Transportation Feasibility & Impact Analyses FY 2013

I-85 Future Interchange Location Analysis

Technical Memorandum #3: Impact

June 28, 2013

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Contents

Introduction

Study Purpose

This study focuses on the identification of potential I-85 interchange locations and the resulting performance of the overall transportation network performance, with due consideration given to EMS response, economic development, and land use. The purpose of this analysis is to recommend a location for a new interchange that would meet the federal interchange access justification criteria, one that would improve mobility and emergency management on I-85 while maintaining the existing character of the study area and providing economic development opportunities. NC 56 at exit 191 and US 15 at exit 202 are central spines for Butner, Creedmoor, and Oxford downtowns, and the absence of additional exits between these towns has no doubt influenced the development character of these communities. Balancing mobility, development, and incident management can be accomplished through coordination and consideration of various alternatives.

Tech Memo Purpose

The purpose of this technical memorandum is to document the potential impacts of an interchange between Exit 191 and Exit 202 on I-85 in Granville County.

This tech memo is #3 of 3, with the others being:

- Tech Memo #1: Existing Conditions
- Tech Memo #2: Feasibility

Interchange Alternatives Functional Analyses

Brogden Road (SR 1127)

Brogden Road is located 2 miles north of I-85 Exit 191 at MM 193. It is the most direct route connecting the Towns of Creedmoor and Stem. It is a two lane rural road, has a speed limit of 55 mph and passes over I-85 at its intersection. The interchange is included in the Regional Comprehensive Transportation Plan and the Triangle Regional Model in the year 2030.

From a traffic standpoint as determined by the baseline Triangle Regional Model and interchange

LOS results described previously, there is little need to advance an interchange for regional mobility or localized congestion mitigation. Therefore, this and all alternatives tested are for the year 2040. Modeled performance of the study area roadways are summarized below for this alternative and the baseline alternative for the build year.

TABLE 1 2040 BROGDEN ROAD INTERCHANGE OPTION ROADWAY SUMMARY

Roadway	2040 Brogden Interchange*			2040 Baseline		
	% Change in AADT from 2030	Travel Speed (mph)	V/C	% Change in AADT from 2030	Travel Speed (mph)	V/C
I-85 btwn Exits 191 and 202	15.8%	70	**0.45**	1.4%	72	0.29
US 56 West of I-85 Interchange	102.3%	45	**0.27**	76.4%	44	0.37
US 56 East of I-85 Interchange	44.0%	46	**0.28**	55.6%	44	0.35
Brogden Road at I-85	12.8%	39	**0.40**	-6.9%	41	0.24
E. Thollie Green Road at I-85	0.0%	46	0.01	14.3%	46	0.01
Sanders Road at I-85	30.0%	38	0.01	25.0%	38	0.01
Smith Road at I-85	17.2%	49	0.02	15.4%	46	0.02
Belltown Road at Sanders Rd	13.6%	48	0.10	14.3%	48	0.10
Belltown Road at Brogden Rd	13.2%	49	0.11	14.7%	48	0.11
W. Lyons Station Rd. at Brogden	24.0%	45	**0.09**	-5.7%	42	0.34
US 15 N of Creedmoor	21.3%	52	**0.20**	8.6%	52	0.24
US 15 at Hester Rd.	13.6%	53	**0.08**	-5.7%	53	0.11
US 15 at Sanders Rd.	10.2%	52	0.17	10.0%	52	0.16
US 15 at Smith Rd.	8.6%	52	0.13	9.3%	53	0.13

V/C increase over 2040 Base in **Red; V/C decrease over 2040 Base in **Green***

Mainline congestion remains low with a new Brogden Interchange with a relative increase in volumes expected on the I-85 mainline NC 56 at W. Lyon Station Road, US 15 North of Creedmoor and at Hester Road, and on Brogen and its link with W. Lyon Station Road. These changes in travel patterns point toward shifts in traffic from Creedmoor, Butner, Oxford, and Stem to use the new interchange. The performance of the interchange itself is shown in the LOS table below.

