



NORTH CAROLINA
Department of Transportation

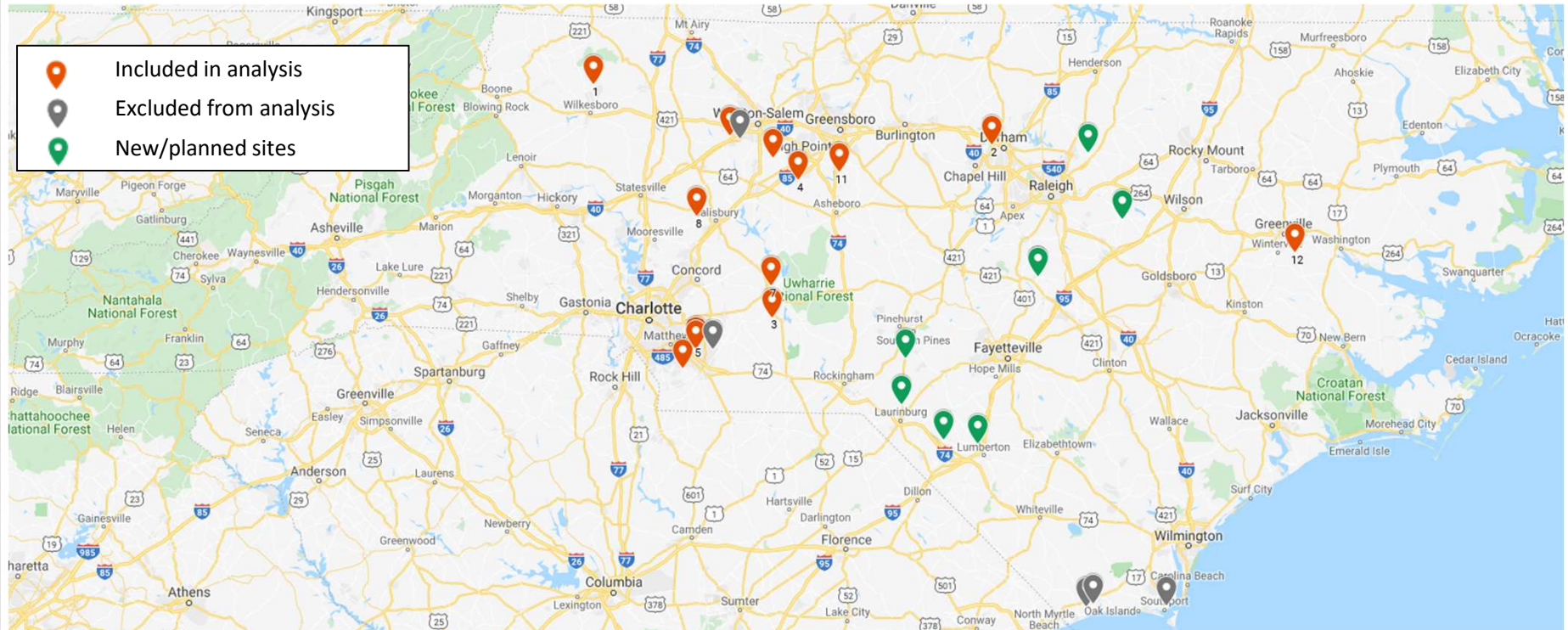


Roundabouts on High Speed Roads – Empirical Bayes Methodology Evaluation

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Location map of High-Speed Roundabouts



- High speed roundabouts are installed or planned for at least 9 of our 14 Divisions, including Divisions 2, 3, 4, 5, 6, 8, 9, 10 and 11. They have been installed on high speed SR, US, and NC routes. The map shows 26 sites. Note: All are single lane.

