BOILING SPRINGS BCA MEMORANDUM

Purpose

This memorandum documents the methodology and results of a benefit-cost analysis for the proposed build alternative for the S Main Street Connection Improvements Project in Boiling Springs, North Carolina.

This stretch of undivided highway is in the heart Boiling Springs and the eastern edge of Gardner-Webb University. It is a 2-lane section, 0.6 miles long and includes 8 intersections. Majority of the two-lane section has on-street parking, a 19-foot-wide southbound travel-lane and a 15 foot northbound travel-lane. There is one signalized intersection of East College Avenue which is also the main east-west corridor through town. North and south of the signalized intersection, the intersections of E Branch Avenue, Falcon Circle, Decker Court, Quinn Circle, Hamrick Avenue, Woodland Avenue, Green/Bethel Avenue, and Holland Drive have higher pedestrian use or are planned for future development and were thus included in a corridor study. Currently, there are no trails, sidewalks, or multi-use paths to connect downtown or the campus to the highly used facility. **Figure 1** shows an overview of the project location.

Figure 1. Project Location

To mitigate risks associated with the two-lane section, a reduction of lane width to 11 feet is proposed and would incorporate additional on-street parking with permeable pavement, 12-foot multi-use path, 7 feet of additional greenspace for reduction of impervious pavement, multiple highly visible pedestrian crossings with bump outs to reduce crossing width, improvement to the signal with improved signal timing, improved pedestrian facilities. This stretch of roadway is a key corridor for pedestrians during in the week and provides the primary state highway route from south to west in Boiling Springs.

Development opportunities exist in nearby residential neighborhoods, but more specifically, housing inventory along Hamrick Avenue and Woodland Avenue could redevelop into a multi-family or attached housing typology to increase density and increase housing availability.

For the study, a build alternative was analyzed and compared to a no-build alternative. The alternatives are listed below:

1. No-Build – Do nothing alternative
2. Build - Construct improved two-lane section of Main Street from E Branch Avenue to Holland Drive consisting of a reduction of lane width to 11 feet is proposed and would incorporate additional on-street parking with permeable pavement, 12-foot multi-use path, 7 feet of additional greenspace for reduction of impervious pavement, multiple highly visible pedestrian crossings with bump outs to reduce crossing width, improvement to the signal with improved signal timing, improved pedestrian facilities.

Background Info

A primary goal for this project is to improve safety and provide multimodal transportation opportunities while maintaining traffic flow at an acceptable level of service. Using North Carolina Department of Transportation (NCDOT) crash data from 2013-2022, showed that there were 15 crashes along the corridor. In all, there were two fatalities, and two suspected serious injury crashes associated with this stretch of roadway in the 10-year time period. **Table 1** shows a summary of collisions along this stretch.

Table 1. 2013-2022 Main Street

KABCO Level	Severity	Number of Collisions
K	Fatal	2
A	Suspected Serious Injury	2
B	Suspected Minor Injury	0
C	Possible Injury	2
O	No Injury	9
	Total	**15**

Providing alternative modes of transportation is another priority in undertaking this project. Boiling Springs has higher than average pedestrian traffic for a community its size due to the Gardner-Webb University. There are currently multiple pedestrian crossings along the corridor that are highly visible due to the on-street parking.

With the changes being made to improve pedestrian facilities along Main Street, there may be an increase in other forms of transportation such as biking and walking. See **Table 2** for a summary of expected AADTs for build and no-build conditions. These volumes include 0% traffic growth and a 5% reduction of vehicular use.

Table 2. Expected Main Street AADTs

Alternative	Year	
	2026	2045
No-Build	9,200	9,200
Build	8,800	8,800

The purpose of a benefit-cost analysis is to express the effects of an initial investment into a common measure, base-year dollars. This accounts for benefits occurring over long periods of time, while most of the costs are incurred as an initial investment. Under this approach, a project with monetized benefits that

are greater than its costs will have a benefit-to-cost ratio greater than one and therefore is considered an economically beneficial endeavor.

Benefit-Cost Methodology

The monetary benefit for this project is quantified in terms of either a reduction or increase in vehicle miles traveled (VMT), vehicle hours traveled (VHT), project area collisions, vehicle emissions, and roadway maintenance. The costs considered for the project include surfacing, subbase/base, grading and drainage, signal and lighting construction, right-of-way acquisition, as well as engineering and design fees.

The results of the analysis provide input for evaluating the overall benefit of the proposed improvements to the area. Since the current design is still preliminary, it should be noted that certain benefits and costs may change prior to final design, however these changes are anticipated to be relatively minor as initial cost estimates were made to be conservative.

