Transportation Feasibility and Impact Assessment for the Town of Knightdale

Intersection of Smithfield Road and First Avenue

Final Technical Memorandum

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Introduction

Smithfield Road is a major north-south connector between US 64 and the 64 bypass, connecting to these major highways at points where congestion is high and increasing (V/C ratios were listed as above 1.2 during peak hour for both US 64 and 64 bypass in the 2035 LRTP), while First Avenue connects some of Knightdale's older commercial and residential areas before connecting to US 64 a half-mile east of Smithfield Road The Carolina Coastal Railway runs 200 feet south of First Avenue, paralleling it briefly before turning, continuing on its east-west route.

The Town of Knightdale was approached by NCDOT Rail Division with a plan to close the Fayetteville Street rail crossing to the east of the study intersection, which would also close the First Ave / Fayetteville Street intersection. This is likely to increase congestion at the study intersection, which has already been slated for long-term vehicular and bicycle/pedestrian improvements.

Purpose and Need

The purpose of this analysis is to identify potential multi-modal operational and capital improvements to the intersection of Smithfield Road First Avenue necessary to provide a vehicular level of service (in both the near-term and mid-term) that satisfies increased volumes as a result of the Fayetteville Street rail crossing closure, in addition to a high-quality travel environment for bicyclists and pedestrians, while minimizing costs and local impacts.

Approach

The framework for this evaluation includes the following steps: Existing Conditions Analysis, Transportation Improvements, and Recommendations. The approach:

- Focuses on the needs of Knightdale and CAMPO's vision as identified in a scoping meeting held on May 9, 2011
- Involves taking an "integrated planning" approach such that land use, transportation, and environmental relationships are understood at a broad level
- Develops solutions focused on efficiency and congestion mitigation
- Considers strategic capacity enhancements, but also operational and demand management strategies as warranted
- Identifies affordable solutions that can be implemented in the near future to address safety and congestion and promote the long-term benefit of the community
- Identifies an implementation strategy

Existing Conditions

Existing Vehicular Context

The intersection of Smithfield Road and First Avenue is a nexus of Knightdale's transportation system. Smithfield Road is one of the few roads that connect US 64 and US 64 Bypass, while First Avenue connects the traditional downtown of Knightdale to more recent residential development. There are currently three significant local destinations in close proximity to the study intersection; to the north, Harper Park, a neighborhood park slated for major renovation and upgrade in the next few years; to the south, Knightdale Elementary School. A third, more significant destination, the future Old Town Park and Community Center, is planned for a 68 acre site on First Avenue north of 4th Street.

Smithfield Road is paralleled by Fayetteville Street, which currently connects to First Avenue and provides an alternate route to downtown and to Knightdale Elementary. The grade crossing closure would require this traffic use Smithfield.

The intersection currently has some operational issues, most notably a northbound right turn radius that

Aerial view of study area and surroundings

is difficult for school buses to traverse. The radius is made tighter by the location of the westbound stop bar on First Avenue, which is very close to Smithfield Road. This turn is common for school buses, and will become more common with the closing of the Fayetteville Street crossing.

Existing Pedestrian Context

There is no existing bicycle or pedestrian infrastructure at the study intersection. Sidewalks are sporadic, and bike lanes or wide shoulders are non-existent, even between Knightdale Elementary and Harper Park. This does not mean that there is no bicycle or pedestrian activity. Mule paths, makeshift paths made by recurring foot traffic, can be found within the vicinity of the study intersection. The future Old Town Park and planned Harper Park improvements suggest that pedestrian activity is likely to increase significantly in the coming years.

Intersection has no sidewalks, crosswalks, or bike lanes

Mule path along N. Smithfield Road

Review of Existing Plans

CAMPO and Knightdale have released several planning documents relevant to the study area. Listed below are some of the key recommendations from these documents.

Knightdale 2027 Comprehensive Plan – Parks and Recreation

- Land for a future central community park was purchased in 2010 off of First Avenue, within walking distance of the Smithfield intersection. The Implementation Plan recommends completing Phase 1 of this park within 5 years.
- Harper Park, at 209 Main Street, is planned to undergo a series of improvements, including walking trails and an amphitheater.
- The study intersection is part of a larger area designated as a future community center.

Knightdale 2027 Comprehensive Plan – Transportation

- The study area is entirely within the proposed Short-Term Transit Service Area. This Service Area includes Harper Park, the future central community park, and Knightdale Elementary School.

- Harper Park and Knightdale Elementary School are both listed as Points of Interest in the Short-Term Transit Service Area.
- The Bicycle & Pedestrian Plan recommends wide sidewalks, bicycle routes, and a multi-use path within the study's area of interest.
- Bethlehem Rd/First Ave is designated as an avenue with 74-foot right of way. Smithfield Rd is designated as a main street with 64-foot right of way.

Knightdale 2008 Unified Development Ordinance

- Planting areas between sidewalks and street should be 42 inches in width.

Knightdale First Avenue Road Improvements Project

- This multi-phase project is in the process of adding new sidewalk infrastructure on First Avenue, starting from downtown and eventually connecting to Smithfield Road. Phase 2 of this project, which includes the study area, is only in the planning stages as of July 2011.

CAMPO LRTP

- Smithfield Rd on both sides of First Ave is proposed to be expanded into a four-lane road by 2025.
- Smithfield Rd is designated as a significant on-road bicycle/pedestrian facility.
- First Ave from Smithfield to Grasshopper Road (where First Avenue becomes Bethlehem Road) is recommended for bicycle/pedestrian improvements with an expected cost of $1.7 million.
- Increasing local bus service on both Smithfield and First is listed as a year 2025 recommendation.

CAMPO MTIP

- The Mingo Creek Greenway, which would cross Smithfield Road north of First and connect to the central community park, is scheduled for a feasibility study.

Other documents reviewed, including the CAMPO ITS Deployment Plan Update and the Triangle Regional Transit Program, did not include notable recommendations or planned improvements to the study area or vicinity.

Traffic Analysis

Existing Conditions

Smithfield Road is a two-lane roadway that runs in a north-south direction through the Town of Knightdale. The posted speed limit is 35 mph and lane widths are approximately 10 feet. First Avenue is a two-lane roadway that generally runs north to south from Sills Drive to US 64 (Knightdale Boulevard). First Avenue becomes Bethlehem Road south of the project area where it crosses the Carolina Coastal Railroad (CLNA). The posted speed limit is 25 mph and lane widths are approximately 10 feet. First Avenue is oriented east-west at its intersection with Smithfield Road.

The intersection of Smithfield Road and First Avenue is a two-phased actuated signalized intersection that is not coordinated with other signals. This location does not have railroad pre-emption associated with it, despite Smithfield Road crossing the CLNA at Crossing #465682W at Milepost S22098, approximately 200 feet south of the study intersection. Bethlehem Road crosses the CLNA at Crossing #465683D at Milepost S22110, approximately 1,270 feet west of its intersection with Smithfield Road.

Data Collection

Data for this operational analysis was obtained from the Town of Knightdale and field collection. Turning movement counts were conducted at the intersection on June 20, 2011 from 4:00 PM to 6:00 PM and on June 21, 2011 from 7:00 AM to 9:00 AM. The peak hours were determined to be 7:15 AM in the morning peak and 5:00 PM in the afternoon. The peak-hour turning movement counts are presented in the appendix. These counts were conducted while school was not in session and thus were merely used to verify the turning movement counts that were conducted by STV in 2010 as part of the Fayetteville Street at-grade rail crossing closure study solicited by the North Carolina Department of Transportation (NCDOT).