TABLE 2 2040 BROGDEN ROAD INTERCHANGE OPTION TRAFFIC SUMMARY

2040 Future Traffic (Brogden Interchange)

Level-of-Service, Capacity, and Delay Summary

	MOE	Overall	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
AM Peak Hour														
1. NC 56 (E-W) & I-85 NB Ramps (N-S)	*LOS*	B	A	A			A		D		C			
	Capacity (v/c)	0.48	0.23	0.26			0.44		0.72		0.12			
	Delay	12.6	6.2	4.9			8.7		45.7		34.1			
2. NC 56 (E-W) & I-85 SB Ramps (N-S)	*LOS*	B	B			B	A					D		D
	Capacity (v/c)	0.62	0.54			0.59	0.29					0.61		0.48
	Delay	15.8	15.1			14.1	3.2					39.3		36.0
3. NC 56 (E-W) & W. Lyon Station Rd (N-S)	*LOS*	C	D	B			C	C				D		B
	Capacity (v/c)	0.67	0.28	0.24			0.59	0.14				0.86		0.20
	Delay	24.3	39.2	10.4			22.4	25.5				40.9		16.9
4. US 15 (N-S) & I-85 NB Ramps (E-W)	*LOS*		C									A		
	Capacity (v/c)		0.43									0.07		
	Delay		23.3									8.0		
5. US 15 (N-S) & I-85 SB Ramps (E-W)	*LOS*					C			A					
	Capacity (v/c)					0.37			0.03					
	Delay					16.0			8.0					
6. Brogden Rd (N-S) & I-85 NB Ramps (E-W)	*LOS*	B	C		C				A	A			B	B
	Capacity (v/c)	0.42	0.43		0.06				0.18	0.42			0.41	0.06
	Delay	10.4	25.7		23.3				4.3	5.4			11.0	15.3
7. Brogden Rd (N-S) & I-85 SB Ramps (E-W)	*LOS*	A				C		C	A	A			B	A
	Capacity (v/c)	0.55				0.47		0.06	0.18	0.41			0.54	0.06
	Delay	9.5				26.9		24.2	2.4	2.9			12.2	7.6
PM Peak Hour														
1. NC 56 (E-W) & I-85 NB Ramps (N-S)	*LOS*	C	D	A			C		D		E			
	Capacity (v/c)	0.87	0.84	0.45			0.86		0.61		0.85			
	Delay	25.8	42.5	6.0			28.7		36.2		55.4			
2. NC 56 (E-W) & I-85 SB Ramps (N-S)	*LOS*	B	B			D	A					D		C
	Capacity (v/c)	0.71	0.75			0.67	0.37					0.59		0.07
	Delay	15.8	17.1			35.0	4.2					39.7		33.7
3. NC 56 (E-W) & W. Lyon Station Rd (N-S)	*LOS*	C	D	A			A	B				D		B
	Capacity (v/c)	0.62	0.54	0.52			0.33	0.34				0.75		0.05
	Delay	21.0	39.1	8.4			18.3	37.9				40.3		19.6
4. US 15 (N-S) & I-85 NB Ramps (E-W)	*LOS*		F									A		
	Capacity (v/c)		1.64									0.12		
	Delay		347.2									8.4		
5. US 15 (N-S) & I-85 SB Ramps (E-W)	*LOS*					D			A					
	Capacity (v/c)					0.67			0.02					
	Delay					30.3			8.3					
6. Brogden Rd (N-S) & I-85 NB Ramps (E-W)	*LOS*	B	C		C				B	B			B	B
	Capacity (v/c)	0.70	0.62		0.10				0.61	0.72			0.69	0.09
	Delay	13.7	28.6		22.5				14.8	10.4			12.3	14.9
7. Brogden Rd (N-S) & I-85 SB Ramps (E-W)	*LOS*	B				D		C	B	A			C	A
	Capacity (v/c)	0.92				0.73		0.10	0.54	0.69			0.93	0.11
	Delay	19.2				37.7		23.9	19.3	6.3			30.7	8.6

LOS Poorer than 2040 Base and LOS D or worse

LOS Better than 2040 Base at LOS C or better

The interchange was modeled as a signalized modified diamond interchange. As shown in the Brogden Interchange LOS table above, the new interchange functions well during the AM Peak hour with one movement (I-85 SB Ramp to SB Brogden) functioning at LOS D in the PM Peak period, if just barely so. Other notable changes include more congestion at the intersection of NC 56 and W. Lyon Station Road, and the SB I-85 to SB US 15 movement at Exit 202 due to more vehicles using the interstate for their commutes, adding to the current congestion at W. Lyon Station Road. Other movements are expected to function at or better than the baseline case.

