PDO Crashes	Use 1.18.1A and 1.18.1B together	B 31		10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400



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1 - Traffic Signals															
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
1.19 - Add Split Side Street Signal Phasing															
1.19.1	Intersection	Left Turn	Add Split Side Street Signal Phasing	All	Left Turn Same Roadway Crashes	Include Only LTSR Crashes on Side Streets	70	Subjective	10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.20 - Add Dynamic Red Extension															
1.20.1	Intersection	Frontal Impact	Add Dynamic Red Extension	Rural, Isolated	Target Frontal Impact Crashes	Target = Red Light Run Crashes on Treated Approaches	25	Interim	10	\$ 125	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.21 - Overhead Intersection Flashing Beacons (Non-Actuated)															
1.21.1	Intersection	Frontal Impact	Overhead Intersection Flashing Beacons (Non-Actuated)	2-lane at 2-lane Rural Intersection	Frontal Impact Crashes	Use 1.21.1 OR 1.21.2 - Do Not combine them. Include all Frontal Impact Crash Types	9		10	\$ 300	\$ 260	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.21.2	Intersection	Frontal Impact	Overhead Intersection Flashing Beacons (Non-Actuated)	2-lane at 2-lane Rural Intersection	"Ran Stop Sign" Crashes	Use 1.21.1 OR 1.21.2 - Do Not combine them	26		10	\$ 300	\$ 260	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
1.22 - Implement Rest in Red															
1.22.1	Intersection	Frontal Impact	Implement Rest in Red	All	Frontal Impact Crashes		51	Interim	10	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400



## 2 - Reduce Conflicts





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2 - Reduce Conflicts

NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
<b>2.1 - Single-Lane Roundabout</b>															
2.1.1	Intersection	Frontal Impact	Two-Way Stop to One-Lane Roundabout	Urban and Suburban	Injury Crashes	Injury includes fatality and injury crashes	78		25	\$ 2,500	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.1.2	Intersection	Frontal Impact	Two-Way Stop to One-Lane Roundabout	Rural, At least one 55 mph approach	Injury Crashes	Injury includes fatality and injury crashes	79		25	\$ 2,500	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.1.3	Intersection	Frontal Impact	Signal to One-Lane Roundabout	Urban and Suburban	Injury Crashes	Injury includes fatality and injury crashes	55		25	\$ (200)	\$ (475)	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.1.4A	Intersection	Frontal Impact	Two-Way Stop to Mini-Roundabout	All	Injury Crashes	Injury includes fatality and injury crashes. Use 2.1.4A and 2.1.4B together.	A 59		25	\$ 2,500	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.1.4B	Intersection	Frontal Impact	Two-Way Stop to Mini-Roundabout	All	PDO Crashes	Use 2.1.4A and 2.1.4B together.	B -9		25	\$ 2,500	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>2.2 - Multi-Lane Roundabout</b>															
2.2.1A	Intersection	Frontal Impact	Two-Way Stop to Two-Lane Roundabout	All	Injury Crashes	Injury includes fatality and injury crashes. Use 2.2.1A and 2.2.1B together.	A 84	Interim	25	\$ 2,500	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.2.1B	Intersection	Frontal Impact	Two-Way Stop to Two-Lane Roundabout	All	PDO Crashes	Use 2.2.1A and 2.2.1B together.	B -71	Interim	25	\$ 2,500	\$ -	Total	\$ 3,570,000	\$ 151,000	\$ 12,400
2.2.2	Intersection	Frontal Impact	Signal to Two-Lane Roundabout	Urban and Suburban	Injury Crashes	Injury includes fatality and injury crashes	71		25	\$ (200)	\$ (475)	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.2.3	Intersection	Frontal Impact	Signal to Two-Lane Roundabout	Urban and Rural - 4-Leg	Injury Crashes	Use for rural scenarios not covered by CRF 2.2.2; Injury includes fatality and injury crashes	65		25	\$ (200)	\$ (475)	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.2.4A	Intersection	Frontal Impact	Stop Control to Multilane or Single Lane Roundabout at Ramp Terminal	All	Injury Crashes	Injury includes fatality and injury crashes. Study included mix of multilane RAB and single lane RAB, specific to interchange locations. Use 2.2.4A and B together.	A 65	NEW	25	\$ 2,500	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.2.4B	Intersection	Frontal Impact	Stop Control to Multilane or Single Lane Roundabout at Ramp Terminal	All	PDO Crashes	Study included mix of multilane RAB and single lane RAB, specific to interchange locations. Use 2.2.4A and B together.	B 33	NEW	25	\$ 2,500	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.2.5A	Intersection	Frontal Impact	Signal to Multilane Roundabout at Ramp Terminal	All	Injury Crashes	Injury includes fatality and injury crashes. Only multilane RAB included in study, specific to interchange locations. Use 2.2.5A and B together.	A 41	NEW	25	\$ (200)	\$ (475)	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.2.5B	Intersection	Frontal Impact	Signal to Multilane Roundabout at Ramp Terminal	All	PDO Crashes	Only multilane RAB included in study, specific to interchange locations. Use 2.2.5A and B together.	B -14	NEW	25	\$ (200)	\$ (475)	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>2.3 - Unsignalized Reduced Conflict Intersection (RCI)</b>															
2.3.1	Intersection	Frontal Impact	Two-Way Stop to Unsignalized RCI	Rural - Principal Arterial	Injury Crashes	Injury includes fatality and injury crashes. Research collected crashes 500' beyond median U-turns on major road & 150' beyond intersection on minor road.	63		20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.3.2	Intersection	Frontal Impact	Two-Way Stop to Unsignalized RCI	Principal Arterial (40-55 mph, 4-8 Lanes with AADT > 34,000)	Injury Crashes	Use if location type is not applicable for CRF 2.3.1; Injury includes fatality and injury crashes. Research used segments up to 0.25 mi on major road with 250' y-line.	36		20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.3.3	Intersection	Frontal Impact	Signal to Unsignalized RCI	All	Injury Crashes	Injury includes fatality and injury crashes	50	Interim	20	\$ (2,700)	\$ (475)	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>2.4 - Signalized Reduced Conflict Intersection (RCI)</b>															
2.4.1	Intersection	Frontal Impact	Signal to Signalized RCI	Suburban	Injury Crashes	Injury includes fatal and injury crashes. Research collected crashes within 1500' of main intersection along major street & 500' along minor street.	22		20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.4.2	Intersection	Frontal Impact	Two-Way Stop to Signalized RCI	All	Injury Crashes	Injury includes fatal and injury crashes	40	Interim	20	\$ 3,500	\$ 475	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.4.3	Intersection	Frontal Impact	Unsignalized RCI to Signalized RCI	All	Frontal Impact Crashes		65	Subjective	20	\$ 2,700	\$ 475	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
<b>2.5 - Median U-Turn</b>															
2.5.1	Intersection	Frontal Impact	Signal to Median U-Turn	Urban and Suburban	Total Crashes	MUT intersection with median U-turn crossovers downstream of the main intersection for both directions. Research included crashes within 250' of main intersection and 50' of median U-turns.	37	NEW	20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400



North Carolina Project Development Crash Reduction Factor Information

LAST UPDATED: 6/28/2023

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2 - Reduce Conflicts

NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO	
2.6 - Offset T Intersection																
2.6.1A	Intersection	Frontal Impact	Convert Four-Leg Intersection into Two T-Intersections	Urban	Injury Crashes	Minor Road Traffic >30% of Total Entering; Injury includes fatal and injury crashes. Use 2.6.1A and 2.6.1B together.	A	33	20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
2.6.1B	Intersection	Frontal Impact	Convert Four-Leg Intersection into Two T-Intersections	Urban	PDO Crashes	Minor Road Traffic >30% of Total Entering. Use 2.6.1A and 2.6.1B together.	B	10	20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
2.6.2	Intersection	Frontal Impact	Convert Four-Leg Intersection into Two T-Intersections	Rural	Total Crashes			70	Interim	20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.7 - Continuous Green T																
2.7.1	Intersection	Frontal Impact	Signal to Continuous Green T	3-Leg Intersection	Injury Crashes	Injury includes fatal and injury crashes		15		20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.8 - Continuous Flow Intersection (CFI)																
2.8.1	Intersection	Frontal Impact	Signal to Continuous Flow Intersection	All	Total Crashes	In this research, analysis included crashes within 150' from the left turn cross-over point of any treated approach back to the main intersection.		12	NEW	20	\$ 6,200	\$ 950	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.9 - Remove Leg from Intersection																
2.9.1	Intersection	Frontal Impact	Remove Leg from Intersection	All	Total Crashes involving the Treated Leg			100	Subjective	20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.10 - Remove Crossover																
2.10.1	Intersection	All	Remove Crossover	All	Total Crashes			90	Subjective	20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.11 - Access Management near Intersections																
2.11.1	Intersection	Frontal Impact	General Intersection Channelization	All	Total Crashes			25	Interim	20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.11.2	Intersection	Frontal Impact	Median Channelization near Signals	Urban / Suburban	Total Crashes	Apply to the treated approaches of the intersection where median channelization will be installed		27	Interim	20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.12 - Raised Median																
2.12.1A	Section	All	Provide a Raised Median	Urban Multilane Arterial	Injury Crashes	Injury includes fatality and injury crashes (include both section and intersection). Use 2.12.1A and 2.12.1B together.	A	22		20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.12.1B	Section	All	Provide a Raised Median	Urban Multilane Arterial	PDO Crashes	Include both section and intersection crashes. Use 2.12.1A and 2.12.1B together.	B	-9		20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.12.2A	Section	All	Provide a Raised Median	Rural Multilane Arterial	Injury Crashes	Injury includes fatality and injury crashes (include both section and intersection). Use 2.12.2A and 2.12.2B together.	A	12		20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.12.2B	Section	All	Provide a Raised Median	Rural Multilane Arterial	PDO Crashes	Include both section and intersection crashes. Use 2.12.2A and 2.12.2B together.	B	18		20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.12.3	Section	All	Provide a Raised Median	Urban Two-Lane Roadway	Injury Crashes	Injury includes fatality and injury crashes (include both section and intersection)		39		20	\$ 800	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.13 - Grade Separation - No Interchange																
2.13.1	Intersection	All	Grade Separation - No Interchange	All	Total Crashes			90	Subjective	50	\$ 2,000	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400