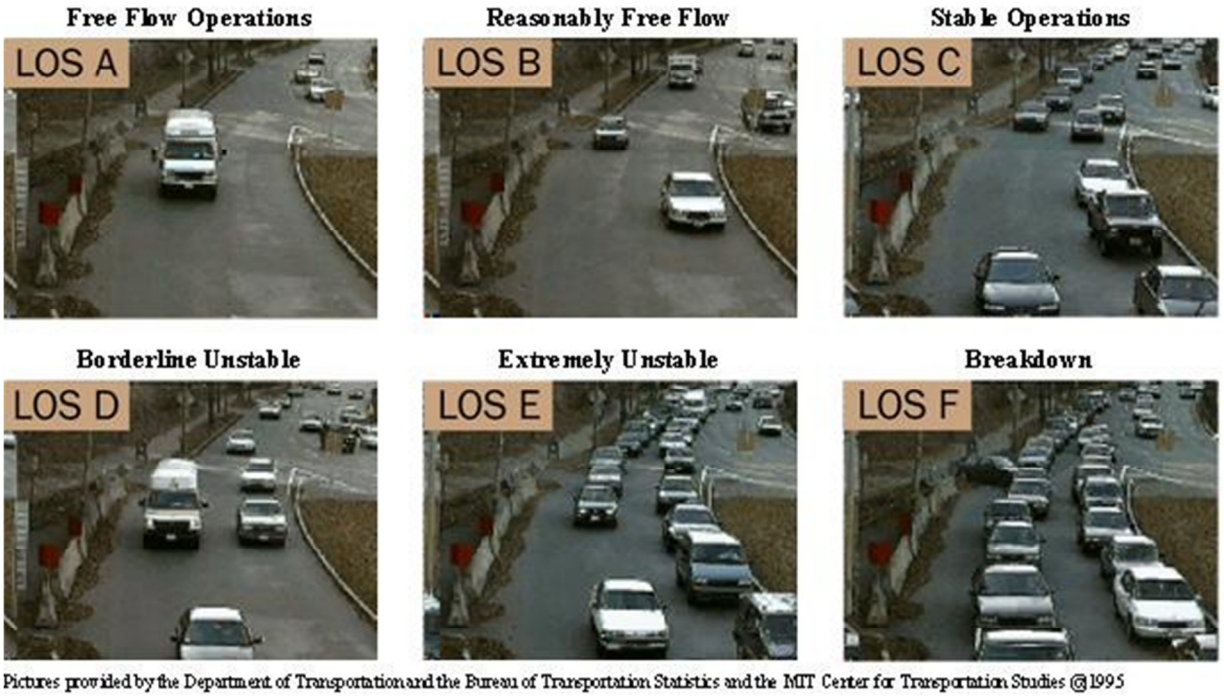
Analyses were performed for existing 2011 conditions and an assumed mid-term future year in 2016. Analyses were also performed using the STV traffic counts as 2011 data as well as assuming that the Fayetteville Street crossing was closed in the year 2016.

Intersection traffic operations were modeled and analyzed in accordance with the Transportation Research Board's Highway Capacity Manual[1] (HCM). Level-of–Service (LOS) is defined as a "qualitative measure describing operation conditions within a traffic stream, based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience." The LOS for intersections is measured in seconds of delay. The HCM also defines six levels-of-service for intersections with LOS A representing the best operating condition and LOS F the worst. The tables below give the criteria for LOS at signalized and two-way stop-controlled (TWSC) intersections.

[1] National Research Council. Transportation Research Board. Highway Capacity Manual, Special Report 209. 4th Edition, Washington, DC. 2000.

LOS Criteria for Signalized Intersections	
LOS	Control Delay Per Vehicle (sec)
A	≤ 10
B	> 10 - 20
C	> 20 - 35
D	> 35 - 55
E	> 55 - 80
F	>80

LOS Criteria for TWSC Intersections	
LOS	Control Delay Per Vehicle (sec)
A	0 - 10
B	>10 - 15
C	>15 - 25
D	>25 - 35
E	>35 - 50
F	>50



Pictures provided by the Department of Transportation and the Bureau of Transportation Statistics and the MIT Center for Transportation Studies @1995

A model of the study area was developed in Synchro 7.0. Field data was entered into the model, including speed limits, lane geometry, and signal phasing. The signal phasing was obtained from the signal upgrade plan dated January, 2010 from the NCDOT. Existing operational conditions were further imputed into the model including the allowance of Right-Turns on Red (RTOR). The intersection worksheet reports are provided in the appendix.

The results of the capacity analysis for the 2011 existing conditions, presented below, indicate that the intersections in the study area operate within acceptable levels-of-service of C or better for both the morning and afternoon peak-hours. However, the southbound movement shows a volume to capacity ratio (v/c) of 0.93 for the afternoon peak period indicating that this lane is approaching its traffic carrying limit at this time. A v/c ratio over 0.80 indicates that the associated movement or intersection is nearing its available capacity.

2011 Existing Traffic														
Level-of-Service, Capacity, and Delay Summary														
	MOE	Overall	Northbound			Southbound			Eastbound			Westbound		
			L	T	R	L	T	R	L	T	R	L	T	R
AM Peak Hour														
Smithfield Rd & First Avenue	***LOS***	A	B			B			A			A		
	Capacity (v/c)	0.58	0.53			0.45			0.61			0.29		
	Delay	10.0	11.4			10.8			9.9			7.1		
PM Peak Hour														
Smithfield Rd & First Avenue	***LOS***	C	B			C			C			B		
	Capacity (v/c)	0.86	0.46			0.93			0.78			0.36		
	Delay	23.8	11.8			33.1			23.3			12.9		

Estimated Future Conditions

Traffic volumes for the future conditions were developed by increasing the 2011 existing volumes by annual growth rates of 2% and 5% until 2016. The 2% per year growth rate could be assumed to encompass conservative growth in the area, while 5% growth is assumed to encompass aggressive growth from nearby development, including the proposed Old Town Park and Community Center.

The results of the capacity analysis for the 2016 scenario, shown as the "No-Build" scenario, indicate that the intersection will function well during the morning peak hour. The 2% per year growth rate scenario in the afternoon peak hour, however, shows the southbound movement failing with a LOS of E. The intersection as a whole and the eastbound movement are also shown to be nearing capacity during the afternoon peak hour. Under the 5% per year growth rate scenario the intersection and the southbound movement fail with a LOS of F during the afternoon peak hour, with the eastbound movement nearing capacity.

The intersection was also analyzed assuming that the Fayetteville Street at-grade rail crossing was closed by the future date. The traffic volumes were obtained from the traffic counts and analysis performed by STV. The results of the analysis indicate that in addition to the intersection failures noted in the no-build scenario, the northbound approach of Smithfield Road also would approach capacity.

To mitigate the issues at the intersection—assuming that the Fayetteville Street at-grade rail crossing was closed by the future date—a slate of improvements was developed. The first analyzed mitigation was a southbound right-turn lane with a minimum of 150 feet of storage and a 100 foot taper. The results of the analysis show that this will improve operations under the 2% per year growth rate scenario to acceptable levels-of-service and well under capacity. Under the 5% per year growth rate scenario the intersection operates within acceptable levels-of-service; however, the intersection, eastbound, and northbound movements are nearing capacity.

To further improve the intersection, an eastbound left-turn lane was analyzed. As the intersection would need to be widened to accommodate the eastbound left-turn lane, an area for a westbound left-turn lane is naturally developed. These improvements will aid traffic that would normally turn south onto Fayetteville Street from westbound First Avenue, but is required to turn left at Smithfield Road with the closing of the at-grade crossing. This also removes traffic from the through stream, thereby increasing capacity. As indicated by the analysis, this configuration allows the intersection to operate with a LOS of B or better and all movements operate below capacity.

2016 Traffic – 4 Turn Lanes														
Level-of-Service, Capacity, and Delay Summary														
	MOE	Overall	Northbound			Southbound			Eastbound			Westbound		
			L	T	R	L	T	R	L	T	R	L	T	R
AM Peak Hour														
Smithfield Rd & First Avenue	***LOS***	A		B	A		A	A	A	A		A	A	
	Capacity (v/c)	0.55		0.57	0.04		0.29	0.12	0.53	0.28		0.23	0.25	
	Delay	8.9		11.0	8.3		9.1	8.5	9.3	7.5		7.6	7.6	
PM Peak Hour														
Smithfield Rd & First Avenue	***LOS***	B		B	A		B	B	B	A		B	A	
	Capacity (v/c)	0.70		0.63	0.06		0.75	0.25	0.66	0.24		0.32	0.22	
	Delay	13.2		13.9	9.6		17.1	10.4	15.3	9.6		10.4	9.7	

With the closing of the Fayetteville Street at-grade rail crossing the northbound right-turn movement is also affected. Although the analysis does not indicate the need for improvements to the maneuver; the potential operational conditions may lend itself to this need. Traffic that was once traveling northbound on Fayetteville Street and turning right onto First Avenue now must do so on Smithfield Road. This is also a major route for the school busses traveling north from the elementary school and could use a larger turning radius to prevent encroachment into oncoming traffic. As expected this scenario operates with a LOS of B or better and all movements below capacity.