Sanders Road (SR 1132)

Sanders Road is located 5.75 miles north of I-85 Exit 191 near MM 197. It is a two lane rural road, has a speed limit of 55 mph and passes under I-85 at its intersection. Sanders connects US 15 to the east and Belltown Road to the west and provides access to Granville Central High School. Modeled performance of the study area roadways are summarized below for this alternative and the baseline alternative for the build year.

TABLE 3 2040 SANDERS ROAD INTERCHANGE OPTION ROADWAY SUMMARY

Roadway	2040 Sanders Interchange: % Change in AADT from 2030	2040 Sanders Interchange: Travel Speed (mph)	2040 Sanders Interchange: V/C	2040 Baseline: % Change in AADT from 2030	2040 Baseline: Travel Speed (mph)	2040 Baseline: V/C
I-85 btwn Exits 191 and 202	0.5%	72	0.29	1.4%	72	0.29
US 56 West of I-85 Interchange	53.8%	45	0.32	76.4%	44	0.37
US 56 East of I-85 Interchange	40.2%	45	0.32	55.6%	44	0.35
Brogden Road at I-85	-25.8%	41	0.20	-6.9%	41	0.24
E. Thollie Green Road at I-85	1528.6%	46	0.04	14.3%	46	0.01
Sanders Road at I-85	2741.7%	37	0.23	25.0%	38	0.01
Smith Road at I-85	-12.8%	46	0.02	15.4%	46	0.02
Belltown Road at Sanders Rd	-21.8%	49	0.08	14.3%	48	0.10
Belltown Road at Brogden Rd	-22.8%	49	0.08	14.7%	48	0.11
W. Lyons Station Rd. at Brogden	-25.2%	43	0.28	-5.7%	42	0.34
US 15 N of Creedmoor	18.0%	52	0.22	8.6%	52	0.24
US 15 at Hester Rd.	-20.2%	53	0.09	-5.7%	53	0.11
US 15 at Sanders Rd.	11.4%	52	0.16	10.0%	52	0.16
US 15 at Smith Rd.	13.1%	52	0.14	9.3%	53	0.13

**V/C increase over 2040 Base in Red; V/C decrease over 2040 Base in Green*

TRM results show significant increases in mainline volumes on E. Thollie Green Road and Sanders Road. E. Thollie Green Road increases are misleading in that there is very little volume and although a significant increase in terms of percentage, it results in a relatively minor increase in overall volumes as shown by the still very low V/C ratio. Other notable changes include decreased volumes on Belltown Road and Smith Road. The performance of the interchange itself is shown in the LOS table below.