General Assumptions

- All monetary values are discounted to the 2021 analysis year.
- The 20-year benefit period is based on a 2026 day-of-opening through the year 2045. Benefits are assumed to start July 1st, 2026 and end December 31st, 2045.
- Yearly Build and No-Build benefits are calculated based on linear interpolation over the 20-year analysis period.
- Longer travel times and rerouting of trips during construction years are not included in this analysis. Construction is anticipated to occur under traffic.
- Preliminary cost estimates were completed using unit costs for grading, base, and pavement. An appropriate risk factor given the early stage in the project development process was therefore used.
- 260 days per year was used in the analysis of weekday VHT, VMT, and emissions.
- Weekend VHT, VMT, and emissions were considered as well. A proportion of weekday VHT, VMT, and emissions benefits were applied to 105 weekend days per year. This process used a fraction of traffic for Saturdays and Sundays versus an average of Tuesday, Wednesday, and Thursday traffic to allocate weekend benefits since weekend traffic was not modeled as part of the traffic analysis.

Traffic Analysis

Traffic forecasts were determined under both no-build and build scenarios. The forecasts were determined based on historical Annual Average Daily Traffic (AADT) counts available from the NCDOT, current year traffic count data collected in 2021. The AADT data along with historical AADT data was used to determine growth rates on Main Street through the corridor. It was noted that volumes have fluctuated positively and negatively over the last 20 years. Most recently, a rate of -3.5% was observed from 2016 to 2021. For a conservative traffic estimate, 0% growth was assumed.

No Build

For the No Build forecast, the growth rate along Main Street was 0 percent per year based on the AADT's.

Build

The Build scenario keeps the traffic flow the same, therefore the forecast the growth rate along Main Street is also 0 percent per year based on the AADT's.

Analysis

Synchro/SimTraffic was used to analyze the various traffic scenarios and configurations. The traffic signal at College Ave and Main St was simulated according to recommended signal and timing settings in the NCDOT Congestion Management Capacity Analysis Guidelines. Hourly Turning Movement Counts were estimated using national data from NCHRP 716 and assumed heavy vehicle factor of 2%. A speed of 25 MPH was used for all scenarios. The Lane Width along Main Street was set to 16' (Synchro Max) for the No Build simulation and 11' for the Build simulation.

The values obtained using the modeling software provide travel distance (vehicle miles traveled - VMT) and travel time (vehicle-hours traveled - VHT) for the corridor. See **Table 3** for VMT and **Table 4** for VHT during 2026 and 2045 build and no-build scenarios.

Table 3. Vehicle Miles Traveled

	Vehicle Miles Traveled				Value Per Mile[1]		Cost			Difference (Benefit)
	Weekday		Weekend							
	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Total	
2026 No Build	6,075,940	123,998	1,962,996	40,061	$ 0.46	$ 1.01	$ 3,697,910.56	$165,698.86	$ 3,863,609.42	**$212,446.99**
2026 Build	5,741,840	117,181	1,855,056	37,859	$ 0.46	$ 1.01	$ 3,494,572.16	$156,590.27	$ 3,651,162.43	
2045 No Build	6,075,940	123,998	1,962,996	40,061	$ 0.46	$ 1.01	$ 3,697,910.56	$165,698.86	$ 3,863,609.42	**$212,446.99**
2045 Build	5,741,840	117,181	1,855,056	37,859	$ 0.46	$ 1.01	$ 3,494,572.16	$156,590.27	$ 3,651,162.43	

Table 4. Vehicle Hours Traveled

	Veh-Hour				Hourly Value[1]		Cost			Difference (Benefit)
	Weekday		Weekend							
	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Total	
2026 No Build	302,017	6,164	97,575	1,991	$31.40	$32.40	$ 12,547,196.13	$ 264,220.17	$ 12,811,416.30	**$ 828,974.00**
2026 Build	282,475	5,765	91,261	1,862	$31.40	$32.40	$ 11,735,318.74	$ 247,123.57	$ 11,982,442.31	
2045 No Build	302,017	6,164	97,575	1,991	$31.40	$32.40	$ 12,547,196.13	$ 264,220.17	$ 12,811,416.30	**$ 828,974.00**
2045 Build	282,475	5,765	91,261	1,862	$31.40	$32.40	$ 11,735,318.74	$ 247,123.57	$ 11,982,442.31	

Calculation of Benefits

Economic values for VHT, VMT, and emissions were obtained from the US Department of Transportation (USDOT) guidance: "Benefit Cost Analysis Guidance for Discretionary Grant Programs (2023)". See **Tables 3 and 4** for a summary of economic values that were used for this analysis. A 20-year analysis period beginning in 2026 and ending in 2045 was chosen for the benefit-cost evaluation with all values discounted to 2021 dollars.