Level of service tables for all discussed scenarios are provided in the Appendix.

Train Operations, Crossing, and Accident History

Currently there are approximately 4 trains per day, as reported by the Federal Railroad Administration (FRA), using the line in this area. (Officials at the Town reported that this may be high, and as few as 1-2 trains per week may be using the line.) The rail line is operated by the Carolina Coastal Railway (CLNA). Speed of the trains range from 10 to 49 mph.

The Smithfield Road crossing has active warning devices installed including 2 quadrant gates with flashing lights and audible devices.

The signalized intersection of Smithfield Road and First Avenue does not currently have any railroad preemption associated with it. Traffic signal preemption is a method for altering the normal pattern of a signal to a special condition giving priority to a particular movement; generally for transit, emergency vehicles, or railroads. Railroad preemption occurs when a train approaches a highway crossing near a signalized intersection. An electrical connection exists between the tracks and the traffic signal control cabinet. When the train arrives at the point where the connection is, the traffic signal stops all movements except those that need to clear the tracks before the train arrives. Once the time elapses to clear the tracks the gates are lowered and all vehicular movements at the intersection are allowed to proceed, except those that would remain on the rail line. These movements are prohibited by the signal phasing and/or special illuminated signs, blank-out signs, which turn on during the preemption. Once the train has passed the traffic signal returns to normal operation.

There have been no reported rail-vehicle accidents at the Smithfield Road crossing as indicated by the FRA.

Traffic accident reports were provided by the Knightdale Police department for a total of three years, as the policy of the police department is to keep detailed accident reports for only this period. The reports indicate that there were a total of 14 accidents at this intersection. Of those accidents seven were rear-end collisions with four of those on the northern leg of the intersection heading southbound. There were also six angled collisions, four of which are the result of turning vehicles. Additionally, one side-swipe accident took place as a result of a northbound right turning vehicle making a wide turn into a westbound vehicle. The accidents appear to be the result of driver error.

To improve the southbound rear-end accidents, advanced warning signs for the signalized intersection could be installed as this type of accident is generally exhibited from drivers not anticipating the potential for stopped vehicles or speeds in excess of those posted.

The angled collisions can be a result of aggressive driving by vehicles attempting to turn with less of a gap then they believed was adequate or simply driver inattention. This can be improved as turn lanes are developed and movements more controlled.

Queuing

The queuing of vehicles was analyzed using the both Synchro and SimTraffic. Minimum turn lane lengths and tapers were developed in looking at the intersection constraints and the calculated values. A detailed table showing all the turn lanes, queuing lengths is provided in the appendix.

The table below shows the recommended turn lane storage lengths and associated tapers. In most cases the turn lanes are constrained by the physical environment. The eastbound left-turn lane movement is constrained by the grocery store to the west of the intersection, the westbound movement is constrained by 2nd Street, and the northbound movement is constrained by the railroad tracks. The storage length need will decrease as additional improvements are made and the intersection increases efficiency.

Turn Lane Storage Length		
Direction	**Storage Length (feet)**	**Taper Length (feet)**
Southbound Right	150	100
Eastbound Left	150	100
Westbound Left	75	100
Northbound Right	100	100

Summary of Existing Conditions and Traffic Analysis

The existing conditions analysis and traffic analysis yielded a series of findings related to vehicular and non-vehicular travel. In sum, they point to the demand for both vehicular and pedestrian improvements that help maintain traffic flow while improving the connections between nearby, burgeoning destinations to each other and to the community at-large. Identifying improvement options that can meet this demand is the focus of the next section.

A summary of the existing conditions and traffic analysis is provided in the figures on the following pages.

VEHICULAR CONTEXT

Smithfield is designated as a main street with 64-foot ROW. Bethlehem/First is designated an avenue with 74-foot ROW.

Knightdale Elementary School is currently the only significant generator, but Harper Park improvements and Old Town construction will add traffic.

Fayetteville Street currently provides an alternative into downtown, as well as additional access to Knightdale Elementary, though volumes are low.

S Smithfield Rd has existing queues that occassionally back up to the railroad tracks.

Intersection of Bethlehem Rd and Railroad St has limited accessibility - Railroad St is one way, and left turns are prohibited from Bethlehem onto Railroad.

Fayetteville Street closing in conjunction with Railroad Street alignment forces all traffic through Smithfield and Bethlehem/ First intersection.

Turning radius at S Smithfield and First Ave is inadequate for school buses, and the Fayetteville St closing will increase bus activity at this turn.

Heavy volumes are forecast for SB right turns and EB left turns. NB right turns and WB left turns are forecast to have moderate volumes. (2016 build condition, 5% growth rate.)

BICYCLE & PEDESTRIAN CONTEXT

Primary pedestrian destinations are Knightdale Elementary School, Harper Park, and the future Old Town Park and Community Center.

There is no existing contiguous bicycle or pedestrian infrastructure between these destinations.

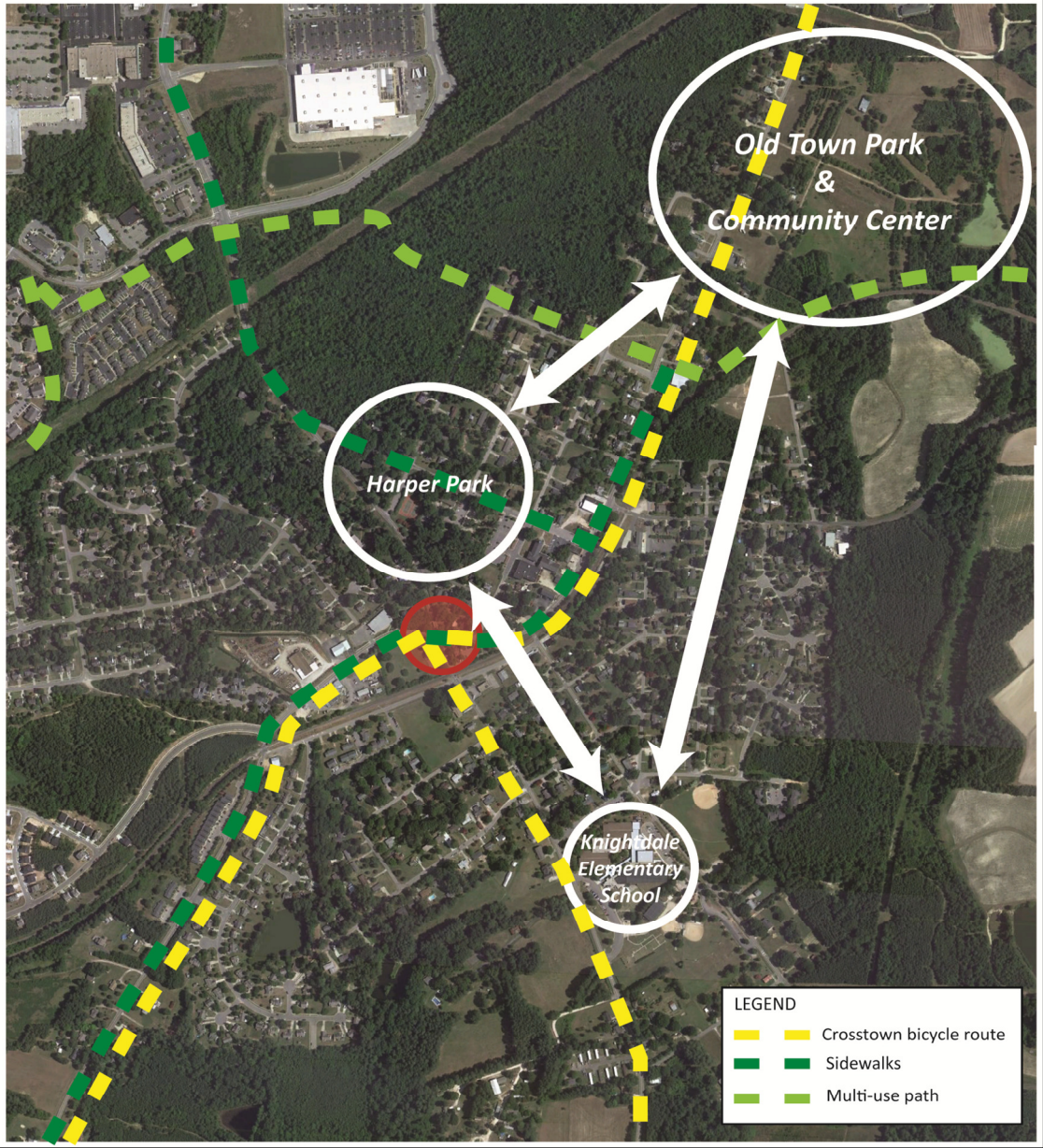
Existing bike/ped volumes are very low at the intersection. This is likely due to a combination of low demand and existing available alternative routes. This may change with the closing of Fayetteville St, improvements to Harper Park, and the construction of Old Town Park.