2 - Reduce Conflicts															
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
2.14 - Grade-Separated Interchange															
2.14.1A	Intersection	All	Convert At-Grade Intersection to Grade-Separated Interchange	4-Leg Intersection	Injury Crashes	Injury includes fatality and injury crashes. Use 2.14.1A and 2.14.1B together.	A	57	50	\$ 2,000	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.14.1B	Intersection	All	Convert At-Grade Intersection to Grade-Separated Interchange	4-Leg Intersection	PDO Crashes	Use 2.14.1A and 2.14.1B together	B	36	50	\$ 2,000	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.14.2	Intersection	All	Convert At-Grade Intersection to Grade-Separated Interchange	3-Leg Intersection	Total Crashes			16	50	\$ 2,000	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
2.15 - Diverging Diamond Interchange (DDI)															
2.15.1	Intersection	All	Convert Conventional Diamond Interchange to Diverging Diamond Interchange (DDI)	All	Injury Crashes	Injury includes fatality and injury crashes		54	50	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400



# 3 - Turn Lanes & Ramps



Note: Approval must be obtained from the CRF Committee if CRFs are identified from sources other than this sheet. Subjective CRFs are determined when no data is available and the committee has agreed upon a subjective value. Interim CRFs are determined when limited data is available but a robust study has not been performed or the study from past research summaries could not be found. Both Subjective and Interim CRFs may be used until a more statistically reliable CRF becomes available.

### 3 - Turn Lanes & Ramps

NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
<b>3.1 - Install Left Turn Lane at an Intersection</b>															
3.1.1	Intersection	Rear End / Left Turn	Left Turn Lane at a Signal Controlled Intersection	4-leg Urban	Target Left Turn-Same Road and Rear-End Crashes	Both Approaches on Major Road received LTL - Include treatable LTSR and Rear End Crashes on targeted approach	24		20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.1.2	Intersection	Rear End / Left Turn	Left Turn Lane at a Signal Controlled Intersection	4-leg Urban	Target Left Turn-Same Road and Rear-End Crashes	1 Approach on Major Road received LTL - Include treatable LTSR and Rear End Crashes on targeted approach	13		20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.1.3	Intersection	Rear End / Left Turn	Left Turn Lane at a Signal Controlled Intersection	3-leg Urban	Total Crashes	1 Approach on Major Road received LTL	7		20	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.1.4	Intersection	Rear End / Left Turn	Left Turn Lane at a Signal Controlled Intersection	4-leg Rural	Rear End Crashes	Major Road received LTL (1 or Both Approaches) - Include all Rear End Crashes in intersection	45		20	\$ 250	\$ -	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
3.1.5	Intersection	Rear End / Left Turn	Left Turn Lane at a Signal Controlled Intersection	3-leg Rural	Rear End Crashes	1 Approach on Major Road received LTL - Include all Rear End Crashes in intersection	59		20	\$ 250	\$ -	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
3.1.6	Intersection	Rear End / Left Turn	Left Turn Lane at a Signal Controlled Intersection	Not Specified	Target Left Turn-Same Road and Rear-End Crashes	*Modified from Study. Include treatable LTSR and Rear End Crashes on targeted approaches. Only use this CRF when no others are applicable.	45	Interim	20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.1.7	Intersection	Rear End / Left Turn	Left Turn Lane at a Stop Sign Controlled Intersection	4-leg Urban	Target Left Turn-Same Road and Rear-End Crashes	1 Approach on Major Road received LTL - Include treatable LTSR and Rear End Crashes on targeted approach	25		20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.1.8	Intersection	Rear End / Left Turn	Left Turn Lane at a Stop Sign Controlled Intersection	4-leg Urban	Target Left Turn-Same Road and Rear-End Crashes	Both Approaches on Major Road received LTL - Include treatable LTSR and Rear End Crashes on targeted approaches	45		20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.1.9	Intersection	Rear End / Left Turn	Left Turn Lane at a Stop Sign Controlled Intersection	3-leg Urban	Total Crashes	1 Approach on Major Road received LTL - Include treatable LTSR and Rear End Crashes on targeted approach	33		20	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.1.10	Intersection	Rear End / Left Turn	Left Turn Lane at a Stop Sign Controlled Intersection	4-leg Rural	Target Left Turn-Same Road and Rear-End Crashes	1 Approach on Major Road received LTL - Include treatable LTSR and Rear End Crashes on targeted approach	37		20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.1.11	Intersection	Rear End / Left Turn	Left Turn Lane at a Stop Sign Controlled Intersection	4-leg Rural	Target Left Turn-Same Road and Rear-End Crashes	Both Approaches on Major Road received LTL - Include treatable LTSR and Rear End Crashes on targeted approaches	60		20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.1.12	Intersection	Rear End / Left Turn	Left Turn Lane at a Stop Sign Controlled Intersection	3-leg Rural	Target Left Turn-Same Road and Rear-End Crashes	1 Approach on Major Road received LTL - Include treatable LTSR and Rear End Crashes on targeted approach	62		20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.1.13	Intersection	Rear End / Left Turn	Left Turn Lane at an Intersection Without Signal	Not Specified	Target Left Turn-Same Road and Rear-End Crashes	*Modified from Study. Include treatable LTSR and Rear End Crashes on targeted approaches. Only use this CRF when no others are applicable.	50	Interim	20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
<b>3.2 - Install Right Turn Lane at an Intersection</b>															
3.2.1	Intersection	Rear End / Sideswipe	Right Turn Lane at a Signal Controlled Intersection	Rural and Urban	Total Crashes	1 Approach on Major Road received RTL	4		20	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.2.2	Intersection	Rear End / Sideswipe	Right Turn Lane at a Signal Controlled Intersection	Rural and Urban	Total Crashes	Both Approaches on Major Road received RTL	8		20	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.2.3	Intersection	Rear End / Sideswipe	Right Turn Lane at a Stop Sign Controlled Intersection	Rural and Urban	Total Crashes	1 Approach on Major Road received RTL	14		20	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.2.4	Intersection	Rear End / Sideswipe	Right Turn Lane at a Stop Sign Controlled Intersection	Rural and Urban	Total Crashes	Both Approaches on Major Road received RTL	26		20	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.2.5	Intersection	Rear End / Sideswipe	Right Turn Lane at an Intersection	Not Specified	Target Right Turn Crashes	*Modified from Study. Include only RTDR and Right Turning Rear End crashes on treated approaches. Only use this CRF when no others are applicable.	50	Interim	20	\$ 250	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
<b>3.3 - Add Dual Left Turn Lanes at an Intersection</b>															
3.3.1A	Intersection	Rear End / Left Turn	Dual Left Turn Lanes at a Signal Controlled Intersection	All	Injury Crashes	Injury includes fatal and injury crashes. Use 3.3.1A and 3.3.1B together. Installing dual LT on 1 or 2 approaches with protected LT phasing before and after.	16	NEW	20	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.3.1B	Intersection	Rear End / Left Turn	Dual Left Turn Lanes at a Signal Controlled Intersection	All	PDO Crashes	Use 3.3.1A and 3.3.1B together. Installing dual LT on 1 or 2 approaches with protected LT phasing before and after.	-1	NEW	20	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>3.4 - Add Dual Right Turn Lane at an Intersection</b>															
3.4.1	Intersection	Rear End / Sideswipe	Install Dual Right Turn Lane	All	Total Crashes		15	Subjective	20	\$ 250	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>3.5 - Provide Positive Offset for Left Turn Lanes</b>															
3.5.1A	Intersection	Left Turn	Improve Left Turn Lane Offset to Create Positive Offset at Signalized Intersection	Not Specified	Left Turn Same Roadway Crashes	Include only LTSR crashes on treated approaches. Use 3.5.1A and 3.5.1B together.	38	A	20	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.5.1B	Intersection	Left Turn	Improve Left Turn Lane Offset to Create Positive Offset at Signalized Intersection	Not Specified	Rear End Crashes	Include only RE crashes on treated approaches. Use 3.5.1A and 3.5.1B together.	32	B	20	\$ -	\$ -	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
3.5.2	Intersection	Left Turn	Improve Left Turn Lane Offset to Create Positive Offset at Unsignalized Intersection	Multilane Divided Facilities	Left Turn Same Roadway Crashes	Include only LTSR crashes on treated approaches	85	Interim	20	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
3.5.3	Intersection	Left Turn	Positive Offset for New Left Turn Lanes	All	Total Crashes		10	Subjective	20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400