TABLE 4 2040 SANDERS ROAD INTERCHANGE OPTION TRAFFIC SUMMARY

2040 Future Traffic (Sanders Interchange)

Level-of-Service, Capacity, and Delay Summary

	MOE	Overall	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
AM Peak Hour														
1. NC 56 (E-W) & I-85 NB Ramps (N-S)	*LOS*	B	B	A			B		D		C			
	Capacity (v/c)	0.57	0.34	0.32			0.54		0.76		0.20			
	Delay	14.7	11.7	8.0			10.5		46.6		33.3			
2. NC 56 (E-W) & I-85 SB Ramps (N-S)	*LOS*	C	C			D	A					D		D
	Capacity (v/c)	0.83	0.73			0.80	0.36					0.59		0.79
	Delay	22.8	23.0			35.4	4.2					35.8		47.7
3. NC 56 (E-W) & W. Lyon Station Rd (N-S)	*LOS*	C	D	B			C	C				D		B
	Capacity (v/c)	0.80	0.33	0.30			0.77	0.17				0.92		0.24
	Delay	28.1	39.5	12.5			28.1	25.9				46.6		15.4
4. US 15 (N-S) & I-85 NB Ramps (E-W)	*LOS*		C									A		
	Capacity (v/c)		0.43									0.07		
	Delay		23.3									8.0		
5. US 15 (N-S) & I-85 SB Ramps (E-W)	*LOS*					C			A					
	Capacity (v/c)					0.38			0.03					
	Delay					16.2			8.0					
8. Sanders Rd (E-W) & I-85 NB Ramps (N-S)	*LOS*	A	A	A			C		C		C			
	Capacity (v/c)	0.29	0.06	0.18			0.28		0.32		0.02			
	Delay	7.5	2.0	2.1			7.1		27.5		25.6			
9. Sanders Rd (E-W) & I-85 SB Ramps (N-S)	*LOS*	A		A		A	A					C		C
	Capacity (v/c)	0.27		0.26		0.06	0.19					0.29		0.03
	Delay	7.3		6.9		2.1	2.3					27.3		25.7
PM Peak Hour														
1. NC 56 (E-W) & I-85 NB Ramps (N-S)	*LOS*	D	F	A			C		C		E			
	Capacity (v/c)	1.38	1.46	0.57			0.94		0.60		0.97			
	Delay	54.0	254.5	9.2			33.3		32.9		72.9			
2. NC 56 (E-W) & I-85 SB Ramps (N-S)	*LOS*	C	C			D	A					D		C
	Capacity (v/c)	0.85	0.94			0.75	0.45					0.63		0.21
	Delay	21.4	26.3			39.9	5.9					40.0		33.6
3. NC 56 (E-W) & W. Lyon Station Rd (N-S)	*LOS*	C	D	B			B	D				D		B
	Capacity (v/c)	0.73	0.59	0.64			0.43	0.40				0.79		0.09
	Delay	22.5	39.9	11.3			18.9	38.8				40.3		17.6
4. US 15 (N-S) & I-85 NB Ramps (E-W)	*LOS*		F									A		
	Capacity (v/c)		1.67									0.12		
	Delay		360.8									8.4		
5. US 15 (N-S) & I-85 SB Ramps (E-W)	*LOS*					D			A					
	Capacity (v/c)					0.69			0.02					
	Delay					31.2			8.3					
8. Sanders Rd (E-W) & I-85 NB Ramps (N-S)	*LOS*	A	A	A			B		C		C			
	Capacity (v/c)	0.40	0.09	0.25			0.41		0.31		0.04			
	Delay	8.9	2.6	2.70			10.1		25.5		23.9			
9. Sanders Rd (E-W) & I-85 SB Ramps (N-S)	*LOS*	A		A		A	A					C		C
	Capacity (v/c)	0.38		0.39		0.10	0.25					0.30		0.04
	Delay	9.0		9.8		3.3	3.4					25.6		24.1

LOS Poorer than 2040 Base and LOS D or worse

LOS Better than 2040 Base at LOS C or better

The interchange at Sanders Road would be expected to function within acceptable LOS. LOS changes to the existing interchanges remain relatively unchanged except for the intersection of NB I-85 and NC 56 which functions poorly, and functions more poorly than under the Brodgen Road alternative presumably because travelers are looking to access populations further south (Creedmoor, Butner, Stem) than Sanders Road. (For example, travel delay for PM northbound right turns is 17.5 seconds higher in the Sanders Road alternative).

Smith Road (SR 1135)

Smith Road is located approximately 5 miles south of I-85 Exit 202 near MM 197 and 6 miles north of I-85 Exit 191. It is a two lane rural road, has a speed limit of 55 mph and passes over I-85 at its intersection. Like Sanders, Smith Road connects US 15 to the east and Belltown Road to the west. Modeled performance of the study area roadways are summarized below for this alternative and the baseline alternative for the build year.

TABLE 5 2040 SMITH ROAD INTERCHANGE OPTION ROADWAY SUMMARY

Roadway	2040 Smith Interchange: % Change in AADT from 2030	2040 Smith Interchange: Travel Speed (mph)	2040 Smith Interchange: V/C	2040 Baseline: % Change in AADT from 2030	2040 Baseline: Travel Speed (mph)	2040 Baseline: V/C
I-85 btwn Exits 191 and 202	7.2%	72	0.30	1.4%	72	0.29
US 56 West of I-85 Interchange	53.0%	45	0.33	76.4%	44	0.37
US 56 East of I-85 Interchange	40.4%	45	0.32	55.6%	44	0.35
Brogden Road at I-85	-27.8%	42	0.19	-6.9%	41	0.24
E. Thollie Green Road at I-85	14.3%	46	0.01	14.3%	46	0.01
Sanders Road at I-85	16.7%	38	0.01	25.0%	38	0.01
Smith Road at I-85	243.6%	46	0.09	15.4%	46	0.02
Belltown Road at Sanders Rd	-37.6%	49	0.06	14.3%	48	0.10
Belltown Road at Brogden Rd	-37.5%	49	0.06	14.7%	48	0.11
W. Lyons Station Rd. at Brogden	-28.1%	43	0.27	-5.7%	42	0.34
US 15 N of Creedmoor	-3.8%	52	0.21	8.6%	52	0.24
US 15 at Hester Rd.	-31.6%	53	0.07	-5.7%	53	0.11
US 15 at Sanders Rd.	-38.4%	52	0.09	10.0%	52	0.16
US 15 at Smith Rd.	-34.1%	53	0.07	9.3%	53	0.13