Knightdale Bike/Ped Plan recommends wide sidewalks (green), cross-town bicycle routes (yellow) and multi-use paths (light green) throughout the area.

The Knightdale Unified Development Ordinance recommends 42"planters between sidewalk and edge of pavement.

The First Avenue Road Improvements Project will eventually provide sidewalks on First Ave beteween downtown and Smithfield Rd

Using CAMPO Bicycle Facilty Planning and Engineering Guidelines, roads with bike lanes or wide paved shoulders should have 16' minimum travel lanes. For multi-use paths, a 5' separation should be provided between path and edge of pavement.



Improvement Options

The existing conditions analysis suggests that the intersection warrants a mix of improvements that address vehicular infrastructure, bicycle/pedestrian infrastructure, and intersection operation. Fourteen possible improvements have been identified. The following elements of the improvements were analyzed:

- Cost —Detailed or order of magnitude costs of each alternative were estimated.
- Compatibility with other alternatives—The degree to which the proposed element is compatible with other proposed elements, with the assumption that multiple elements are needed to meet the various study goals.
- Implementation Timeline—How long it would take to implement the element, listed as short, medium or long term.
- Degree of Impact – Four categories of impact are analyzed:
    - Capacity – The degree to which vehicular capacity is impacted positively or negatively.
    - Operations - The degree to which traffic operations at and around the intersection is impacted positively or negatively.
    - Safety – The degree to which either freight/vehicle interactions or pedestrian/vehicle are impacted at the rail crossing and intersection, respectively.
    - Multimodalism — The degree to which multimodal access is impacted, positively or negatively.
- Environmental and Environmental Justice Overview - The degree to which there are any potential environmental quality issues or impacts on land acquisitions/ displacements, historic resources, and aesthetics that arise from implementation of an element.

The analyzed options are discussed below. A summary table of the analysis is provided at the end of this section.

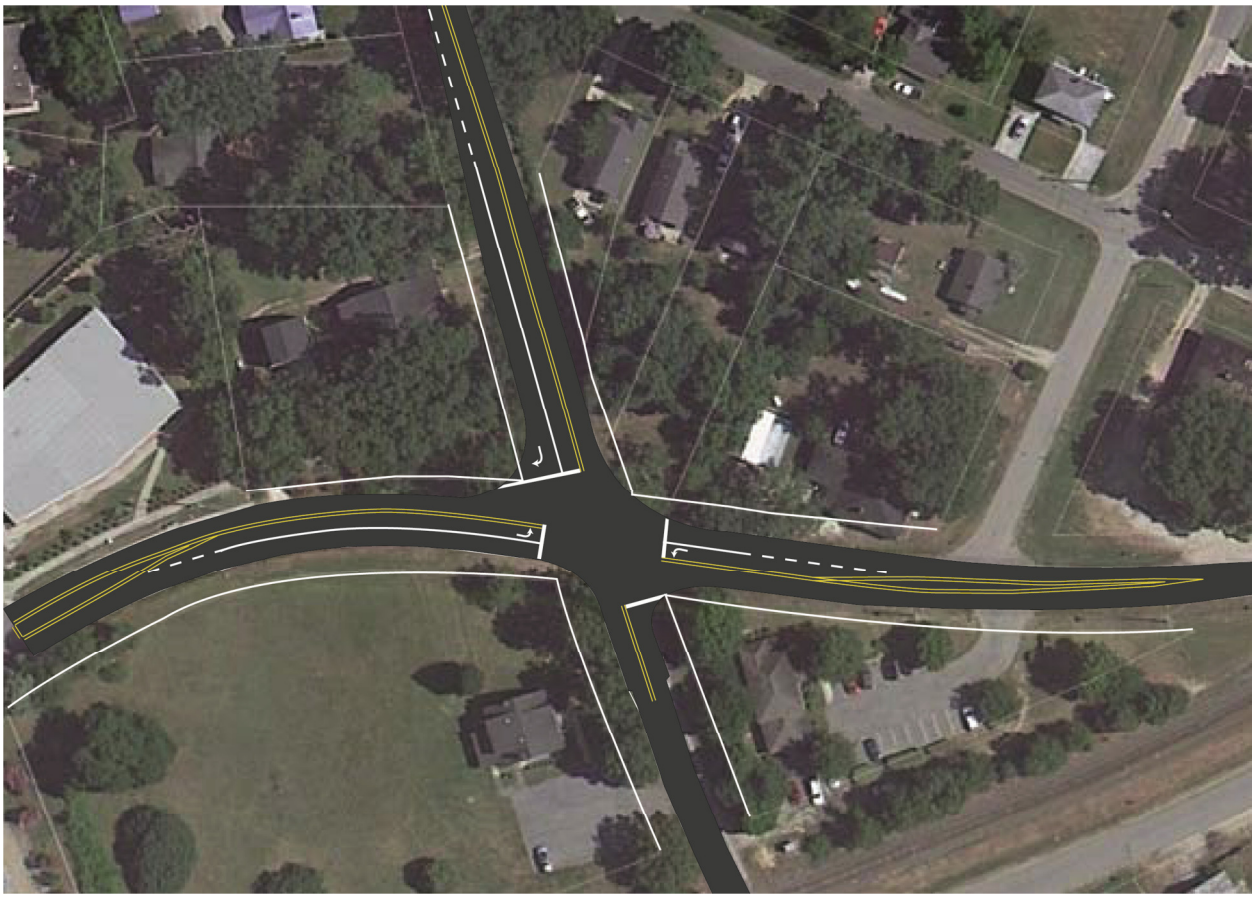
Vehicular Infrastructure

NCDOT Option

This improvement focuses exclusively on improving vehicular flow based on the closing of Fayetteville Street access to First Avenue. Three new turn lanes are proposed: a southbound dedicated right turn lane with 200’ storage and a 150’ taper, an eastbound left turn lane with 200’ storage and a 100’ foot taper, and a westbound left turn lane with 50’ storage and a 100’ taper. A widened turning radius on northbound Smithfield is also proposed. The estimated cost of this proposal is just under $530,000, and it is anticipated that the improvements could be completed in the mid-term. As currently designed, the painted median created by the westbound left turn lane prevents left turns into and out of Second Avenue, but this may be an oversight that can be corrected without impacting the recommended storage or taper.

The alternative provided increased capacity and improved LOS to all three lanes, which is the intended purpose of the alternative. However, it does not address intersection operations or safety issues such as freight/vehicular interactions. Additionally, the designed location of the stop bars prevents the safe locating of crosswalks, limiting even the smallest attempts to improve multi-modal access.

This option is likely to require the acquisition of a small portion of the parcel to the northwest of the intersection.



Plan view of NCDOT Option

Summary

This option does an adequate job of addressing short-term vehicular capacity issues, but does little other good, while potentially limiting bicycle and pedestrian access. Additionally, the design of the westbound left lane on First Avenue should be improved.

Bethlehem Road / Railroad Street intersection re-opened

Within the last few years, as part of the approval process for the Brookfield Station subdivision on Sills Drive, the intersection of Bethlehem Road and Railroad Street was modified to prevent left turns on to or out of Railroad Street. While these improvements were deemed beneficial for circulation on Sills, the changes, which include barriers on Bethlehem Road, and westbound-only movement on Railroad Street

between Bethlehem Road and Heathwick Drive, limit connections between Bethlehem and Smithfield Roads, forcing additional traffic to the First Ave/Smithfield Rd intersection. The proposed option would be to re-open the Bethlehem Road/Railroad Street intersection to left turn movements.

