

Benefit-Cost Analysis Memorandum

Partnership for Active Regional Transportation and Neighborhood Equity in
Rutherfordton and Spindale (PARTNERS)

2022 RAISE Grant Application

Prepared for NCDOT

April 7, 2022

Table of Contents

Executive Summary	3
1. Introduction	7
2. Analysis Framework	9
3. Analysis Assumptions	10
4. Benefit Analysis	12
Safety	12
<i>Roadway Safety and Modernization</i>	13
<i>Safety from Modal Diversion</i>	13
<i>Emergency Services</i>	13
Environmental Sustainability	14
<i>Emissions Savings from Modal Diversion</i>	14
<i>Emissions Savings from Reduced Idling and Signal Coordination</i>	14
Quality of Life	15
<i>Noise and Congestion Avoided</i>	15
<i>Construction Delay</i>	15
Mobility and Community Connectivity.....	15
<i>Bike and Pedestrian Health and Recreation</i>	15
<i>Time Savings for Transit Users from Modal Diversion</i>	15
<i>Transit Amenities</i>	15
Economic Competitiveness and Opportunity.....	16
<i>Travel Time Savings</i>	16
<i>Auto Operating Costs Avoided</i>	16
<i>Transit Operating Cost Efficiency Savings</i>	16
State of Good Repair.....	16
<i>Residual Value</i>	16
<i>Corridor Operating and Maintenance Costs Avoided</i>	16
5. Cost Analysis	17
<i>Capital Costs</i>	17
<i>Annual Operating and Maintenance Costs</i>	17
6. BCA Results	17
Appendix A List of Supporting Documents	19

Exhibits

Exhibit 1 – Impact Matrix.....	4
Exhibit 2 – Costs and Benefits Delivered by Long-Term Outcomes.....	6
Exhibit 3 – Project Location and Elements.....	8
Exhibit 4 – BCA Calculation Inputs.....	10
Exhibit 5 – Undiscounted Capital Costs—in 2020 Dollars.....	17
Exhibit 6 – BCA Results for the Project.....	18

Executive Summary

A benefit-cost analysis (BCA) was conducted for the Partnership for Active Regional Transportation and Neighborhood Equity in Rutherfordton and Spindale (PARTNERS) Project (hereafter called the Project) to support the North Carolina Department of Transportation's (NCDOT's) grant application for the USDOT 2022 Rebuilding America's Infrastructure with Sustainability and Equity (RAISE) program. This analysis was conducted in accordance with the 2022 *Benefit-Cost Analysis Guidance for Discretionary Grant Programs* (Guidance).¹ Capital outlays are scheduled to begin for design and engineering in mid-2023 and construction is scheduled for completion in mid-2027. All values are in 2020 dollars discounted at a 7 percent discount rate to 2020 and cover a 20-year operations period (including partial years of operations), consistent with Guidance.

Exhibit 1 presents the Impact Matrix, which describes the baseline or No Build, the Project as a whole, and the estimated results.

¹ USDOT Benefit Cost Analysis Guidance 2022, <https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20%28Revised%29.pdf>

Exhibit 1 – Impact Matrix

Current Status/Baseline	Change to Baseline	Benefit	Affected Population	Economic Benefit (PV, \$2020M)	Page Reference in BCA Memo
<p>Charlotte Road/US 221 in Rutherfordton, NC is a multilane roadway connecting to Spindale, NC where it is called Main St. The 2.5 mile corridor between Maple St in Rutherfordton and Oakland Rd in Spindale is currently three to five lanes wide with limited bicycle and pedestrian facilities, and signalized intersections. Transit operates in the corridor, and two greenway/trail systems in the project area are disconnected. The towns have a high percentage of zero-car households and transit-dependent communities.</p>	<p>The Project will transform an existing multilane roadway into a vibrant and inclusive complete street that improves safety, connects communities, and promotes active transportation options by linking the Purple Martin Greenway and Thermal Belt Rail Trail. The Project will construct a roundabout at the College Ave/Railroad Ave and Charlotte Rd intersection, reducing crashes and saving time for corridor users. As part of the Project, the transit system will optimize routes to improve efficiency and reduce operating costs, add four new shelters, and install bus stop amenities. The corridor's signals will be upgraded to provide priority to emergency vehicles, saving lives through faster response time.</p>	Safety			
		Roadway Safety and Modernization	Corridor drivers and pedestrians	\$11.93	13
		Safety from Modal Diversion	Auto users diverted to transit, and remaining corridor drivers	\$0.00	13
		Emergency Services	Entire population of Rutherfordton and Spindale	\$5.68	13
		Environmental Sustainability			
		Emissions Savings from Modal Diversion	All regional users and non-users	\$0.00	14
		Emissions Savings from Reduced Idling and Signal Coordination	All regional users and non-users	\$0.06	14
		Quality of Life			
		Noise & Congestion Avoided	Corridor drivers and pedestrians	\$0.00	15
		Construction Delay	Corridor drivers and pedestrians	-\$2.36	15
		Mobility and Connectivity			
		Bike and Pedestrian Health & Recreation	Purple Martin Greenway and Thermal Belt Rail Trail users, and other corridor cyclists and pedestrians	\$0.68	15
		Time Savings for Transit Users from Modal Diversion	Transit riders	\$0.07	15
		Transit Amenities	Transit riders	\$0.05	15
		Economic Competitiveness and Opportunity			
		Travel Time Savings	Walkers diverted to transit, and remaining corridor drivers	\$5.63	16
Auto Operating Costs Avoided	Auto users diverted to transit	\$0.00	16		
Transit Operating Cost Efficiency Savings	Auto users diverted to transit	\$0.07	16		