13 High-Speed roundabouts installed prior to 2018 included in crash analysis – At Least one 55 mph approach

High Speed Roundabouts (At Least One 55 mph Approach)										
Congestion #	Division	County	Location	GPS	Year Built	Legs	Inscribed Diameter	Major	Minor	Project
291	11	Wilkes	SR 1716/SR 1713 (Yellowbanks Rd) at SR 1716/SR 1707 (Haymeadow Rd)	36.264585, -81.147135	2002	4	120'	55	55	SS 11-11-210
60	5	Durham	NC 751 at SR 1307 (Old Erwin Rd)	36.000834, -78.962089	2003	3	100'	55	45	SS 05-00-208
276	10	Stanly	SR 1918 (Cottonville Rd) at SR 1922 (South Stanly School Rd)	35.233158, -80.167665	2006	4	135'	45	55/45	-
190	8	Randolph	SR 1547 (Fitch Farm Rd) at SR 1553 (Old Mountain Rd)	35.843000, -80.022445	2010	3	120'	45	55	-
277	10	Union	SR 1514 (Rocky River Rd) at SR 1520 (Indian Trail Fairview Rd)	35.106032, -80.584290	2011	4	130'	55/45	45	W-5309
192	9	Davidson	SR 1802 (Midway School Rd) at SR 1806 (Hoy Long Rd)	35.942019, -80.162979	2012	4	120'	55	55	-
275	10	Stanly	SR 1650 (Northeast Connector) at SR 1542 (Ridge St)	35.377332, -80.170340	2012	4	125'	55	45	W-5210D
222	9	Rowan	SR 1526 (Sherrills Ford Rd) at SR 1728 (Barringer Rd)	35.686241, -80.580887	2013	4	150'	55	55	W-5209D
199	9	Forsyth	SR 1891 (Peace Haven Rd) at SR 1101 (Harper Rd)	36.041647, -80.395258	2014	4	120'	35	55/45	09-10-236
286	10	Union	NC 84 at SR 1349 (Airport Rd)	35.0049364, -80.6537708	2014	3	160'	55	55	W-5210G
187	8	Randolph	US 220 Business at SR 2114 (Providence Church Rd)	35.878812, -79.798036	2015	3	130'	45	55	SS 08-13-6066
9	2	Pitt	SR 2241 (Ivy Rd) at SR 1774 (Mills Rd)	35.52358, -77.306614	2016	4	140'	55	55	W-5601N
279	10	Union	SR 1514 (Rocky River Rd) at SR 1508 (Poplin Rd)	35.089691, -80.585219	2016	4	135'	55	55/45	W-5210N

- Used August 2018 Congestion Management spreadsheet to build list.
- Included sites were built between 2002 and 2016
- Four additional high-speed roundabouts not included in before-after analysis because something else changed when the roundabout was installed that does not allow for fair before and after crash comparison
- One additional site not included in EB evaluation due to 5 lane configuration (evaluated separately)
- Four new sites installed in 2018 and Four in planning phase – may be included in future analysis

Site Characteristics



- 6 out of 12 (50%) inventoried sites have lighting (in at least one quadrant)
- 12 out of 12 (100%) inventoried sites have yield lines on all approaches, yield signs located (on shoulder or median and/or both) and white chevron signs installed in the inscribed diameter
- 6 out of 12 (50%) inventoried sites have keep right symbol signs located in the median on all approaches

*Inventory could not be completed for Treatment Site #1 and is therefore not included in these statistics

Site Characteristics Continued



- 12 out of 12 (100%) inventoried sites have advance roundabout circulation warning signage (on at least one approach)
- 6 out of 12 (50%) inventoried sites have posted advisory speeds (on at least one approach)
- 2 out of 12 (17%) inventoried sites have lane control sign arrow and yield pavement markings

*Inventory could not be completed for Treatment Site #1 and is therefore not included in these statistics

Crash Analysis Results

Evaluation of 13 High-Speed Roundabouts – Empirical Bayes Methodology	Crash Reduction Factors
Total Crashes	41 +/- 10%
Fatal and Injury (KABC) Crashes	79 +/- 8%
Frontal Impact Crashes	62 +/- 10%
Frontal Impact – Fatal and Injury (KABC) Crashes	96 +/- 4%

- All treatment sites converted from minor road stop control to a roundabout
 - Major AADT = 6,000 Average (Range: 2,000 – 12,500)
 - Minor AADT = 3,600 Average (Range: 400 – 11,000)
- 35 Reference Sites
- Crash Proportions calculated from Reference Sites for Site Type & Crash Type
- All results are statistically significant at the 95% confidence interval

Crash Analysis Results

Evaluation of 13 High-Speed Roundabouts – Empirical Bayes Methodology	Crash Reduction Factors
Total Crashes	41 +/- 10%
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Frontal Impact – Fatal and Injury (KABC) Crashes	96 +/- 4%

- The results are strong for all of the crash types we analyzed and are especially strong for Frontal Impact Fatal and Injury (KABC) crashes.
- Treatment Sites - 3 Fatal and 2 Class-A injury crashes during the study before periods.
- Treatment Sites - NO reported Fatal or Class-A injury crashes during the study after periods.

Crash Analysis Results

Naïve Methodology Comparison

Crash Analysis Results

Empirical Bayes

Evaluation of 13 High-Speed Roundabouts – Empirical Bayes Methodology	Crash Reduction Factors
Total Crashes	41 +/- 10%
Fatal and Injury (KABC) Crashes	79 +/- 8%
Frontal Impact Crashes	62 +/- 10%
Frontal Impact – Fatal and Injury (KABC) Crashes	96 +/- 4%

Naive

Evaluation of 13 High-Speed Roundabouts – Naive Methodology	Crash Reduction Factors
Total Crashes	46 +/- 9%
Fatal and Injury (KABC) Crashes	82 +/- 7%
Frontal Impact Crashes	69 +/- 9%
Frontal Impact – Fatal and Injury (KABC) Crashes	97 +/- 3%

The crash reduction factors calculated utilizing the EB Methodology are slightly lower than the crash reduction factors calculated utilizing the Naïve Methodology. Crash reduction factors calculated using the EB Method are typically more conservative due to addressing the bias of regression-to-the-mean. A naive before-after study does not consider regression-to-the-mean and may overestimate the effect of a treatment.