This option provides a slight capacity improvement, as vehicles would have the option of avoiding a left turn on Smithfield Road at Bethlehem Road, thus potentially reducing traffic volume. Additionally, the option could improve safety by eliminating the need for cars to cross the rail line on both Smithfield and Bethlehem Roads, reducing freight/vehicular interactions. This is particularly beneficial in the long term, as commuter rail is being discussed as a future possibility. However, Railroad Street between Smithfield Road and Bethlehem Road is residential, and measures that increase traffic volumes may be opposed by current residents.

This option has no impacts, positive or negative, on operations or multi-modalism. Assumed implementation costs include the removal of existing barriers on Bethlehem Road, and restriping Railroad Street for two-way traffic. The cost is estimated to be $30,000 - $50,000.

Summary

The benefits of this option are the minimized interaction between vehicles and freight (or commuter) trains, at a fairly modest financial cost. However, routing traffic on a residential street is not ideal, and the changes would remove recent NCDOT-approved infrastructure improvements. Additionally, the volume of relevant turning movements – left turns on northbound S Smithfield Road, and right turns on eastbound First Avenue – are not high, limiting the efficacy of this improvement. Overall, this should be considered a long-term improvement contingent upon increased traffic or rail volumes and the inclusion of impacted residents in the decision process.

Closing Railroad Street between Fayetteville Street and Smithfield Road

This option attempts to improve capacity and minimize vehicle/freight interactions by limiting traffic in the immediate vicinity of Smithfield Road and the rail crossing. Restricting turning movements adjacent to the railroad tracks can potentially improve traffic flow at the railroad crossing. Railroad Street is less than 25’ from the rail line, and traffic that backs up at this intersection can be a cause of both congestion and confusion as drivers on Smithfield try to accommodate vehicles on Railroad Street. School buses, which as a rule stop at the rail crossing, serve to increase potential confusion and accident possibilities at the location. Closing Railroad Street between Fayetteville Road and Smithfield Road will eliminate these potential concerns.

This option, while potentially having small positive impacts on capacity and vehicle/freight interaction, has potential economic and environmental justice impacts, as this block of Railroad Street is home to several stores that serve a primarily minority neighborhood. With the closing of the Fayetteville Street crossing, these businesses will only be accessible via Fayetteville Street, which has much smaller traffic volumes than Smithfield Road. Additionally, there are no positive operational or multi-modal impacts.

Summary

This option is unlikely to be very successful in improving conditions at the study’s primary intersection, while potentially having significant negative impacts. This option should only be pursued if clear

evidence emerges that the Fayetteville Street crossing closure significantly degrades traffic and safety conditions on northbound Smithfield Road

Roundabout

The use of a roundabout was considered as a possible option at the study intersection. Roundabouts are designed to slow traffic and thus reduce accident rates for both vehicles and pedestrians. They are in place throughout North Carolina, with over a dozen in Wake County, as they are seen as a publicly acceptable alternative to traditional signalized intersections. A typical single-lane roundabout is about 120 feet across.

A roundabout would have positive impacts on capacity and operations, as traffic would be free flowing and no signalization would be required. Additionally, multi-modal access and safety would be increased, as pedestrians are easily accommodated by roundabouts. However, the proximity to the rail line is a concern. There are limited options for preventing vehicles from entering S. Smithfield Road when the crossing is closed, which raises safety and congestion risks. Additionally, right-of-way acquisition would be needed on four properties, making this the most invasive –and one of the more expensive - vehicular improvement evaluated. Of note, this option was considered by NCDOT Rail Division when they first proposed closing the Fayetteville Street, but it was discarded due to the amount of right-of-way acquisition needed.

Summary

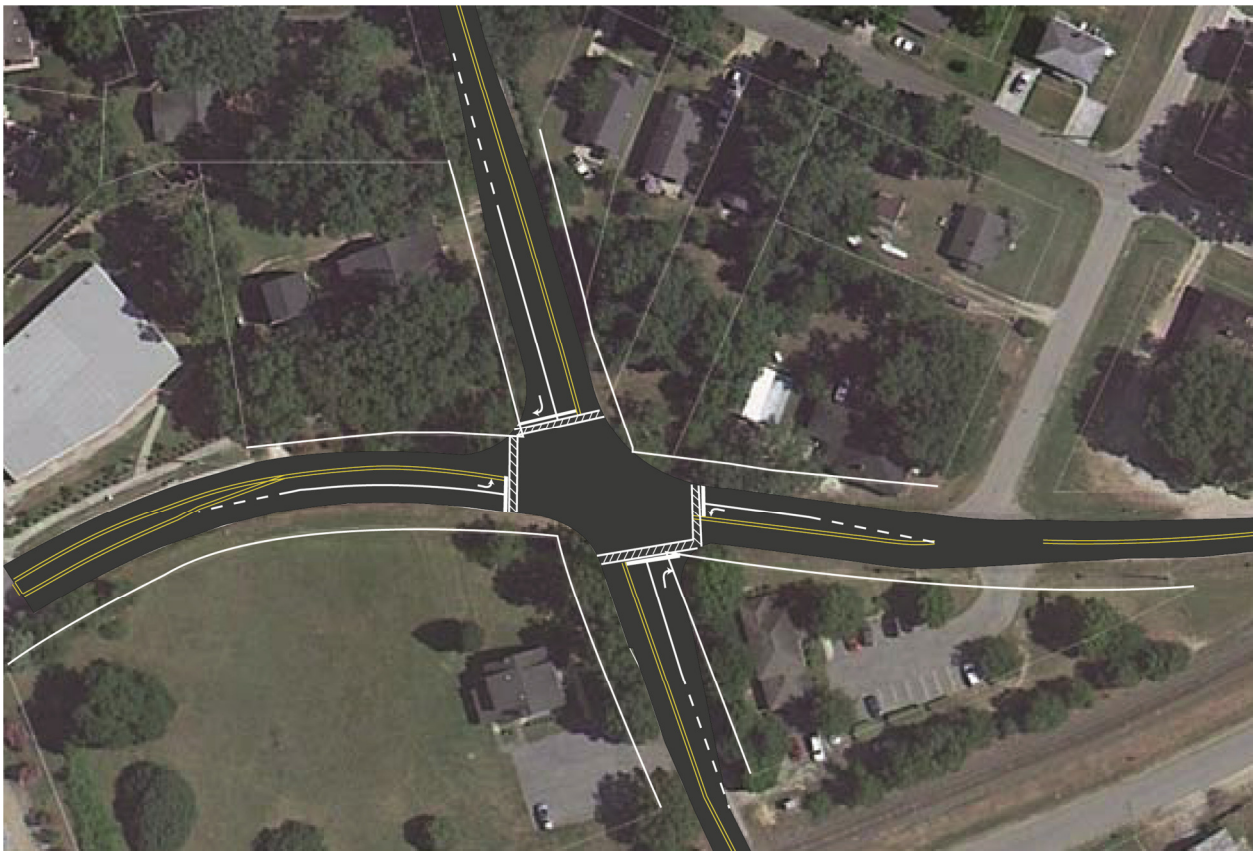
Roundabouts have several advantages, and would likely be a highly desirable option were the intersection not so close to the rail crossing. However, safety and property acquisition issues make this a less attractive option than others proposed.

Vehicular Growth Scenario

This option is based on the findings of the 2016 build conditions using a 5% growth factor. Like the DOT option, this improvement focuses on improving vehicular flow through the Smithfield Road / First Avenue intersection. As traffic continues to grow, southbound Smithfield Road will fail and be over capacity. Similar to the DOT option, a southbound right-turn lane is proposed with a minimum 150 feet of storage and a 100 foot turn bay taper. This will mitigate a significant amount of southbound queuing traffic as this can be considered the dominant turning movement at the intersection. Eastbound and westbound left-turn lanes should be constructed with 150 feet and 75 feet of storage, respectively, each with a 100 foot turn bay taper. The eastbound left is a dominant movement paired with the southbound right. This movement will operate at an acceptable LOS. However, it will approach capacity and will develop long queues of traffic. As First Avenue will need to be widened, a westbound left-turn lane is naturally developed. The westbound left turn volumes will also increase as the Fayetteville Street at-grade rail crossing is closed and traffic is diverted westward. A northbound right-turn lane with 150 feet of storage and a 100 foot turn bay taper is also recommended for school bus traffic and the potential increase in traffic from the Fayetteville Street at-grade rail crossing closure. A larger turning radius is also recommended to accommodate the school buses. Unlike the configuration proposed by DOT, this option does not prevent left turns between First and Second Avenues by simply modifying the striping.