V/C increase over 2040 Base in* ***Red**; V/C decrease over 2040 Base in* ***Green***

Regional model results show significant increases in mainline volumes on Smith Road, with reductions in volumes on US 15 south of Smith Road and Belltown Road. Inclusion of this interchange still results in very low V/C ratios throughout the regional system. The changes in travel patterns points to an interchange at this location being utilized primarily by commuters north of the interchange in the Oxford area. There is also a reduction in vehicles utilizing Exit 202, US 15. The performance of the Smith Road interchange and Exits 191 and 202 are shown in the LOS table below.

TABLE 6 2040 SMITH ROAD INTERCHANGE OPTION TRAFFIC SUMMARY

2040 Future Traffic (Smith Interchange)

Level-of-Service, Capacity, and Delay Summary

	MOE	Overall	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
AM Peak Hour														
1. NC 56 (E-W) & I-85 NB Ramps (N-S)	LOS	B	A	A			A		D		C			
	Capacity (v/c)	0.49	0.24	0.27			0.46		0.73		0.12			
	Delay	12.8	6.5	5.2			8.9		46.4		34.0			
2. NC 56 (E-W) & I-85 SB Ramps (N-S)	LOS	B	B			B	A					D		D
	Capacity (v/c)	0.64	0.56			0.62	0.30					0.61		0.55
	Delay	16.6	16.4			16.1	3.2					38.7		37.6
3. NC 56 (E-W) & W. Lyon Station Rd (N-S)	LOS	C	D	B			C	C				D		B
	Capacity (v/c)	0.69	0.29	0.25			0.61	0.15				0.87		0.21
	Delay	24.5	39.3	10.6			22.7	24.5				41.8		16.8
4. US 15 (N-S) & I-85 NB Ramps (E-W)	LOS		B									A		
	Capacity (v/c)		0.15									0.04		
	Delay		12.8									7.7		
5. US 15 (N-S) & I-85 SB Ramps (E-W)	LOS					B			A					
	Capacity (v/c)					0.14			0.02					
	Delay					11.0			7.7					
10. Smith Rd (E-W) & I-85 NB Ramps (N-S)	LOS	A	A	A			A		C		C			
	Capacity (v/c)	0.11	0.02	0.07			0.10		0.20		0.01			
	Delay	6.3	1.8	1.6			4.5		28.6		27.2			
11. Smith Rd (E-W) & I-85 SB Ramps (N-S)	LOS	A		A		A	A					C		C
	Capacity (v/c)	0.10		0.09		0.02	0.07					0.21		0.01
	Delay	6.3		4.5		1.7	1.6					28.8		27.3
PM Peak Hour														
1. NC 56 (E-W) & I-85 NB Ramps (N-S)	LOS	C	D	A			C		D		E			
	Capacity (v/c)	0.92	0.90	0.46			0.86		0.62		0.87			
	Delay	27.1	50.7	6.2			28.6		36.4		58.6			
2. NC 56 (E-W) & I-85 SB Ramps (N-S)	LOS	B	B			D	A					D		C
	Capacity (v/c)	0.73	0.77			0.70	0.38					0.59		0.07
	Delay	16.4	18.0			37.0	4.4					39.8		33.5
3. NC 56 (E-W) & W. Lyon Station Rd (N-S)	LOS	C	D	A			B	D				D		B
	Capacity (v/c)	0.63	0.54	0.53			0.34	0.35				0.76		0.06
	Delay	21.4	39.1	8.7			18.8	39.0				40.6		19.3
4. US 15 (N-S) & I-85 NB Ramps (E-W)	LOS		C									A		
	Capacity (v/c)		0.48									0.06		
	Delay		21.0									7.8		
5. US 15 (N-S) & I-85 SB Ramps (E-W)	LOS					B			A					
	Capacity (v/c)					0.21			0.01					
	Delay					12.8			7.8					
10. Smith Rd (E-W) & I-85 NB Ramps (N-S)	LOS	A	A	A			A		C		C			
	Capacity (v/c)	0.19	0.04	0.12			0.18		0.22		0.02			
	Delay	6.9	2.0	2.0			6.0		27.0		25.9			
11. Smith Rd (E-W) & I-85 SB Ramps (N-S)	LOS	A		A		A	A					C		C
	Capacity (v/c)	0.18		0.17		0.04	0.12					0.23		0.02
	Delay	7.0		6.1		2.0	2.0					27.3		26.0