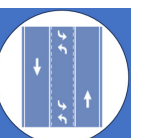
North Carolina Project Development Crash Reduction Factor Information

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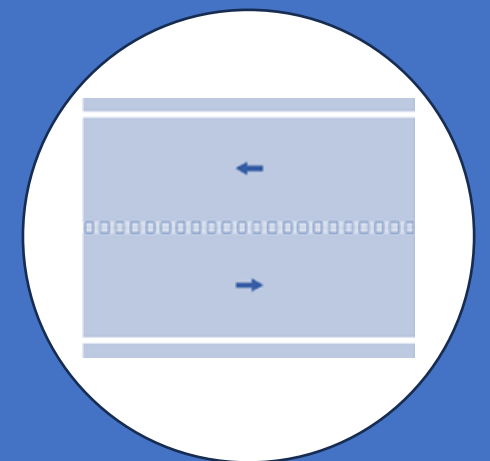
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3 - Turn Lanes & Ramps

NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
<b>3.6 - Install Offset Right Turn Lane</b>															
3.6.1	Intersection	Frontal Impact	Install Offset Right Turn Lane at Unsignalized Intersection	All	Target Frontal Impact Crashes	Target = Frontal Impact crashes caused by mainline right turners blocking line of sight	37	Interim	20	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
<b>3.7 - Increase Length of Left or Right Turn Lane at an Intersection</b>															
3.7.1	Intersection	Rear End / Sideswipe	Increase Length of Left or Right Turn Lane at an Intersection	Not Specified	Total Crashes		15	Interim	20	\$ 100	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>3.8 - Install Continuous Two-Way Left Turn Lane</b>															
3.8.1	Section	Rear End / Left Turn	Install TWLTL (Two-Way Left Turn Lane) on 2 Lane Road	All	KAB Injury Crashes		26		20	\$4,500 per mile (Secondary) \$8,000 per mile (Primary)	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.8.2	Section	Rear End / Left Turn	Install TWLTL (Two-Way Left Turn Lane) on 2 Lane Road	Rural	KAB Injury Crashes		35		20	\$4,500 per mile (Secondary) \$8,000 per mile (Primary)	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.8.3	Section	Rear End / Left Turn	Install TWLTL (Two-Way Left Turn Lane) on 4 Lane Road	Urban	Non-Intersection Crashes		52		20	\$4,500 per mile (Secondary) \$8,000 per mile (Primary)	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>3.9 - 4 Lane to 3 Lane Conversion with TWLTL</b>															
3.9.1	Section	Rear End / Left Turn	4 Lane to 3 Lane Conversion with TWLTL	Urban Minor Arterial	Total Crashes		29		20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>3.10 - Revise Interchange Ramps</b>															
3.10.1	Ramp	Rear End / Sideswipe	Modify Length of Acceleration Lane	Principal Arterial Interstate	Injury Crashes	Injury includes fatal and injury crashes. CMFunction where Lnew = new length of accel lane in miles and Lexist = existing length of accel lane in miles. May be applicable to work zones.	$CRF = (1 - e^{-(4.55 * (L_{new} - L_{exist}))}) * 100$		20	\$4,500 per mile (Secondary) \$8,000 per mile (Primary)	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.10.2	Ramp	Rear End / Sideswipe	Extend Deceleration Lane by approx. 100 Ft	Not Specified	Total Crashes	May be extrapolated in proportion to change in length for increases of less than or more than 100 Ft as long as resulting decel length does not exceed 790 Ft. May be applicable to work zones.	7		20	\$ 100	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
3.10.3	Ramp	All	Provide Straight Ramp Instead of Cloverleaf Ramp	Not Specified	Total Crashes		45		20	\$ 500	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>3.11 - Ramp Queue Detection</b>															
3.11.1	Ramp	All	Ramp Queue Detection	All	Total Crashes		30	Subjective	10	\$ 100	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400

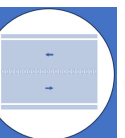


# 4 - Roadway Improvements



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4 - Roadway Improvements																
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO	
<b>4.1 - Shoulder Rumble Strips / Stripes</b>																
4.1.1	Section	Lane Departure	Install Milled-In Shoulder Rumble Strips / Stripes on Existing Shoulder	Rural 2-lane Roads	Lane Departure Crashes	Include all lane departure crashes. Includes shoulder or edgeline. Multilane undivided roads not included in study but can use in interim. Standard or sinusoidal in interim. May use for vibralline as an interim value (with 5 year service life).	23	Interim	10	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
4.1.2	Section	Lane Departure	Install Milled-In Shoulder Rumble Strips on Existing Shoulder	Rural Multilane Divided Roads	Injury Single-Vehicle Run-Off-Road Crashes	Injury includes fatality and injury crashes. May be used for vibralline as an interim value (with 5 year service life).	22		10	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
4.1.3	Section	Lane Departure	Install Milled-In Shoulder Rumble Strips / Stripes on Existing Shoulder	Rural Freeways	Injury Single-Vehicle Run-Off-Road Crashes	Injury includes fatality and injury crashes. Both shoulder Rumble Strips and edgeline Rumble Stripes included in estimate.	17		10	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
4.1.4	Section	Lane Departure	Install Milled-In Shoulder Rumble Strips on Existing Shoulder	Urban Freeways	Injury Single-Vehicle Run-Off-Road Crashes	Injury includes fatality and injury crashes	7		10	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
<b>4.2 - Shoulder Rumble Strips / Stripes and Shoulder Widening</b>																
4.2.1	Section	Lane Departure	Install Shoulder Rumble Stripes, Shoulder Widening and Resurface Pavement	Rural 2-lane Roads	Injury Head-on and Run-off-Road Crashes	Injury includes fatality and injury crashes	27		20	\$ -500 per Mile	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
4.2.2	Section	Lane Departure	Install Shoulder Rumble Strips in Conjunction with Shoulder Widening	Principal Arterial Freeway or Expressway	Run Off Road Crashes		13		20	\$ -500 per Mile	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
<b>4.3 - Centerline Rumble Strips</b>																
4.3.1	Section	Lane Departure	Install Centerline Rumble Strips	Rural 2-lane Roads	Lane Departure Crashes	Include all lane departure crashes. Applicable to standard and sinusoidal RS in the interim.	28	Interim	10	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
4.3.2	Section	Lane Departure	Install Centerline Rumble Strips	Urban 2-lane Roads	Head-on and Sideswipe Opposite Direction Crashes	Study did not include ROR-Left Crashes. Applicable to standard and sinusoidal RS in the interim.	40		10	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
4.3.3	Section	Lane Departure	Install Centerline Rumble Strips	Multilane Undivided Roads	Head-on and Sideswipe Opposite Direction Crashes	Only includes multi-vehicle lane departure crashes to match 4.3.2. Applicable to standard and sinusoidal RS in the interim.	40	Interim	10	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
4.3.4	Section	Lane Departure	Install Centerline and Shoulder Rumble Strips	Rural 2-lane Roads	Lane Departure Crashes	Include all lane departure crashes. Applicable to standard and sinusoidal RS in the interim.	36	Interim	10	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
<b>4.4 - Install Transverse Rumble Strips at Intersection</b>																
4.4.1	Intersection	Frontal Impact	Install Transverse Rumble Strips at Minor Road Stop Controlled Intersection	Rural - 3-Leg	KAB Injury Crashes	Although study applies to minor road stop controlled intersections, CRF may be used for all way stop applications.	10		5	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
4.4.2	Intersection	Frontal Impact	Install Transverse Rumble Strips at Minor Road Stop Controlled Intersection	Rural - 4-Leg	KAB Injury Crashes	Although study applies to minor road stop controlled intersections, CRF may be used for all way stop applications.	25		5	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
<b>4.5 - Groove Pavement</b>																
4.5.1	Section	Wet	Groove Pavement	Not Specified	Wet Crashes		50		10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
<b>4.6 - Diamond Grinding</b>																
4.6.1	Section	Wet	Diamond Grinding	Freeways	Wet Crashes		13		10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
<b>4.7 - Open Graded Friction Course</b>																
4.7.1	Section	Wet	Open Graded Friction Course (OGFC)	Freeways	Wet Crashes		49		10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
4.7.2	Section	Wet	Open Graded Friction Course (OGFC)	Non-Freeways	Wet Crashes	Includes 2-Lane, Multilane Undivided & Divided Roadways	70	Interim	10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
<b>4.8 - Microsurfacing</b>																
4.8.1	Section	Wet	Microsurfacing	Multilane Roads	Wet Crashes		21		10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
4.8.2	Section	Wet	Microsurfacing	2-lane Roads	Wet Crashes		48		10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
<b>4.9 - Slurry Seal</b>																
4.9.1	Section	Wet	Slurry Seal	2-lane Roads	Wet Crashes		20		10	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	



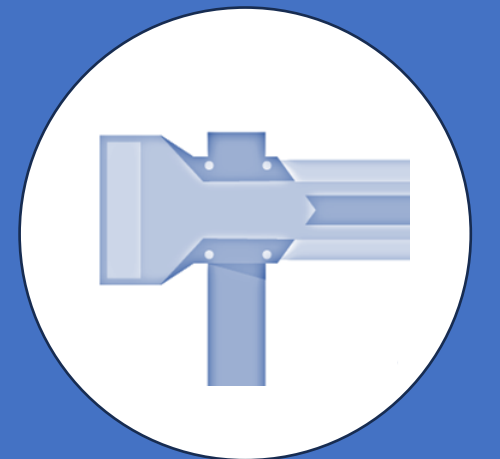


Note: Approval must be obtained from the CRF Committee if CRFs are identified from sources other than this sheet. Subjective CRFs are determined when no data is available and the committee has agreed upon a subjective value. Interim CRFs are determined when limited data is available but a robust study has not been performed or the study from past research summaries could not be found. Both Subjective and Interim CRFs may be used until a more statistically reliable CRF becomes available.