This option significantly improves capacity, and provides acceptable levels of service into the near future. On its own, it is not designed to provide operational improvements, but this option is best paired with signal timing improvements discussed later in this section. The improvements on S. Smithfield provide potential safety improvements by reducing northbound queues, and thus vehicle/freight interactions. However, there are no multimodal improvements as part of this option.

Additional right-of-way acquisition is very likely, particularly on the southeast corner of the intersection, due primarily to the new right-turn lane. The need for right-of-way acquisition even before consideration of pedestrian improvements suggests that this option will not be compatible with many pedestrian options. This includes crosswalks, which do not fit with the stop bar alignments.



Plan view of Vehicular Growth Scenario

Summary

This option ensures adequate vehicular flow through for the next five years, and it can be completed in the same amount of time as the DOT option. However, these improvements are done at the cost of increased right-of-way acquisition and limiting bicycle and pedestrian options on the east side of Smithfield Road - where these accommodations are likely to be best located.

Modified Growth Scenario

This option is similar to the Growth Scenario described above, with two notable exceptions: no northbound right turn lane is provided, and the stop bars are moved back a minimum of 15’ (up to 25’) from the intersection to allow for compatibility with crosswalks. The moving of the stop bars requires

shorter storage or tapers on both sides of First Avenue, as a driveway curb cut west of the intersection and the entrance onto Second Avenue at First Avenue are barriers to moving the origin of the turn lanes. The southbound right-turn lane could remain at 150' storage and 100' taper if needed, though LOS and V/C ratios are not impacted by the reduction of storage/taper space.

This option provides the same multi-year improvements to vehicular flow as the Growth Scenario on First and N Smithfield, while reducing the amount of right-of-way acquisition and also allows for the potential of improved multi-modal access and safety. The possibility of vehicle/freight interaction on S. Smithfield is not reduced, however, and northbound level of service, while still adequate, is not improved to the degree provided by the Growth Scenario. Conversely, by moving the westbound stop bar back, buses effectively have a wider turning radius available to them, improving the efficiency of northbound movements.

Plan view of Modified Growth Scenario

Summary

This option provides an opportunity for multi-modal improvements, and as such has a clear benefit above and beyond other vehicular improvement options, while the negatives that exist can all be mitigated.

Grade Separation

Whether designed as rail over road or road over rail, grade separation is a costly improvement. NCDOT's Traffic Separation Study process helps determine the appropriate crossing improvement, and is a multi-

step process that involves input from the MPO, the municipality, and the public, and is designed to provide a solution that is specific to the crossing. Some states use an equation called the exposure factor to help determine if separation is warranted. The exposure factor is defined as the product of daily train crossings and AADT. When this number is greater than 100,000, it is suggested that grade separation be explored. The exposure factor of this crossing, given the range of daily crossing from less than one to no higher than four, and an AADT of less than 10,000, is well below the 100,000 threshold.

Summary

The large cost and low number of trains suggest that grade separation is unwarranted, and thus this option was not reviewed further.

Pedestrian Infrastructure

Crosswalks

Crosswalks are a simple and cost-effective way to improve pedestrian access to the study intersection. Crosswalks cost $1.00 per linear foot, per the 2010 NCDOT bid averages, and they provide a clear, recognizable path for pedestrians. Crosswalks, if implemented, should be used on all four intersection crossings.

Summary

Crosswalks would improve multi-modal access, as well as multi-modal safety. Given this intersection's close proximity to Knightdale Elementary School, Harper Park, and the Old Town Park and Community Center and the reasonable unit cost, there is reason to include crosswalks in the recommended design option.

Sidewalks

Sidewalks, like crosswalks, help improve pedestrian safety and multi-modal access, but do little to change capacity or traffic operations. While there are no sidewalks in the study area currently, several planning efforts are aimed at changing this. The Knightdale 2027 Comprehensive Plan recommends sidewalks on at least one side of Bethlehem Road / First Avenue, and the First Avenue Road Improvement Project already underway plans to upgrade sidewalks between the study area and downtown. Additionally, previous effort has been made to secure a Safe Routes to School grant that would help build sidewalks to connect to Knightdale Elementary School, though this route is not shown in the Comprehensive Plan.

This option would include sidewalks on both sides of all four road segments of the study intersection. A northbound leg connecting to Harper Park, while not included in the Knightdale Comprehensive Plan, is included because of the potential benefits of a direct pedestrian connection between the park and the Elementary School.

Sidewalks on both sides of S. Smithfield Road and First Avenue may be incompatible with the more robust vehicular build alternatives like the Vehicular Growth Scenario, as right-of-way acquisition on the

southwest corner may reach several feet around the property, much more than was proposed in the DOT option, though this has not been verified through surveying.

Sidewalks are currently bid at slightly over $20/sq. yard.

Summary

The installation of sidewalks connecting Knightdale Elementary, the two parks, and the proposed Mingo Creek multi-use path would improve multi-modal access in the study area. It is also compatible with town planning goals and existing infrastructure improvement projects. There is a concern about acquiring the necessary right-of-way, particularly if sidewalks are paired with bicycle infrastructure, but this is not likely to impact more than one or two parcels. Alternatives that minimize right-of-way acquisition would be preferable if right-of-way acquisitions are larger than anticipated; however, the improved pedestrian connectivity is recommended as part of a final intersection improvement effort.

Bicycle Lanes / Wide Outside Shoulders

This option considers two of the more common on-road bicycle accommodations. Both are considered appropriate for two-lane, low to moderate speed streets like Smithfield Road and First Avenue. Knightdale's Comprehensive Plan recommends a bike route on all but N. Smithfield Road, connecting Old Town Park to Knightdale Elementary School and destinations south. CAMPO Bicycle Facility Planning and Engineering Guidelines recommend that any bicycle accommodation result in a minimum distance of 16' from street centerline to edge of pavement. This would require six new feet of paved surface for bicycles on both sides of the street along the full bicycle route, as existing lanes are 10' wide. If bicycle lanes are provided along with sidewalks and one of the more robust vehicular options (such as the Growth Scenario), there will be right-of-way acquisition required on the east side of S. Smithfield Road, and acquisition may be needed near the intersection on both sides of First Avenue.

Bicycle accommodation provides improved multi-modal access, but has negligible effects on capacity, intersection operations, and safety. Bicycle lanes can cost as little as $5,000 per mile, though estimates vary widely.

Summary

Bicycle lanes provide multi-modal access, at moderate cost. However, the added street width may cause compatibility issues with other options if right-of-way impacts are larger than anticipated.

Multi-Use Path

Multi-use paths accommodate pedestrians and cyclists on a 10' wide path separated from the road by a five foot planter. The primary benefit of multi-use paths is that they require less impervious surface – you only need a path on one side of the road instead of two. Knightdale is already planning a multi-use path along Mingo Creek, with a connection to the future Old Town Park. The option proposed as part of this study is that a new leg of the path be created that connects Knightdale Elementary School to the planned path at First Avenue near Pine Street, using the east side of S. Smithfield Road and the south side of First Avenue.

This option provides improved multi-modal access, and may have slight intersection safety benefits by separating vehicles and non-motorized travelers. This options is more compatible with vehicular improvements by limiting right-of-way acquisition than traditional bike lanes and sidewalks, but could still integrate with crosswalks, sidewalks, or bike lanes in other parts of the study area.

Summary

A multi-use path is compatible with the Knightdale Comprehensive Plan while still accommodating the increased vehicular capacity associated with the Fayetteville Street closing. However, it would require a larger right-of-way acquisition of the parcel on the southeast corner of the Smithfield Road / First Avenue intersection. It is also likely that there will be a conflict with the existing location of the railway crossbuck and flashers, which sit very close to the edge of pavement on the east side of S. Smithfield Road.