LOS Poorer than 2040 Base and LOS D or worse

LOS Better than 2040 Base at LOS C or better

A new interchange at Smith Road would be expected to function at acceptable levels of service. The most pronounced improvement over the baseline 2040 forecasts is the functionality of Exit 202. During the AM peak period, the northbound exit ramp movement to US 15 WB is shown to operate at LOS F in the baseline and LOS B with a

Smith Road interchange. Functionality at Exit 191 worsens, however, particularly in the PM Peak period.

Additional Impacts/Considerations

In addition to the impact on congestion resulting from the addition of a new interchange, the FHWA requires a comprehensive look at the secondary impacts as well. These include environmental and community impacts, multimodal (bicycle/pedestrian) impacts, and economic well-being. Summarized below are items to consider when conducting further analysis on a future interchange.

Environmental Impacts

Environmental impact considerations are critical to any decision to implement large transportation projects such as a new interstate interchange. Detailed environmental documents are required as the planning process moves forward, however environmental consideration should be taken into account early in the process to ensure potential issues are identified as soon as possible. The general environmental issues and their considerations are discussed below.

Water quality

Run off from an interchange construction site, and the resulting facility, may impact the quality of ground water. This is especially true in rural areas where wells provide drinking water to residents. Obviously, all improvements would have some additional impact to the ground water quality. Therefore it would be most beneficial if operational improvements were made to existing interchanges if the project is attempting to address capacity, air quality issues, emergency management access, etc. As part of this analysis, water quality would benefit from exploring if operational improvements at Exits 191 and 202 would assist in meeting the regions goals.

Wetlands and Wildlife

Impacts to wetlands and wildlife are often present when a project is close to a wetland, is near an upstream water source, or within a wildlife migration path or habitat. Wetlands and flood hazards are documented in the immediate vicinity of the Brogden Road interchange, though much of the identified wetlands are several hundred feet or more from the roadway, particularly south of the interstate. The impact of this interchange will need to be investigated within subsequent studies, in addition to impacts to wildlife habitat.

Air quality

Air quality in a non-attainment area requires that transportation projects conform to not contribute, and ideally reduce, impacts to air quality. Granville County is a non-attainment county for 8-hour ozone readings (as of March 12, 2009). A Clean Air Act requires states to submit to EPA its recommendations for nonattainment designations within 1-year of promulgation of a new or revised National Ambient Air Quality Standard (NAAQS). The 8-Hour Ozone NAAQS was revised to 0.075 parts per million (ppm) on March 12, 2008.
Auto congestion contributes to poor air quality, so implementing projects that reduce congestion generally benefit air quality. Based on this analysis, air quality modeling should be conducted to determine the impacts of the new interchange alternatives. Because the Brogden interchange is included as part of the adopted regional CTP and the Triangle Regional Model, it is assumed that this location has no adverse impacts to the region.

Energy usage

Energy usage is becoming a larger part of planning for transportation improvements. In general, more efficient movement of vehicles contributes to a reduction in the amount of energy required. A well designed new interchange would increase the number of access points which would theoretically reduce energy regionally, but may produce localized congestion off-setting the benefits. This would have to be studied in further detail.

Community Impacts

Community impacts of large-scale transportation improvements such as this are wide-ranging. As the interchange development moves forward, public involvement will be required to gauge what the community impacts will be. However, there are some considerations that can be assessed independently, including following.