4 - Roadway Improvements																
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO	
4.10 - Chip Seal																
4.10.1	Section	Wet	Chip Seal	Multilane Roads	Wet Crashes		22		10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.10.2	Section	Wet	Chip Seal	2-lane Roads	Wet Crashes		35		10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.11 - Ultra-Thin Bonded Wearing Course																
4.11.1	Section	Wet	Ultra-Thin Bonded Wearing Course (UTBWC)	Freeways	Wet Crashes		40	Subjective	10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.11.2	Section	Wet	Ultra-Thin Bonded Wearing Course (UTBWC)	2-lane Roads	Wet Crashes		31		10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.12 - Thin HMA																
4.12.1	Section	Wet	Thin HMA	Freeways	Wet Crashes	This is a conventional thin HMA overlay	9		10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.12.2	Section	Wet	Thin HMA	Multilane Roads	Wet Crashes	This is a conventional thin HMA overlay	13		10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.12.3	Section	Wet	Thin HMA	2-lane Roads	Wet Crashes	This is a conventional thin HMA overlay	-26		10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.13 - High Friction - Spot Treatments																
4.13.1	Intersection	Wet	Increase Pavement Friction at Intersection Approaches	All	Wet Crashes	Includes stop controlled, yield controlled, and signalized intersections	57		10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.13.2	Section	Wet	High Friction Surfacing at Curves	All	Wet Crashes		52		10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.13.3	Ramp	Wet	High Friction Surfacing at Ramps	All	Wet Crashes		86		10	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.14 - Resurfacing with Safety Edge																
4.14.1	Section	Lane Departure	Resurfacing with Safety Edge	Rural 2-Lane	Run Off Road and Rollover Crashes	Intersection-related and animal crashes were excluded from the data.	3	Interim	10	\$	- \$	-	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
4.15 - Pavement Widening																
4.15.1	Section	Lane Departure	Increase Shoulder Widths by 2'	Rural 2-Lane	Lane Departure Crashes	Lane Departure includes Ran Off Road, Head On, Sideswipe Opposite Direction, and Sideswipe Same Direction. AADT > 2,000.	13		20	- \$500 per Mile	\$	-	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
4.15.2	Section	Lane Departure	Increase Shoulder Widths by 4'	Rural 2-Lane	Lane Departure Crashes	Lane Departure includes Ran Off Road, Head On, Sideswipe Opposite Direction, and Sideswipe Same Direction. AADT > 2,000.	23		20	- \$500 per Mile	\$	-	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
4.15.3	Section	Lane Departure	Increase Shoulder Widths by 6'	Rural 2-Lane	Lane Departure Crashes	Lane Departure includes Ran Off Road, Head On, Sideswipe Opposite Direction, and Sideswipe Same Direction. AADT > 2,000.	33		20	- \$500 per Mile	\$	-	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
4.15.4	Section	Lane Departure	Increase Shoulder Widths by 2'	Urban Arterials	Injury Crashes	Injury includes fatality and injury crashes	7		20	- \$500 per Mile	\$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.15.5	Section	Lane Departure	Increase Shoulder Widths by 4'	Urban Arterials	Injury Crashes	Injury includes fatality and injury crashes	13		20	- \$500 per Mile	\$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.15.6	Section	Lane Departure	Increase Shoulder Widths by 6'	Urban Arterials	Injury Crashes	Injury includes fatality and injury crashes	19		20	- \$500 per Mile	\$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.15.7	Section	All	Widening for an Additional Thru Lane	Not Specified	Total Crashes		10	Subjective	20	\$4,500 per mile (Secondary) \$8,000 per mile (Primary)	\$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.15.8	Section	Lane Departure	Increase Shoulder Widths	Rural Multilane Highways	Total Crashes	Applies to 45 - 70 mph speed limit roadways. Shoulder widths not specified.	18	NEW	20	- \$500 per Mile	\$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.16 - Add Passing Lanes																
4.16.1	Section	All	Add Passing Lanes (Single Direction of Travel)	Rural 2-Lane	Total Crashes	Include crashes in both directions of travel over the length of the passing lane	25		20	\$4,500 per mile (Secondary) \$8,000 per mile (Primary)	\$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
4.16.2	Section	All	Add Passing Lanes (Both Directions of Travel)	Rural 2-Lane	Total Crashes	Include crashes in both directions of travel over the length of the passing lane	35		20	\$4,500 per mile (Secondary) \$8,000 per mile (Primary)	\$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400



# 5 - Roadside Improvements



5 - Roadside Improvements

NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context		CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
<b>5.1 - New or Upgraded Guardrail</b>																
5.1.1A	Section	Lane Departure	New or Upgraded Guardrail	Rural 2-lane	Fatal and Class A Injury Crashes	Use 5.1.1A, 5.1.1B and 5.1.1C together	A	56	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.1.1B	Section	Lane Departure	New or Upgraded Guardrail	Rural 2-lane	Class B and C Injury Crashes	Use 5.1.1A, 5.1.1B and 5.1.1C together	B	8	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.1.1C	Section	Lane Departure	New or Upgraded Guardrail	Rural 2-lane	PDO Crashes	Use 5.1.1A, 5.1.1B and 5.1.1C together	C	-1	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.1.2A	Section	Lane Departure	New or Upgraded Guardrail	Rural 4-lane Undivided	Fatal Crashes	Use 5.1.2A, 5.1.2B and 5.1.2C together	A	44	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.1.2B	Section	Lane Departure	New or Upgraded Guardrail	Rural 4-lane Undivided	Non-Fatal Injury Crashes	Use 5.1.2A, 5.1.2B and 5.1.2C together	B	23	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.1.2C	Section	Lane Departure	New or Upgraded Guardrail	Rural 4-lane Undivided	PDO Crashes	Use 5.1.2A, 5.1.2B and 5.1.2C together	C	44	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.1.3A	Section	Lane Departure	New or Upgraded Guardrail	Rural 4-lane Divided	Fatal Crashes	Use 5.1.3A and 5.1.3B together	A	46	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.1.3B	Section	Lane Departure	New or Upgraded Guardrail	Rural 4-lane Divided	Non-Fatal Injury Crashes	Use 5.1.3A and 5.1.3B together	B	13	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.1.4A	Section	Lane Departure	New or Upgraded Guardrail	Urban 2-lane or 4-lane	Injury Crashes	Injury includes fatality and injury crashes. Use 5.1.4A and 5.1.4B together.	A	28	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.1.4B	Section	Lane Departure	New or Upgraded Guardrail	Urban 2-lane or 4-lane	PDO Crashes	Use 5.1.4A and 5.1.4B together	B	10	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>5.2 - New Median Barrier</b>																
5.2.1A	Section	Lane Departure	New Median Barrier	Freeway	Median Lane Departures	All lane departures that involved a vehicle traveling into the median (Ex. ROR-left, head on, SS-OD, rollover). Use 5.2.1A and 5.2.1B together.	A	-93	Interim	20	See Example Below	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
5.2.1B	Section	Lane Departure	New Median Barrier	Freeway	Cross Median Crashes	All crashes that involved a vehicle completely crossing the median. Use 5.2.1A and 5.2.1B together.	B	72	Interim	20	See Example Below	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
5.2.2A	Section	Lane Departure	New Median Barrier	Multilane Divided	Median Lane Departures	All lane departures that involved a vehicle traveling into the median (Ex. ROR-left, head on, SS-OD, rollover). Use 5.2.2A and 5.2.2B together.	A	-155	Interim	20	See Example Below	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
5.2.2B	Section	Lane Departure	New Median Barrier	Multilane Divided	Cross Median Crashes	All crashes that involved a vehicle completely crossing the median. Use 5.2.2A and 5.2.2B together.	B	75	Interim	20	See Example Below	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
<b>5.3 - Bridge Guardrail</b>																
5.3.1A	Section	Lane Departure	Bridge Approach Guardrail	Not Specified	Fatal Crashes	Use 5.3.1A, 5.3.1B and 5.3.1C together	A	55	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.3.1B	Section	Lane Departure	Bridge Approach Guardrail	Not Specified	Non-Fatal Injury Crashes	Use 5.3.1A, 5.3.1B and 5.3.1C together	B	20	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.3.1C	Section	Lane Departure	Bridge Approach Guardrail	Not Specified	PDO Crashes	Use 5.3.1A, 5.3.1B and 5.3.1C together	C	-50	Interim	20	See Example Below	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>5.4 - Bridge Replacements</b>																
5.4.1A	Section	Lane Departure	Bridge Replacements	All	Injury Crashes	Injury includes fatality and injury crashes. Use 5.4.1A and 5.4.1B together.	A	32		50	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.4.1B	Section	Lane Departure	Bridge Replacements	All	PDO Crashes	Use 5.4.1A and 5.4.1B together	B	15		50	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>5.5 - Barrier End Unit Replacement/Upgrade</b>																
5.5.1	Section	Lane Departure	Barrier End Unit Replacement/Upgrade	All	Barrier End Unit Hit - Injury Crashes	Injury includes fatality and injury crashes		25	Subjective	10	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
<b>5.6 - Motorcycle Rub Rail Under Existing W-Beam</b>																
5.6.1A	Section	Motorcycle	Motorcycle Rub Rail Under Existing W-Beam	All	Motorcycle Barrier Hit - Fatal Crashes	Use 5.6.1A and 5.6.1B together	A	75	Subjective	20	See Example Below	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
5.6.1B	Section	Motorcycle	Motorcycle Rub Rail Under Existing W-Beam	All	Motorcycle Barrier Hit - Non-Fatal Injury Crashes	Use 5.6.1A and 5.6.1B together	B	40	Subjective	20	See Example Below	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400