Travel Time Benefit

Delay benefit was calculated in terms of delay per person. Using USDOT's guidance of 1.67 persons per car and 1.0 persons per truck, delay was calculated by using these multipliers and the travel time reported in vehicle hours by SimTraffic. The economic costs of this delay were then quantified by using USDOT's suggested values for auto and truck travel time savings. The benefits derived from the build scenario for travel time are estimated at **$5,556,000** for a 7 percent discount rate. This value qualifies the benefit of

fewer vehicles using the roadway, as 5% of traffic was assumed to switch to pedestrian travel. 2026 and 2045 delay benefits can be seen in **Table 4**.

Vehicle Operation and Emissions Benefits

Vehicle operations and emissions benefit were determined by using USDOT's suggested values based on a cost per mile traveled. The benefits derived from the build scenario for vehicle operations are estimated at **$1,424,000** for a 7 percent discount rate. By providing a route for pedestrian travel, members of the community are expected to save costs of operating a vehicle. The benefits derived from the build scenario for vehicle emissions are estimated at (**$6,000)** for a 7 percent discount rate. 2026 and 2045 delay benefits can be seen in **Table 5** below.

Table 5. Environmental Analysis

	Emissions (Metric Tons)		Value Per Metric Ton	Cost	Difference (Benefit)
	Weekday	Weekend			
	NOx	NOx	NOx[1]	NOx	
2026 No Build	5.19	1.57	$ 16,600	$ 112,162.31	**$ (32,896.72)**
2026 Build	4.85	3.88	$ 16,600	$ 145,059.03	
2045 No Build	5.19	1.57	$ 16,600	$ 112,162.31	**$ (32,896.72)**
2045 Build	4.85	3.88	$ 16,600	$ 145,059.03	

Operation and Maintenance Benefits

Roadway and utilities maintenance along Main Street would not be needed if the project does not happen, as NCDOT just performed maintenance on the corridor in 2020. A City of Charlotte standard of $0.70 per square yard of concrete was used to estimate the annual maintenance cost for minor repairs on the sidewalk. More frequent maintenance activities such as crack sealing and routine activities was taken to be equal between build and no-build scenarios and therefore not taken into considerations when monetizing maintenance operations.

The expenditure cost for the lifetime cycle cost of the project is expected to be **($22,475.66)**. Total discounted maintenance benefits are (**$9,000)** at a 7 percent rate.

Safety Benefits

The methodology used to complete the crash analysis and corresponding benefit-cost ratio is described in the following paragraphs. Crash reduction within the project area was determined by separating intersections and segments so that factors and state averages could be applied appropriately. Crashes were obtained from the NCDOT Crash database for a ten-year period from 2013-2022. These collisions were then annualized and reductions and additions of crashes were added appropriately relative to geometry reconfigurations.

Main Street will reduce traveling lane widths from average of 17 feet wide to 11 foot lanes, reduce the parking lanes from 9 feet to 8 feet, and include a new 12 foot multi-use trail with a 7 foot greenspace. The current and projected traffic volumes allow the conversion with limited other improvements required. The following are improvements at intersections based on the traffic study:

- At the signalized intersection, the signal heads will be made highly visible with highlighted backplates, updated timings and pedestrian crossings timings, introduction of flashing yellow left-turn for the protected permitted left-turns.

- Installation of high-visibility crosswalks will be installed near the intersections of E Branch Avenue and Decker Court.
- Installation of a raised median refuge for the crosswalk near Holland Drive.

Crash modification factors were reviewed from the Highway Safety Manual (HSM) and the Crash Modification Factors (CMFs) Clearinghouse. Crash modification factors were used to determine the anticipated number of crashes after an improvement is made to an intersection or roadway. The Crash Modification Factors (CMF) for each improvement type are as follows:

- Pedestrian (Install High-Visibility Crosswalk) (CMF ID: 4123)
    - Shows improvements for all crashes at both signalized and unsignalized intersections.
        - CMF = 0.60
- Pedestrian (Install Raised Median with Marked Crosswalk - Uncontrolled) (CMF ID: 175)
    - Shows improvements for all crashes.
        - CMF = 0.54
- Improve Signal Head Visibility (CMF ID: 1430)
    - Install highly visible backplates to the signal heads
        - CMF = 0.93
- Modify Signal Phasing (Implement a Leading Pedestrian Interval) (CMF ID: 1993)
    - Highly effective at intersections with more than 300 pedestrians a day
        - CMF = 0.413
- Changing Left-Turn Phasing from Protected-Permissive to Flashing Yellow Arrow (CMF ID: 9668)
    - Flashing Yellow Arrow has been shown to be more effective than a green ball
        - CMF = 0.86

After establishing no-build and build crashes for 2022 using the CMFs, forecasted 2026 and 2045 collisions were obtained by inflating numbers according to the expected AADT growth along Main Street for the no-build and build scenarios.