Mobility

Communities are impacted in large part by how well people are able to travel to work, groceries, entertainment, home, family, etc. Increasing access to the extent possible to allow residents, goods, and materials to flow more freely generally benefits a community. An interstate interchange would reduce travel times for residents who travel to/from the middle of the study area, to/from Oxford and points north or to/from Butner and points south.

The Sanders Road interchange would impact Granville Central High School by increasing traffic by the school. The school however is supportive of a new interchange at this location for increased mobility. Sixty-two full time employees and 8 part time employees commute to the school, and of the current number of students 30 percent do not ride the bus. There is a large cluster of students residences in the Butner area with others scattered throughout the district.

Land use

Land use policies impact communities in direct and profound ways, and define the character of an area. Land uses at interchanges, particularly in rural areas, are predominantly service based and cater to highway traveler needs as well as the local towns. This is evident particularly at I-85 Exit 191. The land use at Exit 202 is rural in character, with low density and limited services. One of the aims of providing a new interchange is to spur economic development in the study area. The future provision of water and sewer services along Brogden Road would make this interchange location more attractive for development and the land use policy changes necessary to change the area from low density to another use of higher density should be considered carefully.

Medical/emergency management response

One of the reasons a new interchange is being studied is because of a local desire to allow emergency personnel better access to the interstate in case of an incident. Currently there are no access points along the 11 mile stretch between Exits 191 and 202. Ideally an interchange in the middle of the segment would provide the best access. This would make the Smith Road location the most attractive for EMS responders. However, the majority of crashes on I-85 occur between Sanders Road and Exit 191, pointing toward potential emergency response benefits in having an interchange further south. In addition, the Stem Fire Department would have more direct access with a Brogden interchange.

Due to generally better access to I-85, any of the scenarios would shorten response times for certain stretches of the Interstate particularly for the Stem Fire Department because it is located in the middle of the inaccessible stretch of the interstate. For example, response times could reasonably be reduced by as much as half, from around eight minutes to four minutes, if responding to an incident between Brogden and Sanders and an interchange at Brogden were in place. The Providence and Butner Departments would realize fewer benefits since they have relatively close interstate access.

Bicycle/Pedestrian

The area of study is an interstate corridor and not conducive to bicycle or pedestrian travel, and therefore these modes are not the focus of this study. However, design of bicycle and pedestrian facilities at interchanges and intersections within the area as part of the Interchange Justification Criteria should be considered. Both NC 56 and US 15 have been identified in regional plans as potential future bicycle routes and, in the case of NC 56, a planned multi-use corridor (bicycle and pedestrian). Therefore, consideration should be given to providing sidewalks, bicycle lanes, wide shoulders, or a combination of each in addition to pedestrian signals and crosswalks.

In general, pedestrian signals improve multi-modal access and safety, and can be considered an upgrade to intersection operation. Capacity is relatively unaffected. MUTCD guidelines state the following with regards to pedestrian signals:

According to MUTCD Section 4E.03 Application of Pedestrian Signal Heads Standard, pedestrian signal heads shall be used in conjunction with vehicular traffic control signals under any of the following conditions:

- If a traffic control signal is justified by an engineering study and meets either Warrant 4, Pedestrian or Volume or Warrant 5, School Crossing;
- If an exclusive signal phase is provided or made available for pedestrian movements in one or more directions, with all conflicting vehicular movements being stopped;
- At an established school crossing at any signalized location; or
- Where engineering judgment determines that multi-phase signal indications (as with split-phase timing) would tend to confuse or cause conflicts with pedestrians using a crosswalk guided only by vehicular signal indications.

Economic Development Impacts

All things being equal, economic development is maximized when it is targeted in areas where raw materials, work force, housing, utilities and efficient transportation are available. Therefore, economic development closer to population centers and roadway access would yield greater results than in rural undeveloped areas.

In this study area the population is primarily clustered at the southern end in Butner, Creedmoor, and Stem, with a rural mid-section and Oxford to the north. From an economic development perspective the placement of an interchange closer to the south would yield the most benefit. Water and sewer extensions are planned along Brogden Road and the interchange alternative is on a direct connection between Creedmoor and Stem. From an economic perspective, a new interchange would be best suited in this location over Sanders or Smith Roads.

New and infill development planning and economic efforts should be conducted in accordance with good land use planning practices, meaning land near existing interchanges should be utilized to the fullest potential to maximize transportation efficiency and minimize adverse impacts.