5 - Roadside Improvements

NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
<b>5.7 - Remove or Relocate Fixed Objects</b>															
5.7.1	Section	Lane Departure	Remove or Relocate Fixed Objects Outside of Clear Zone	Not Specified	Injury Crashes	Injury includes fatality and injury crashes	38		20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.7.2	Section	Lane Departure	Increase Distance to Roadside Obstacle from around 1 m (3.3 ft) to around 5 m (16.7 ft)	Rural	Total Crashes		22		20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.7.3	Section	Lane Departure	Increase Distance to Roadside Obstacle from around 5 m (16.7 ft) to around 9 m (30 ft)	Rural	Total Crashes		44		20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.7.4	Section	Lane Departure	Change the lateral offset of utility poles	Rural Undivided	Fixed Object Crashes	Review all Lane Departure Crash types to determine which are correctable by treatment. CMF Function where Oa = after offset; Ob = before offset in meters. CRF values range from approx. 20-75% depending on offsets.	CRF = 100 * (1-e^-0.0905*(Oa-Ob))		20	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
<b>5.8 - Flatten Sideslope</b>															
5.8.1A	Section	Lane Departure	Flatten Sideslope from 1V:3H to 1V:4H	Rural	Non-Fatal Injury Crashes	Use 5.8.1A and 5.8.1B together	A 42		20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.8.1B	Section	Lane Departure	Flatten Sideslope from 1V:3H to 1V:4H	Rural	PDO Crashes	Use 5.8.1A and 5.8.1B together	B 29		20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.8.2A	Section	Lane Departure	Flatten Sideslope from 1V:4H to 1V:6H	Rural	Non-Fatal Injury Crashes	Use 5.8.2A and 5.8.2B together	A 22		20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
5.8.2B	Section	Lane Departure	Flatten Sideslope from 1V:4H to 1V:6H	Rural	PDO Crashes	Use 5.8.2A and 5.8.2B together	B 24		20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>5.9 - Drainage Improvements</b>															
5.9.1	Section	Wet	Spot Specific Water Removal such as Drop Inlets, Drainage Grates, and Debris Removal	Not Specified	Wet Road Crashes		40		20	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400

Double Faced W-Beam (Median Barrier)	\$625 x After Period ROR Crashes Per Year
Concrete Median Barrier	\$1,025 x After Period ROR Crashes Per Year
Single Faced W-Beam	\$500 x After Period ROR Crashes Per Year
Cable Barrier	\$300 x After Period ROR Crashes Per Year

**Shoulder Guardrail Improvement Example:**

20 crashes over 5 years (2K, 1A, 2B, 5C, 10 PDO)  
 Average per year: 0.4 Fatal, 0.2 A, 0.4B, 1C, 2 PDO

CRFs for "New or Upgraded Guardrail - Rural 2-Lane": 56%K and A, 8% B and C, -1% PDO

Fatal Crashes Remaining (per year):  $0.4 - (0.4)(0.56) = 0.176$   
 A Injury Crashes Remaining (per year):  $0.2 - (0.2)(.56) = 0.088$   
 B Injury Crashes Remaining (per year):  $0.4 - (0.4)(.08) = 0.368$   
 C Injury Crashes Remaining (per year):  $1 - (1)(.08) = 0.92$   
 PDO Crashes Remaining (per year):  $2 - (2)(-.01) = 2.02$

Total Crashes Remaining (per year) =  $0.176+0.088+0.368+0.92+2.02 = 3.572$

Annual Maintenance Cost:  $(3.572)(\$500) = \$1786$



# 6 – Alignment & Sight Distance



Note: Approval must be obtained from the CRF Committee if CRFs are identified from sources other than this sheet. Subjective CRFs are determined when no data is available and the committee has agreed upon a subjective value. Interim CRFs are determined when limited data is available but a robust study has not been performed or the study from past research summaries could not be found. Both Subjective and Interim CRFs may be used until a more statistically reliable CRF becomes available.

6 - Alignment and Sight Distance																
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO	
6.1 - Improve Superelevation of Horizontal Curve																
6.1.1	Section	Lane Departure	Improve Superelevation of Horizontal Curve	All	Total Crashes		40	Interim	20	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
6.2 - Improve Horizontal Alignment of Curve																
6.2.1	Section	Lane Departure	Improve Horizontal Alignment of Curve	Rural - 2 Lane	Total Crashes		78	Interim	20	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
6.3 - Improve Vertical Alignment																
6.3.1	Section	All	Improve Vertical Alignment	Rural - 2 Lane	Total Crashes	Applies to Crest or Sag Vertical Curve	32	Interim	20	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
6.4 - Reduce Intersection Skew Angle																
6.4.1	Intersection	All	Reduce Intersection Skew Angle	2-Lane Rural Stop Controlled Intersections	Total Crashes	Does not apply to extremely skewed intersections (with intersection angle < 35 degrees)	20		20	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
6.4.2	Intersection	All	Full Intersection Realignment with Multiple Improvements	Stop Controlled Intersections	Total Crashes		60	Interim	20	\$	- \$	-	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
6.5 - Improve Sight Distance Triangles																
6.5.1	Intesection	Frontal Impact	Improve Intersection Sight Distance Triangles	2-Lane Stop Controlled Intersection, Major Road AADT > 15,000	Target Injury Crashes	Target Crashes involve a vehicle on the major road colliding with a vehicle turning or departing from the treated minor road approach(es). Includes fatal and injury crashes.	25		20	\$	- \$	-	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400
6.5.2	Intesection	Frontal Impact	Improve Intersection Sight Distance Triangles	2-Lane Stop Controlled Intersection, Major Road AADT <=15,000	Target Injury Crashes	Target Crashes involve a vehicle on the major road colliding with a vehicle turning or departing from the treated minor road approach(es). Includes fatal and injury crashes.	15		20	\$	- \$	-	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400



# 7 – Signing, Delineation & Illumination



Note: Approval must be obtained from the CRF Committee if CRFs are identified from sources other than this sheet. Subjective CRFs are determined when no data is available and the committee has agreed upon a subjective value. Interim CRFs are determined when limited data is available but a robust study has not been performed or the study from past research summaries could not be found. Both Subjective and Interim CRFs may be used until a more statistically reliable CRF becomes available.