Table 3. KABCO Collision Values

Severity	Description	2026		2045	
		No-Build	Build	No-Build	Build
K	Fatal	0.20	0.11	0.20	0.11
A	Suspected Major Injury	0.20	0.07	0.20	0.07
B	Suspected Minor Injury	0	0	0	0
C	Possible Injury	0.20	0.06	0.20	0.06
O	Property Damage Only	1.00	0.48	1.00	0.48
Total		**1.60**	**0.71**	**1.60**	**0.71**

The USDOT's value of a statistical life (VSL) provided in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs were used for the values of the crashes. A resulting benefit of **$7,874,000** was obtained for a 7 percent discount rate over the 20-year analysis period.

Property Value Increase

Main Street passes through the downtown business district. The southern portion of the project serves as State Highway 150 and provides connectivity between adjacent residential neighborhoods. Many of the immediately surrounding residential neighborhoods are distressed and are below the low/moderate

income threshold established by HUD. Many residents rely on the corridor for travel to employment, health care and other daily essential services. The proposed project improvements will support the transportation needs of development through the pedestrian, and multi-modal improvements along the corridor. As a result of the proposed project improvements, it is expected that redevelopment will occur along the project corridor and that property values will increase as a result of the project.

We have estimated the property value increase through the review of available properties and proposed zoning. The property value information was analyzed using the existing valuation of the parcels in the corridor, according to the Cleveland County Assessor information.

As identified in the Boiling Springs Downtown Master plan in September 2020, new mixed-use residential developments are proposed to the east of Main Street along Woodland Avenue. The Main Street project will act as a catalyst for the development. The estimated new value of these sites was determined by estimating the square foot of each type of new land use development identified in the concept plan and then assigning a value per square foot for each type of use. The value of the land was not adjusted, only the value of structures and/or dwellings as appropriate. The net total change was determined by the estimated value following redevelopment within the corridor.

This project which could be phased over the 20-year life of the project is estimated to be valued at $3,450,000 and contributes a positive net change to the overall corridor valuation by $1,914,000.

Based on the positive net change anticipated, the estimated benefit along the corridor totals $1,914,000 in the 20 years following construction. The total discounted property value increase benefits are **$973,000** at a 7 percent rate.

Public Health Benefit

Improved public health is another benefit of the proposed project. This benefit was not quantified, but the improved pedestrian and bicycle facilities will improve public health. The project will make Main Street and the community of Boiling Springs more pedestrian and bicycle friendly through the following improvements:

- Reduced crossing width of Main Street
- Wider sidewalks
- Wider boulevard between pedestrians and vehicles
- ADA compliant facilities
- Intersection bump outs which will reduce vehicle speed, reduce the pedestrian crossing distance, and improve pedestrian visibility to vehicles.

Stormwater Runoff Mitigation

The project will also improve stormwater runoff management through less vehicle travel lanes, tree plantings, permeable widened boulevard space, and other green street elements where practical to reduce stormwater runoff and improve water quality. This benefit was not quantified.

Benefit-Cost Analysis Results

See **Table 6** for a results summary of the benefit-cost analysis for the Main Street Improvements Project.

Table 6. Benefit-Cost Analysis Summary

Item	BCA	
	PV (7% Discount Rate)	
Travel Time Benefit	$	5,556,000.00
Collision Reduction Benefit	$	7,874,000.00
Operation and Maintenance Benefit	$	(9,000.00)
Emissions Benefit	$	(6,000.00)
Vehicle Operating Benefit	$	1,424,000.00
Property Value Benefit	$	973,000.00
PV Total Benefit	**$**	**15,812,000.00**
Surfacing	$	935,000.00
Grading and Drainage/Sewer	$	906,000.00
Subbase/Base	$	38,000.00
Other Costs	$	275,000.00
PV Total Cost	**$**	**2,154,000.00**
PV Salvage Value	$	148,000.00
(PV Total Cost - Salvage Value)	**$**	**2,006,000.00**
Benefit-Cost Ratio	**7.882**	

The analysis indicates that the build option has a benefit-cost ratio greater than 1.0, meaning that it is an economically beneficial project. The benefits of the project are estimated to be higher than the costs associated with the construction of the project. In addition, we believe that the estimated property value increase over the analysis period is conservative

Resources Used

"Benefit-Cost Analysis Guidance for Discretionary Grant Programs." 2023. Office of the Secretary. U.S. Department of Transportation, https://www.transportation.gov/mission/office-secretary/office-policy/transportation-policy/benefit-cost-analysis-guidance

"Highway Safety Manual" Washington D.C. American Association of State Highway and Transportation Officials. 2010. Book

"Crash Modification Factors Clearinghouse." *Safety Research Center*, U.S. Department of Transportation Federal Highway Administration, http://www.cmfclearinghouse.org/