Operational improvements

Signal Timing

Timing options can be paired with any of the vehicular improvements (except roundabouts), but will have the biggest impact on the various growth scenarios. The traffic signal at the study intersection can be phased with permitted lefts on First Ave based on the conducted operational analysis. However, the signal should have a detailed analysis performed to confirm the phasing requirements for the left turn and any additional signal upgrades that may be required.

Timing improvements can improve capacity and intersection operations. Improved traffic flow may also have indirect benefits for freight/vehicle safety. On their own, they have limited multi-modal access impact, but upgraded timing can be combined with pedestrian-specific crossing upgrades discussed below. There are no capital costs associated with signal timing – the signal plan represents the majority of the cost of implementation. However, new signals installed with the introduction of left turn lanes are listed by NCDOT at a cost of $50,000.

Summary

As vehicular capacity needs grow, appropriate signal timing is required. This is a necessary inclusion to the list of recommended improvements.

Signal Preemption and Signage for Rail

As an aid to safety, traffic signal upgrads are recommended to include railroad pre-emption to clear the northbound traffic from the southern leg of the intersection and prevent traffic from traveling southbound while the railroad gates are down. Furthermore a W3-3 “Signal Ahead” warning sign should be installed on the southbound approach to the intersection as the distance prescribed in the MUTCD to aid approaching vehicles. These aides are designed to improve vehicle and freight safety, and are compatible with any signal improvements. Costs are likely to be in the range of $25,000 - $50,000

Summary

The obvious safety improvements provided by preemption make this option a needed part of a final recommendation

Pedestrian Signals

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:

> *Section 4E.03 Application of Pedestrian Signal Heads*
> *Standard:*
> *01 Pedestrian signal heads shall be used in conjunction with vehicular traffic control signals under any of the following conditions:*
> *A. If a traffic control signal is justified by an engineering study and meets either Warrant 4, Pedestrian Volume or Warrant 5, School Crossing (see Chapter 4C);*
> *B. 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;*
> *C. At an established school crossing at any signalized location; or*
> *D. 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.*

The study intersection is not currently an established school crossing, but would likely be eligible with the installation of pedestrian infrastructure. Additionally, the introduction of left turn lanes could warrant the need for pedestrian signals under part D.

Under this option, countdown pedestrian signals would be installed at all four corners. All signals will comply with MUTCD regulation in Section 4E.

Summary

Pedestrian signals should be included as part of a more robust pedestrian environment, which includes crosswalks and sidewalks or multi-use path. Both legs of the intersection are state-maintained roads, thus will need to comply with MUTCD guidelines.

#	Improvement Option	Cost	Compatibility	Implementation Timeline	Impact	Environmental	Summary
VEHICULAR INFRASTRUCTURE							
1	DOT Option	$530,000	Incompatible with crosswalks as currently designed	Mid-Term	Capacity - Positive Operations - None Safety - Positive Multimodal - None		Adds new southbound right turn lane, east-west left turn lanes, wider northbound right turn. Adequate option that addresses vehicular operation, but does not address multi-modalism
2	Vehicular Growth Scenario	$630,000-$730,000	All	Mid-Term	Capacity - High Positive Operations - None Safety - Small Positive Multimodal - Negative	Requires ROW acquisition at SE corner of Smithfield and First	New NB right turn lane on S Smithfield provides additional capacity in NB direction and prevent potential backups to RR crossing.
3	Closing of Fayetteville Street @ Railroad	$500 - $5,000	All	Long term	Capacity - Positive Operations - None Safety - Positive Multimodal - None	5 businesses would lose street traffic	Prevents build-up of traffic at Railroad and Smithfield, which is adjacent to the rail line. Reduces access to several businesses already likely to suffer from the railroad crossing closure
4	Opening of RR Street / Bethlehem Rd intersection	$30,000 - $50,000	All	Long term	Capacity - Positive Operations - Positive Safety - Positive Multimodal - None		This option minimizes interaction with the rail line and could relieve some congestion at the Smithfield/Bethlehem intersection, but implementation cost is high, and would go against the recent DOT improvements at this intersection
5	Limited Growth Scenario	$450,000 - $550,000	All	Mid-Term	Capacity - Positive Operations – None Safety - Positive Multimodal - None	Would require ROW Acquisition	Similar to DOT option but with shorter queuing and storage. This option is a better fit with bicycle and pedestrian infrastructure improvements.
6	Roundabout	High Cost (no estimate provided)	Only compatible with options 8, 9, 11	Long term	Capacity - Positive Operations - Positive Safety - Positive Multimodal - None	Requires ROW acquisition at every corner of Smithfield and First	High-cost alternative, where significant ROW cost and major congestion during construction outweigh potential operational improvements
7	Rail Grade Separation	High Cost (no estimate provided)	All	Long term	Capacity - Small positive Operations None Safety - Small positive Multimodal - None	Would very likely require ROW acquisition	X Factor <100,000, so grade separation would not normally be recommended. No accidents, limited rail use, very high cost, all contribute to this being a bad option

#	Improvement Option	Cost	Compatibility	Implementation Timeline	Impact	Environmental	Summary
PEDESTRIAN INFRASTRUCTURE							
8	Crosswalks	$1.00/LF* $100 total cost	All	Short Term	Capacity - None Operations - None Safety - Positive Multimodal - Positive		Low-cost, easily implemented addition to intersection improvements that has positive multimodal impacts (particularly as parks and rec plans are put in place) with no negative impact.
9	Sidewalks	$20.60/SYD*	Incompatible with multi-use path. Only one of the two is needed.	Mid-Term	Capacity - None Operations - None Safety - Positive Multimodal - Positive	Could require additional ROW	Moderate cost option that fits with Town's bike/ped plans. However, using recommended 6' planter strip and 5' sidewalk makes space tight, particularly in conjunction with lane additions on Smithfield
10	Wide Outside Lane / Shoulder	$5,000 - $50,000 / mile	Incompatible with multi-use path. Only one of the two is needed.	Mid-Term	Capacity - None Operations - None Safety - Positive Multimodal - Positive	Could require additional ROW	Similar to sidewalks; improves multi-modalism and reflects bike/ped plans, but 4' on each side may be tight
11	Multi-Use Path	$20.60/SYD (assumes same materials as sidewalks)	All vehicular scenarios, crosswalks Is an alternative to sidewalks, shoulders	Mid-Term	Capacity - None Operations - None Safety - Positive Multimodal - Positive	If combined with aggressive vehicular improvements, there may be ROW acquisition requirements	Has smaller infrastructure needs while still allowing for multimodal access to primary destinations around the study area
OPERATIONAL IMPROVEMENTS							
12	Signal Timing	$50,000 - $250,000 (for new signals associated with additional lanes)	All	Mid-Term	Capacity - Positive Operations - Positive Safety - Positive Multimodal - None		A necessary intersection improvements if new lanes are approved. Upgraded timing improves capacity and operations, with no negative impact.
13	Signal Pre-emption for RR	$25,000 - $50,000	All	Mid-Term	Capacity - None Operations - Positive Safety - Positive Multimodal - None	Coordination with RR required	Low cost alternative that improves safety by clearing northbound lane of Smithfield in the event of freight train at the crossing.
14	Pedestrian Signals	$875 per signal head*	All	Mid-Term	Capacity - None Operations - Positive Safety - Positive Multimodal - Positive		There are no operational negatives to this options, but existing pedestrian volumes do not justify expenditure