7 - Signing, Delineation & Illumination															
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
7.1 - Markings & Delineation - General															
7.1.1	All	All	Improve Markings & Delineation - General	Not Specified	Total Crashes	Only use if there is not a countermeasure available for your specific situation	15	Interim	5 Long Life, 1 Paint	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.2 - Warning Signs - General															
7.2.1	All	All	Warning Signs - General	All	Total Crashes	Only use if there is not a countermeasure available for your specific situation	15	Subjective	20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.3 - Advance Curve Warning Signs															
7.3.1A	Section	Lane Departure	Install Static Combination Horizontal Alignment / Advisory Speed Signs	Not Specified	Injury Crashes	Injury includes fatality and injury crashes. Use 7.3.1A and 7.3.1B together.	A	13	20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.3.1B	Section	Lane Departure	Install Static Combination Horizontal Alignment / Advisory Speed Signs	Not Specified	PDO Crashes	Use 7.3.1A and 7.3.1B together	B	29	20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.3.2	Section	Lane Departure	Install a Solar Powered Flasher on an existing Curve Warning Sign with Advisory Speed Plate	All	Total Crashes			5	10	\$ 100	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.4 - Chevron Signs															
7.4.1	Section	Lane Departure	Install Chevron Signs on Horizontal Curves	Rural - 2-Lane	Lane Departure Crashes	For projects installing new chevrons, revising existing chevron placement, adding bright sides, or installing additional chevrons to a curve		33	20	1.66% of initial cost	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
7.4.2	Section	Lane Departure	Install Oversized Chevron Signs	All	Nighttime Crashes	Exclude intersection and animal crashes. Before condition includes sites where (1) there are no chevrons and (2) there are chevrons but they are being replaced with larger signs.		27	20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.4.3	Section	Lane Departure	Install Sequential Lighted Chevron System	All	Lane Departure Crashes	Before condition includes sites with no chevrons or sites with existing chevrons that are being upgraded		67	10	\$ 100	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.5 - Dynamic Speed Feedback Signs															
7.5.1	Section	All	Install Dynamic Speed Feedback Signs	Not Specified	Total Crashes	Refers to signs that give individual drivers real-time feedback regarding their speed		46	10	\$ 500	\$ 100	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.6 - Speed Reduction Pavement Markings															
7.6.1	Section	All	Install Optical Speed Bars	All	Total Crashes			21	5 Long Life, 1 Paint	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.6.2	Section	All	Install Converging Chevron Pattern Markings	Urban	Total Crashes	Applies to roadway segments		32	5 Long Life, 1 Paint	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.7 - Warning Signs for Queues and Stopped Traffic															
7.7.1A	All	Rear End	Install Changeable Queue Warning Signs	Principal Arterial Freeway and Expressway	Rear-End Non-Fatal Injury Crashes	Use 7.7.1A and 7.7.1B together	A	16	10	\$ 500	\$ 100	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
7.7.1B	All	Rear End	Install Changeable Queue Warning Signs	Principal Arterial Freeway and Expressway	Rear-End PDO Crashes	Use 7.7.1A and 7.7.1B together	B	-16	10	\$ 500	\$ 100	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
7.7.2	All	Rear End	Install "Watch for Slow or Stopped Traffic" Signs	All	Total Crashes			15	20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.7.3	Intersection	Rear End	Actuated "Prepare to Stop" Signs in Advance of Unsignalized Intersection with Sight Distance Issues	All	Total Crashes			32	10	\$ 500	\$ 100	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.8 - Truck Signing															
7.8.1	Section	Truck	Install / Upgrade Truck Warning Signs	All	Truck Crashes			30	20	1.66% of initial cost	\$ -	Truck	\$ 4,928,000	\$ 163,000	\$ 14,400
7.8.2	Section	Truck	Install Truck Regulatory / Restriction Signs	All	Truck Crashes			15	20	1.66% of initial cost	\$ -	Truck	\$ 4,928,000	\$ 163,000	\$ 14,400
7.9 - Motorcycle Signing															
7.9.1	Section	Motorcycle	Mandatory Motorcycle Pull Off Area with Roadway Informational Signing	All	Motorcycle Crashes			20	20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.10 - Dynamic Message Signs															
7.10.1	Section	All	Install Dynamic Message Signs	All	Total Crashes			5	10	\$ 500	\$ 100	Total	\$ 3,865,000	\$ 168,000	\$ 14,400





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7 - Signing, Delineation & Illumination																
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO	
7.11 - Official Use Crossover Signing and Delineation																
7.11.1	Section	Public Use Crossover	Actuated Advanced Flasher at Official Use Crossover	Freeway	Public Use Crossover Crashes		75	Subjective	10	\$ 500	\$ 100	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400	
7.11.2	Section	Public Use Crossover	Transversable Delineator Posts at Official Use Crossover Freeway		Public Use Crossover Crashes		80	Subjective	3	\$ -	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400	
7.12 - Guide and Lane Use Signs																
7.12.1	All	All	Install Guide Signs (General)	Not Specified	Total Crashes		15	Interim	20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
7.12.2A	All	Rear End / Sideswipe	Install Overhead Lane Use Signs	Not Specified	Rear-end Crashes	Use 7.12.2A and 7.12.2B together	A	10	Interim	20	1.66% of initial cost	\$ -	Rear End	\$ 3,230,000	\$ 168,000	\$ 14,400
7.12.2B	All	Rear End / Sideswipe	Install Overhead Lane Use Signs	Not Specified	Sideswipe Crashes	Use 7.12.2A and 7.12.2B together	B	20	Interim	20	1.66% of initial cost	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400
7.13 - Long Life Markings																
7.13.1	Section	Lane Departure	Install 4" Long Life Markings for Centerlines and Edgelines	2-Lane Roads	Lane Departure Crashes	Intersection crashes were excluded from the data. Both centerlines and edgelines were marked with new 4" lines (prior condition was old 4" lines). May be used for edgeline only installation until a CRF for that application becomes available.	13	Interim	5	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
7.13.2	Section	Lane Departure	Install 6" Long Life Markings for Centerlines and Edgelines	2-Lane Roads	Lane Departure Crashes	Intersection crashes were excluded from the data. Both centerlines and edgelines were marked with new 6" lines (prior condition was old 4" lines). May be used for edgeline only installation until a CRF for that application becomes available.	18	Interim	5	\$ -	\$ -	Lane Departure	\$ 4,069,000	\$ 149,000	\$ 14,400	
7.14 - Curve Warning Pavement Markings																
7.14.1	Section	Lane Departure	Install In-Lane Curve Warning Pavement Markings	All	Total Crashes	Exclude intersection and animal crashes	38		5 Long Life, 1 Paint	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
7.15 - Stop Ahead Pavement Markings																
7.15.1	Intersection	Frontal Impact / Run Thru	Introduce Stop Ahead Pavement Markings for All Way Stop Controlled Intersection	Rural	Injury Crashes	Injury includes fatality and injury crashes	42		5 Long Life, 1 Paint	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
7.15.2	Intersection	Frontal Impact / Run Thru	Introduce Stop Ahead Pavement Markings for Minor Road Stop Controlled Intersection	Rural	Injury Crashes	Injury includes fatality and injury crashes	8		5 Long Life, 1 Paint	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
7.16 - Improve Stop Sign Visibility																
7.16.1	Intersection	Frontal Impact / Run Thru	Replace Standard Stop Sign with Flashing LED Stop Sign	Not Specified	Angle Crashes	Include All Angle Crashes in Intersection: May include Angle, LTDR and RTDR Crash Types. Run off road – straight crashes may be included for T intersections.	41		10	\$ 500	\$ 100	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400	
7.16.2	Intersection	Frontal Impact / Run Thru	Install Flasher on Stop Sign	Not Specified	Angle Crashes	Include All Angle Crashes in Intersection: May include Angle, LTDR and RTDR Crash Types. Run off road – straight crashes may be included for T intersections.	58		10	\$ 500	\$ 100	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400	
7.16.3	Intersection	Frontal Impact / Run Thru	Oversize Stop Signs	Not Specified	Total Crashes		19	Interim	20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
7.16.4	Intersection	Frontal Impact / Run Thru	Double Indicate Stop Sign - Shoulder Mounted	Urban	Angle Crashes	Include All Angle Crashes in Intersection: May include Angle, LTDR and RTDR Crash Types. Run off road – straight crashes may be included for T intersections.	36		20	1.66% of initial cost	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400	
7.16.5	Intersection	Frontal Impact / Run Thru	Double Indicate Stop Sign using Splitter Island	Rural	Frontal Impact Crashes	Run off road – straight crashes may be included for T intersections.	47	Interim	20	\$ 800	\$ -	Frontal Impact	\$ 4,195,000	\$ 191,000	\$ 14,400	
7.17 - Convert from Minor Road Stop Control to All Way Stop Control																
7.17.1	Intersection	Frontal Impact	Convert from Minor Road Stop Control to All Way Stop Control Without Overhead Flashers	All	Injury Crashes	Injury includes fatality and injury crashes	72		20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
7.17.2	Intersection	Frontal Impact	Convert from Minor Road Stop Control to All Way Stop Control With Existing Overhead Flashers	All	Injury Crashes	Injury includes fatality and injury crashes. AWS with advance shoulder mounted flashers may apply this CRF.	87		20	1.66% of initial cost	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
7.17.3	Intersection	Frontal Impact	Convert from Minor Road Stop Control to All Way Stop Control With New Overhead Flashers Installed	All	Injury Crashes	Injury includes fatality and injury crashes. AWS with advance shoulder mounted flashers may apply this CRF.	87		10	\$ 300	\$ 260	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
7.18 - Actuated "Vehicle Entering When Flashing" Signs and Flashers																
7.18.1	Intersection	Frontal Impact	Actuated Vehicle Entering When Flashing	2-Lane at 2-Lane Intersections	Total Crashes	Applies ONLY to locations with sight distance constraints or skewed intersections. Includes all signing scenarios. Does not apply to enhancing an existing VEWf system.	10	NEW	10	\$ 500	\$ 125	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	
7.18.2	Intersection	Frontal Impact	Actuated Vehicle Entering When Flashing	4-Lane at 2-Lane Intersections	Total Crashes	Includes all potential countermeasure scenarios	-7		10	\$ 500	\$ 125	Total	\$ 3,865,000	\$ 168,000	\$ 14,400	