Crash Analysis Results

By Number of Intersection Legs

3-Leg Intersections

Evaluation of 4 High-Speed Roundabouts – Empirical Bayes Methodology – 3 Leg Intersections	Crash Reduction Factors
Total Crashes	38 +/- 17%
Fatal and Injury (KABC) Crashes	83 +/- 13%
Frontal Impact Crashes	85 +/- 11%
Frontal Impact – Fatal and Injury (KABC) Crashes	100 +/- 0%

- Four (4) - 3 Leg Intersection Treatment Sites
- All results are statistically significant at the 95% confidence interval



4-Leg Intersections

Evaluation of 9 High-Speed Roundabouts – Empirical Bayes Methodology – 4 Leg Intersections	Crash Reduction Factors
Total Crashes	43 +/- 11%
Fatal and Injury (KABC) Crashes	79 +/- 9%
Frontal Impact Crashes	55 +/- 13%
Frontal Impact – Fatal and Injury (KABC) Crashes	95 +/- 5%

- Nine (9) - 4 Leg Intersection Treatment Sites
- All results are statistically significant at the 95% confidence interval



5-Leg Intersection

Evaluation of a 5-Leg High Speed Roundabout - Simple Before and After Analysis with Traffic Adjustment	Crash Reduction Factors
Total Crashes	40 +/- 22%
Fatal and Injury (KABC) Crashes	46 +/- 23%
Frontal Impact Crashes	66 +/- 37%
Frontal Impact - Fatal and Injury (KABC) Crashes	59 +/- 34%

- One (1) - 5 Leg Intersection Treatment Site (Not Included in EB Analysis)
- All results are statistically significant at the 90% confidence interval



SR 1001/1606 (Sikes Mill Rd) at SR 1001 (Love Mill Rd) and SR 1637 (E Lawyers Rd) and SR 1618 (Tom Helms Rd)
Unionville, Union County

Review of Prior Safety Studies

Crash Analysis Results

	Evaluation of 13 High-Speed Roundabouts – Empirical Bayes Methodology	“Statistical Analysis & Development of Crash Prediction Model for Roundabouts on High-Speed Rural Roadways”
	Crash Reduction Factors	
Total Crashes	41%	62 - 67%
Fatal and Injury (KABC) Crashes	79%	85 - 87%
Frontal Impact Crashes	62%	91%

- Results for total crash and frontal impact reduction are significantly lower compared to the findings published in the TRB Paper “ Statistical Analysis and Development of Crash Prediction Model for Roundabouts on High-Speed Rural Roadways” Hillary Isebrands and Shauna Hallmark (2012)

*Differences may be explained by the study including a diverse group of 20 sites located in Kansas, Maryland, Minnesota, Oregon, Washington State and Wisconsin with maximum speed limits from 40 mph to 65 mph, and a majority were two-way stop in the before period.

Crash Analysis Results

	Evaluation of 13 High-Speed Roundabouts – Empirical Bayes Methodology	NCDOT 2010 Statewide Roundabout Evaluation of 30 Sites
	Crash Reduction Factors	
Total Crashes	41%	46%
Fatal and Injury (KABC) Crashes	79%	75%
Frontal Impact Crashes	62%	76%

- Results are similar to those calculated in 2010 roundabout evaluation

<https://connect.ncdot.gov/resources/safety/TrafficSafetyResources/Roundabouts.pdf>

Crash Trends

Crash Analysis Results

	Before			After		
	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
Total Crashes	26	20	21	14	16	10
Total Crashes Per Year	3.3 CPY	2.5 CPY	2.6 CPY	1.8 CPY	2.0 CPY	1.3 CPY
Frontal Impact Crashes	15	13	11	5	7	4
Frontal Impact Crashes Per Year	1.9 CPY	1.6 CPY	1.4 CPY	0.6 CPY	0.9 CPY	0.5 CPY

- 8 out of the 13 treatments sites with 3 years of before and after data
- Reductions in total and frontal impact crashes per year

Summary

Results:

- 41% Reduction in Total Crashes
- 79% Reduction in Fatal and Injury Crashes
- 62% Reduction in Frontal Impact Crashes

Other Key Points:

- Results are similar to the crash reductions previously determined in an NCDOT study of 30 intersections converted from two-way stop sign control or signalization to a roundabout in urban, suburban, and rural areas with varying ranges of volumes and approach speeds
- Reductions in Total Crashes were similar regardless of whether the intersection has three legs or four legs
- Treatment Sites with 3 years of after data experienced a reduction in total and frontal impact crashes per year with the largest reductions seen in year 3