* Based on 2010 bid averages from NCDOT Division 5

Recommended Improvements

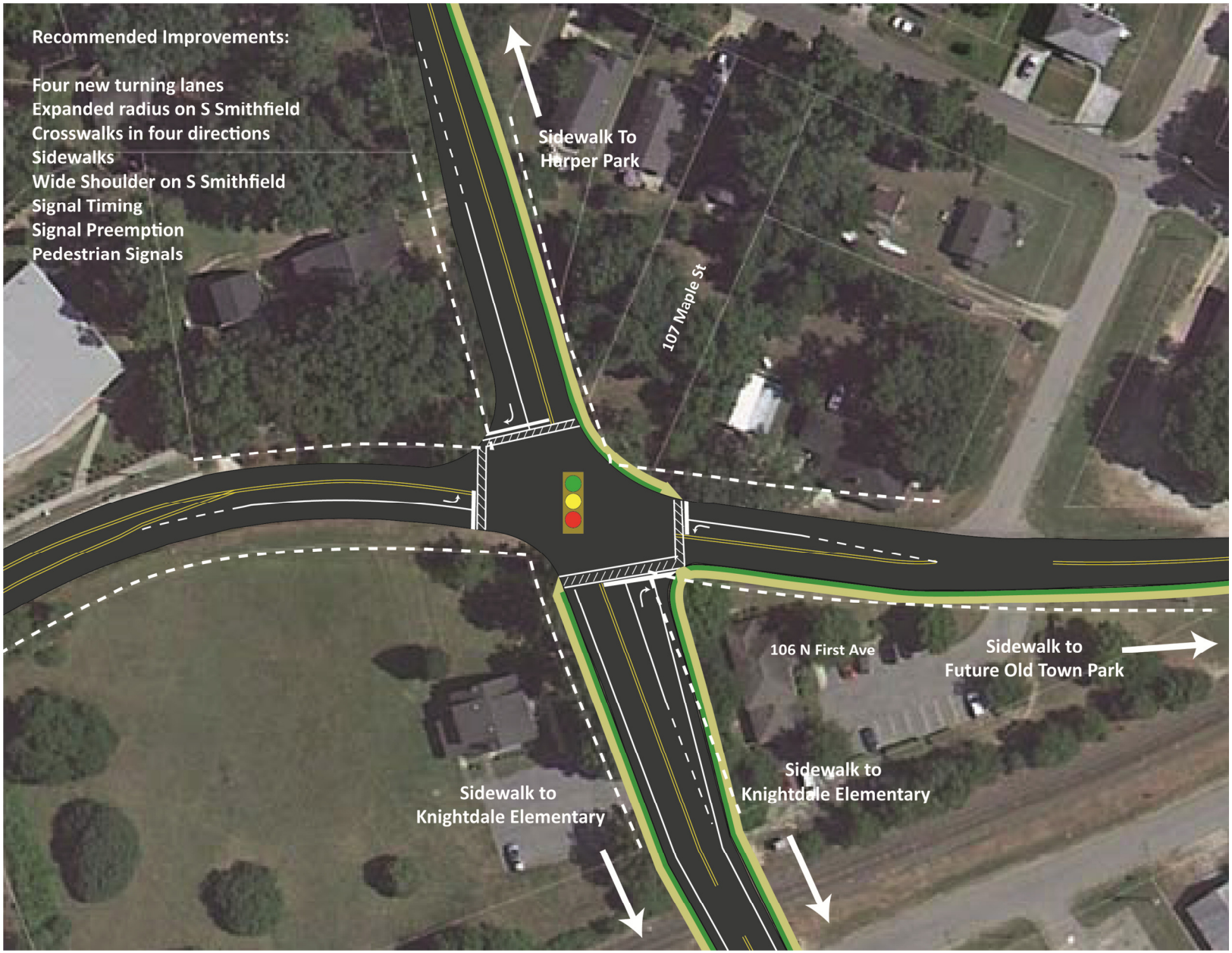
Based on the analysis above the recommended improvement is the incorporation of the following elements:

- Vehicular Growth Scenario, which includes 4 new lanes (right turn lanes on Smithfield Road and left turn lanes on First Avenue) and expanded turning radius on S Smithfield northbound right lane
- Crosswalks on all four corners of the intersection
- 6’ shoulders on S Smithfield Road between First Avenue and Knightdale Elementary School
- 5’ sidewalks with 42” planting strip on both sides of S Smithfield Road between First Avenue and Knightdale Elementary School
- 5’ sidewalk with 42” planting strip on the east side of N. Smithfield Road between First Avenue and Harper Park
- Upgraded Signal Timing, requiring new signals
- Signal Preemption
- Pedestrian Signals

The inclusion of these elements creates a multi-modal, high-capacity intersection that is consistent with near and mid-term traffic modeling and the long-range plans of both Knightdale and CAMPO. The primary concern with the implementation of this package of improvements is the need for right-of-way acquisition on the southeast parcel (106 N. First Avenue) and the possibility of a very small acquisition on 107 Maple Street. It is highly unlikely that these acquisitions will affect existing buildings or parking lots, but existing trees on both sides of S Smithfield Road may be impacted. A reasonable alternative to the Growth Scenario is the Limited Growth Scenario, which does not have a northbound right turn lane. This alternative would reduce northbound capacity, but at a savings of additional right-of-way acquisition at 106 N. First Avenue.

A graphic representation of the recommended improvement package is shown on the following page.

Note that these recommendations are complementary to the Town of Knightdale’s larger bicycle and pedestrian plans, such as wide sidewalks on S. First Avenue and on Main Street, and these other projects should continue to be pursued by the Town in order for these recommendations to provide maximum benefit.


Recommended Improvements:
Four new turning lanes
Expanded radius on S Smithfield
Crosswalks in four directions
Sidewalks
Wide Shoulder on S Smithfield
Signal Timing
Signal Preemption
Pedestrian Signals
Sidewalk To Harper Park
107 Maple St
106 N First Ave
Sidewalk to Future Old Town Park
Sidewalk to Knightdale Elementary
Sidewalk to Knightdale Elementary

Cost Estimates

The costs for these improvements can vary widely depending upon the level of construction. This would include items and decisions such as whether the stormwater is to remain in a ditch or installed curb and gutter, the amount of relocation required for utilities and, other associated constraints from final design. As such, the cost estimates provided for the recommended alternative are gross estimates, and should be used as a ballpark figure only.

Improvement	Cost
Vehicular Growth Scenario (lane additions / expansions)	$350,000 - $750,000
Crosswalks[1]	$1,000 - $1,500
Wide shoulder[2]	$ 25,000
Sidewalk[3]	$ 40,000
New signals[4]	$100,000 - $250,000
Signal Preemption	$25,000 - $50,000
Pedestrian Signals	$2,000 - $3,000
TOTAL	$563,000 and up

[1] Assumes 120 linear feet
[2] Assumes approximately ½ mile at highest estimated price
[3] Assumes approximately 2,000 square yards
[4] The cost for the signal design encompass modification of the existing signal system to account for additional turn lanes, to replacement of the signal system including all poles, heads, loops, cabinet, electronics, etc.

Phasing and Implementation Strategy

At this study phase, it is important to begin to think about how the recommendations will be implemented. Clearly the DOT will be closing the Fayetteville crossing thin the near term (within 2 years) and they recognize that traffic will increase at the study area intersection. The priority for the DOT is to improve the intersection by adding turning lanes on the SB, EB, and WB legs of the intersection. During meetings with CAMPO and the Town of Knightdale, it is their hope that these improvements will be completed with a vision toward the future, by maintaining connections as documented within current plans, rather than a stop gap measure. The prioritized list of improvements is as follows:

- Turning lanes as proposed by NCDOT and restriping
- Upgrade signals including pedestrian signals and RR crossing preemption
- Include cross walks
- Right turn lane on NB Smithfield approach
- Right-of way purchase for multimodal improvements
- Sidewalk between Knightdale Elementary School and Future Old Town Park
- Sidewalk to Harper Park on the east side of the North intersection leg

This study process demonstrated the value of coordination with state, regional, and local interests. The difference between a study and a plan is that the former makes recommendations and the latter a defined course of action. This was a study. However, its recommendations are able to be incorporated into planning documents so that the results are easily implementable.

The plan of action now entails decisions by the community and state leaders on which recommendations it will advance, who will lead each and who will fulfill support roles. The recommendations should also be considered in terms of available resources and priorities. Above all else, leadership must be careful to not allow this report to sit without action. It is always difficult to regain traction and momentum. It is best to make modest steps toward project progression.

The following next steps are recommended to move to implementation.

1. Read the report
2. Establish a dialogue among NCDOT, CAMPO, and the Town of Knightdale to agree on those recommendations critical for advancement.
3. Keep in mind the long term goals of each stakeholder to make the most efficient and effective improvements for the betterment of the community they serve.

List of Appendices

Level of Service Tables

Queue Lengths

Raw Traffic Data

Signal Plans and Timing

Intersection Accident Data

FRA Grade Crossing Information

Synchro Reports