7 - Signing, Delineation & Illumination															
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
7.19 - Roadway Lighting															
7.19.1A	Intersection	Night	Provide Intersection Lighting (Non-Roundabout)	All	Nighttime Fatal Crashes	Use 7.19.1A, 7.19.1B and 7.19.1C together	A	77	10	\$ -	\$ 2,400	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.19.1B	Intersection	Night	Provide Intersection Lighting (Non-Roundabout)	All	Nighttime Non-Fatal Injury Crashes	Injury includes Class A, B, and C crashes. Use 7.19.1A, 7.19.1B and 7.19.1C together.	B	38	10	\$ -	\$ 2,400	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.19.1C	Intersection	Night	Provide Intersection Lighting (Non-Roundabout)	All	Nighttime PDO Crashes	Use 7.19.1A, 7.19.1B and 7.19.1C together	C	31	10	\$ -	\$ 2,400	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.19.2A	Intersection	Night	Provide Intersection Lighting (Roundabout)	All	Nighttime Fatal Crashes	Use 7.19.2A, 7.19.2B and 7.19.2C together	A	77	10	\$ -	\$ 3,600	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.19.2B	Intersection	Night	Provide Intersection Lighting (Roundabout)	All	Nighttime Non-Fatal Injury Crashes	Injury includes Class A, B, and C crashes. Use 7.19.2A, 7.19.2B and 7.19.2C together.	B	38	10	\$ -	\$ 3,600	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.19.2C	Intersection	Night	Provide Intersection Lighting (Roundabout)	All	Nighttime PDO Crashes	Use 7.19.2A, 7.19.2B and 7.19.2C together	C	31	10	\$ -	\$ 3,600	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.19.3A	Section	Night	Lighting of Roadway Segments	All	Nighttime Fatal Crashes	Use 7.19.3A, 7.19.3B and 7.19.3C together	A	69	10	\$ -	\$ 2,100	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.19.3B	Section	Night	Lighting of Roadway Segments	All	Nighttime Non-Fatal Injury Crashes	Injury includes Class A, B, and C crashes. Use 7.19.3A, 7.19.3B and 7.19.3C together.	B	28	10	\$ -	\$ 2,100	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
7.19.3C	Section	Night	Lighting of Roadway Segments	All	Nighttime PDO Crashes	Use 7.19.3A, 7.19.3B and 7.19.3C together	C	17	10	\$ -	\$ 2,100	Total	\$ 3,865,000	\$ 168,000	\$ 14,400



# 8 – Pedestrian & Bicycle



North Carolina Project Development Crash Reduction Factor Information

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8 - Pedestrian & Bicycle															
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
8.1 - Pedestrian Structure															
8.1.1	Section	Pedestrian	Pedestrian Structure	Urban	Pedestrian Crashes	Include Crashes within 656' (0.124 miles) on either side of structure	85		50	\$ 2,000	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.2 - Crosswalks															
8.2.1	All	Pedestrian	Install Crosswalk	Not Specified	Pedestrian Crashes		25	Interim	5 Long Life, 1 Paint	\$ -	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.2.2	Intersection	Pedestrian	Install High Visibility Crosswalk	Urban, Signalized & Unsignalized Intersections	Pedestrian Crashes		40		5 Long Life, 1 Paint	\$ -	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.2.3	All	Pedestrian	Install Crosswalk with Multiple Improvements	All	Pedestrian Crashes	Use CRF when additional improvements installed with crosswalk (i.e. lighting, signing, markings, etc.)	50	Subjective	5 Long Life, 1 Paint	\$ -	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.3 - Raised Median / Pedestrian Refuge Island															
8.3.1	All	Pedestrian	Install Raised Median / Ped Refuge Island with or without Marked Crosswalk	Urban and Suburban, Midblock and Unsignalized Intersection Crossings	Pedestrian Crashes	Include crashes within 350' of crossing. Applicable to 2-7 lane crossings	31		20	\$ 800	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.4 - Barnes Dance (Pedestrian Scramble)															
8.4.1	Intersection	Pedestrian	Implement Barnes Dance (Pedestrian Scramble)	Urban Signalized Intersections	Pedestrian Crashes		51		10	\$ -	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.5 - Countdown Pedestrian Signals															
8.5.1	Intersection	Pedestrian	Replace Standard Pedestrian Heads with Countdown Pedestrian Heads	Urban	Pedestrian Crashes	Include crashes within 200' of intersection.	9		10	\$ 200	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.5.2	Intersection	Pedestrian	Install Pedestrian Countdown Heads Where No Pedestrian Heads Exist	Urban	Pedestrian Injury Crashes	Injury includes fatality and injury crashes	25	Subjective	10	\$ 200	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.6 - Pedestrian Hybrid Beacon (HAWK)															
8.6.1	All	Pedestrian	Pedestrian Hybrid Beacon (HAWK)	Urban and Suburban, Midblock and Unsignalized Intersection Crossings	Pedestrian Crashes	Include crashes within 350' of crossing. Applicable to 2-7 lane crossings	55		10	\$ 500	\$ 100	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.7 - Bicycle Lanes															
8.7.1	Section	Bicycle	Install Bicycle Lane	Urban, 2 Lane Roadways	Bicyclist Crashes		45	NEW	5 Long Life, 1 Paint	\$ -	\$ -	Bicycle	\$ 3,212,000	\$ 129,000	\$ 14,400
8.7.2	Section	Bicycle	Install Bicycle Lane	Urban, 4 Lane Roadways	Bicyclist Crashes		42	NEW	5 Long Life, 1 Paint	\$ -	\$ -	Bicycle	\$ 3,212,000	\$ 129,000	\$ 14,400
8.7.3	Section	Bicycle	Install Buffered Bicycle Lane	Urban, 2 Lane Roadways	Bicyclist Crashes		58	NEW	5 Long Life, 1 Paint	\$ -	\$ -	Bicycle	\$ 3,212,000	\$ 129,000	\$ 14,400
8.7.4	Section	Bicycle	Install Buffered Bicycle Lane	Urban, 4 Lane Roadways	Bicyclist Crashes		63	NEW	5 Long Life, 1 Paint	\$ -	\$ -	Bicycle	\$ 3,212,000	\$ 129,000	\$ 14,400
8.7.5	Section	Bicycle	Install Separated Bicycle Lane	Urban, 2 Lane Roadways	Bicyclist Crashes		47	NEW	5 Long Life, 1 Paint	\$ -	\$ -	Bicycle	\$ 3,212,000	\$ 129,000	\$ 14,400
8.7.6	Section	Bicycle	Install Separated Bicycle Lane	Urban, 4 Lane Roadways	Bicyclist Crashes		41	NEW	5 Long Life, 1 Paint	\$ -	\$ -	Bicycle	\$ 3,212,000	\$ 129,000	\$ 14,400
8.8 - Sidewalks															
8.8.1	Section	Pedestrian	Install Sidewalks	Not Specified	Pedestrian Crashes	Applies to peds that are walking along roadway (not crossing)	74	Interim	20	\$ -	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.9 - Actuated Overhead Flasher for a Pedestrian Location															
8.9.1	All	Pedestrian	Actuated Overhead Flasher for a Pedestrian Location	All	Pedestrian Crashes		20	Subjective	10	\$ 300	\$ 260	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400



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8 - Pedestrian & Bicycle

NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
8.10 - Leading Pedestrian Interval (LPI)															
8.10.1	Intersection	Pedestrian	Implement Leading Pedestrian Interval (LPI)	Urban	Pedestrian Crashes	One or more crossings receive LPI. Include all Pedestrian Crashes at the intersection.	13		10	\$ -	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.11 - Prohibit Right Turns on Red															
8.11.1	Intersection	Pedestrian	Prohibit Right Turns on Red	All	Pedestrian Injury Crashes	Injury includes fatality and injury crashes	25	Subjective	10	\$ -	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400
8.12 - Rectangular Rapid Flash Beacon (RRFB)															
8.12.1	All	Pedestrian	Install Rectangular Rapid Flash Beacon (RRFB)	Urban and Suburban, Midblock and Unsignalized Intersection Crossings	Pedestrian Crashes	Include crashes within 350' of crossing. Applicable to 2-7 lane crossings	47		10	\$ -	\$ -	Pedestrian	\$ 5,252,000	\$ 134,000	\$ 14,400



# 9 – Railroad Crossing



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9 - Railroad Crossing															
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
9.1 - Grade Separation at Railroad Crossing															
9.1.1	Railroad Crossing	Railroad Crossing	Grade Separation at Railroad Crossing	All	Total Crashes		100	Subjective	50	\$ -	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.2 - Add Lights and Bells at Railroad Crossing															
9.2.1	Railroad Crossing	Railroad Crossing	Add Lights and Bells at Railroad Crossing	All	Total Crashes		50		25	\$ 1,214	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.3 - Add Lights, Bells, and Gates at Railroad Crossing															
9.3.1	Railroad Crossing	Railroad Crossing	Add Lights, Bells, and Gates at Railroad Crossing	All	Total Crashes		84	Interim	25	\$ 1,830	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.4 - Add Vehicle Detection at Railroad Crossing															
9.4.1	Railroad Crossing	Railroad Crossing	Add Vehicle Detection at Railroad Crossing	All	Train/Vehicle and Vehicle/Gate Crashes		20	Subjective	10	\$ 3,030	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.5 - Switch Legs of Stop Sign Control at Railroad Crossing															
9.5.1	Railroad Crossing	Railroad Crossing	Switch Legs of Stop Sign Control at Railroad Crossing	All	Total Crashes		50	Subjective	na	na	na	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.6 - Relocate Railroad Equipment on Shoulder															
9.6.1	Railroad Crossing	Railroad Crossing	Relocate Railroad Equipment on Shoulder	All	Total Crashes		22	Subjective	20	\$ -	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.7 - Median Barriers at Railroad Crossing															
9.7.1	Railroad Crossing	Railroad Crossing	Median Barriers at Railroad Crossing	All	Total Crashes		77	Subjective	20	\$ 800	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.8 - Four Quadrant Gates at Railroad Crossing															
9.8.1	Railroad Crossing	Railroad Crossing	Four Quadrant Gates at Railroad Crossing	All	Total Crashes		86	Subjective	25	\$ 1,830	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.9 - Four Quadrant Gates and Median Barriers at Railroad Crossing															
9.9.1	Railroad Crossing	Railroad Crossing	Four Quadrant Gates and Median Barriers at Railroad Crossing	All	Total Crashes		98	Subjective	25	\$ 1,830	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.10 - Close an Existing At-Grade Railroad Crossing															
9.10.1	Railroad Crossing	Railroad Crossing	Close an Existing At-Grade Railroad Crossing	All	Total Crashes		100	Subjective	50	\$ -	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.11 - Improve Vertical Alignment to Remove Sag Hump at Railroad Crossing															
9.11.1	Railroad Crossing	Railroad Crossing	Improve Vertical Alignment to Remove Sag Hump at Railroad Crossing	All	Vehicle Hang-Up Crashes		80	Subjective	30	\$ -	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.12 - Improve Approach Sight Distance for Active Railroad Crossings															
9.12.1	Railroad Crossing	Railroad Crossing	Improve Approach Sight Distance for Active Railroad Crossings	All	Total Crashes		5	Subjective	10	\$ -	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400



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9 - Railroad Crossing															
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
9.13 - Improve Approach Sight Distance for Passive Railroad Crossings															
9.13.1	Railroad Crossing	Railroad Crossing	Improve Approach Sight Distance for Passive Railroad Crossings	All	Total Crashes		25	Subjective	10	\$ -	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.14 - Widen Pavement at Railroad Crossing to Provide Shoulders and/or Walkway															
9.14.1	Railroad Crossing	Railroad Crossing	Widen Pavement at Railroad Crossing to Provide Shoulders and/or Walkway	All	Total Crashes		8	Subjective	20	-\$500 per mile	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.15 - Improve Crossing Surface Traversability at Railroad Crossing															
9.15.1	Railroad Crossing	Railroad Crossing	Improve Crossing Surface Traversability at Railroad Crossing	All	Total Crashes		24	Subjective	10	\$ -	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.16 - Install New Traffic Signal with Railroad Preemption															
9.16.1	Railroad Crossing	Railroad Crossing	Install New Traffic Signal with Railroad Preemption	All	Total Crashes		22	Subjective	10	\$ 3,426	\$ 475	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.17 - Install Railroad Preemption at Existing Traffic Signal															
9.17.1	Railroad Crossing	Railroad Crossing	Install Railroad Preemption at Existing Traffic Signal	All	Total Crashes		15	Subjective	10	\$ 726	\$ 100	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.18 - Install Train Actuated "Second Train Approaching" Sign															
9.18.1	Railroad Crossing	Railroad Crossing	Install Train Actuated "Second Train Approaching" Sign	All	Total Crashes		6	Subjective	10	\$ 500	\$ 100	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.19 - Install Gates at Railroad Crossings with Flashing Lights and Bell															
9.19.1	Railroad Crossing	Railroad Crossing	Install Gates at Railroad Crossings with Flashing Lights and Bell	All	Total Crashes		45		25	\$ 616	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.20 - Install Overhead Cantilever with Flashing Lights at RxR Crossing with Existing Lights & Gates															
9.20.1	Railroad Crossing	Railroad Crossing	Install Overhead Cantilever with Flashing Lights at RxR Crossing with Existing Lights & Gates	All	Train/Vehicle Crashes		42	Subjective	25	\$ -	\$ -	Train	\$ 6,692,000	\$ 112,000	\$ 12,400
9.21 - Replace Tubular Markers with Concrete Medians at Railroad Crossing															
9.21.1	Railroad Crossing	Railroad Crossing	Replace Tubular Markers with Concrete Medians at Railroad Crossing	All	Total Crashes		None	Subjective	na	na	na	na	na	na	na





# 10 – Work Zones



North Carolina Project Development Crash Reduction Factor Information

LAST UPDATED: 6/28/2023

Note: Approval must be obtained from the CRF Committee if CRFs are identified from sources other than this sheet. Subjective CRFs are determined when no data is available and the committee has agreed upon a subjective value. Interim CRFs are determined when limited data is available but a robust study has not been performed or the study from past research summaries could not be found. Both Subjective and Interim CRFs may be used until a more statistically reliable CRF becomes available.

10 - Work Zones															
NCDOT Reference Number	Countermeasure Location Type	Countermeasure Target Crash	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF Context	CRF	Status	Service Life	Annual Maintenance	Utility Costs	Crash Cost Type	Crash Costs F+A	Crash Costs B+C	Crash Costs PDO
<b>10.1 - Work Zone with No Lane Closure</b>															
10.1.1	Section	Work Zone	Work Zone with No Lane Closure (Daytime)	Freeways and Expressways	Daytime Crashes	Before condition is no work zone. Daytime work zone with no lane closure (workers present).	-31		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
10.1.2	Section	Work Zone	Work Zone with No Lane Closure (Nighttime)	Freeways and Expressways	Nighttime Crashes	Before condition is no work zone. Nighttime (7p-6a) work zone with no lane closure (workers present).	-58		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>10.2 - Work Zone with Lane Closure</b>															
10.2.1	Section	Work Zone	Work Zone with One or More Lane Closed (Daytime)	Freeways and Expressways	Daytime Crashes	Before condition is no work zone. Daytime work zone with one or more lanes closed (workers present)	-66		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
10.2.2	Section	Work Zone	Work Zone with One or More Lane Closed (Nighttime)	Freeways and Expressways	Nighttime Crashes	Before condition is no work zone. Nighttime (7p-6a) work zone with one or more lanes closed (workers present)	-61		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>10.3 - Increase Length or Duration of Work Zone</b>															
10.3.1	Section	Work Zone	Increase Duration of Work Zone	Freeway	Total Crashes	Base condition: WZ with duration of 16 days. Applicable to WZ with duration of 16 - 714 days and AADT of 4,000 - 237,000.	CRF = -1.11 * %Increase in Duration		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
10.3.2	Section	Work Zone	Increase Length of Work Zone	Freeway	Total Crashes	Base condition: WZ with length of 0.51 mi. Applicable to WZ with length of 0.5-12.2 mi and AADT of 4,000-237,000.	CRF = -0.67 * %Increase in Length		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>10.4 - Speed Management Strategies in Work Zones</b>															
10.4.1	Section	Work Zone	Use Automated Speed Enforcement	All	Injury Crashes	Injury includes fatality and injury crashes.	17		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
10.4.2	Section	Work Zone	Install Variable Speed Limit System	Urban Interstate	Total Crashes		8		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>10.5 - Queue Warning Systems in Work Zones</b>															
10.5.1	Section	Work Zone	Use Queue Warning Systems in Work Zones	Rural Interstate when queues not present	Nighttime Crashes	End-of-queue warning system consisting of radar speed sensors linked to portable changeable message signs. AADT range of 55,000-110,000.	28		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
10.5.2	Section	Work Zone	Use Queue Warning Systems in Work Zones	Rural Interstate when queues are present	Nighttime Crashes	End-of-queue warning system consisting of radar speed sensors linked to portable changeable message signs. AADT range of 55,000-110,000.	53		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>10.6 - Change Shoulder Width in Work Zone</b>															
10.6.1	Section	Work Zone	Increase Inside Shoulder Width by 1 Ft in Work Zone	Urban Interstate	Total Crashes		3		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
10.6.2	Section	Work Zone	Increase Outside Shoulder Width by 1 Ft in Work Zone	Urban Interstate	Total Crashes		5		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400
<b>10.7 - Change Horizontal Curve Radius in Work Zones</b>															
10.7.1	Section	Work Zone	Change in Horizontal Curvature from X to Y Degrees	Rural 4-Lane Highways	Injury Crashes	The base condition is roadways with a maximum speed limit of 55 mph. Injury includes fatality and injury crashes.	CRF=100*(1-e^(0.0831*(Y-X)))		n/a	\$ -	\$ -	Total	\$ 3,865,000	\$ 168,000	\$ 14,400