Current Status/Baseline	Change to Baseline	Benefit	Affected Population	Economic Benefit (PV, \$2020M)	Page Reference in BCA Memo
		State of Good Repair			
		Residual	NCDOT and NC taxpayers	\$1.68	16
		Corridor O&M Costs Avoided	NCDOT and NC taxpayers	\$0.53	16

Exhibit 2 summarizes long term outcomes of the Project. Taken in total, the Project provides \$23.3 million in benefits over the analysis period, using a 7 percent discount rate. Compared to a similarly discounted cost estimate, the Benefit-Cost Ratio for the Project is 1.56, a solid return on this critical investment for the region. The net benefits of the Project are \$8.3 million using a 7 percent discount rate.

Exhibit 2 – Costs and Benefits Delivered by Long-Term Outcomes

	\$2020 Millions
	Discounted to 2020 at 7%
Costs	20-Year Analysis
Capital Costs	\$14.9
Total Costs	\$14.9
Safety	
Roadway Safety and Modernization	\$11.9
Safety from Modal Diversion	\$0.00001
Emergency Services	\$5.7
Environmental Sustainability	
Emissions Savings from Modal Diversion and Signal Coordination	\$0.0005
Emissions Savings from Reduced Idling	\$0.06
Quality of Life	
Noise & Congestion Avoided	\$0.0005
Construction Delay	-\$2.4
Mobility and Community Connectivity	
Bike and Pedestrian Health & Recreation	\$0.68
Time Savings for Transit Users from Modal Diversion	\$0.07
Transit Amenities	\$0.05
Economic Competitiveness and Opportunity	
Travel Time Savings	\$5.6
Auto Operating Costs Avoided	\$0.002
Transit Operating Cost Efficiency Savings	\$0.07
State of Good Repair	
Residual	\$1.7
Corridor O&M Costs Avoided	\$0.5
O&M Costs	-\$0.8
Total Benefits	\$23.3
Benefit-Cost Ratio	1.56
Net Benefits	\$8.3

1. Introduction

Safe, reliable, and affordable transportation is an urgent challenge faced by many across the nation. Historically, roadway design in many rural communities has prioritized speed and vehicle-oriented design over the needs of other travel modes. Located within an economically distressed county, the towns of Rutherfordton and Spindale have made strides to improve their transportation network by investing in their transit system and developing greenways, knowing that strategic transportation investment is critical to meeting the needs of all citizens, particularly those in transportation disadvantaged communities. In addition to the Rutherfordton Bypass, which will open in 2026, Rutherfordton and Spindale have planned improvements along a 2.5 mile stretch of US 221-A (known as Charlotte Rd. in Rutherfordton and Main St. in Spindale), a vital connection between the two towns, as an important strategic investment needed to create a vibrant, multi-modal corridor that meets local needs and prepares for the future in a safe and equitable way.

The Project is the result of a collaborative partnership between the Town of Rutherfordton, the Town of Spindale, and the North Carolina Department of Transportation (NCDOT) to transform the corridor into a complete street that improves the safety, mobility, quality of life, economic competitiveness, and sustainability of the surrounding community while strengthening the connection between the two rural communities. The Project will address transportation challenges related to equity, safety, mobility, and access along the corridor to create a safe and efficient facility for all users.

The Project, shown in Exhibit 3, will consist of a combination of infrastructure and technological improvements to address transportation challenges along the corridor and create a safe and efficient facility for all modes. These improvements were strategically developed to address to the following goals:

Improve safety

- Provide safer multimodal facilities by separating bicyclists and pedestrians from motorized traffic and adding crosswalks, pedestrian signals, and curb extensions at intersections.
- Construct a roundabout with full pedestrian accommodations at the Railroad Ave. intersection to improve safety and mobility.
- Install signal synchronization and preemption for Emergency Medical Service (EMS) vehicles to reduce response times and improve roadway efficiency.

Increase access

- Construct a new multi-use path (MUP) along the north side of Charlotte Rd., connecting 19 miles of existing greenways
- Enhance access to the Purple-Martin Greenway and the Thermal Belt Rail Trail.

Optimize transit

- Relocate and upgrade four transit stops in the corridor to optimize transit routes and improve safety and access for riders.
- Equip bus stops with shelters, bike racks, and pullouts, to improve passenger safety and comfort while reducing ride times.

Support equity

- Optimize transit stops and complete the bicycle and pedestrian network to provide transportation options for all roadway users, particularly those with no access to a vehicle.

Promote active transportation

- Construct a continuous sidewalk along the south side of the project corridor from Main St. in Rutherfordton to Center St. in Spindale to provide continuous pedestrian facilities.
- Include vegetated buffers between roadway and bicycle and pedestrian facilities.

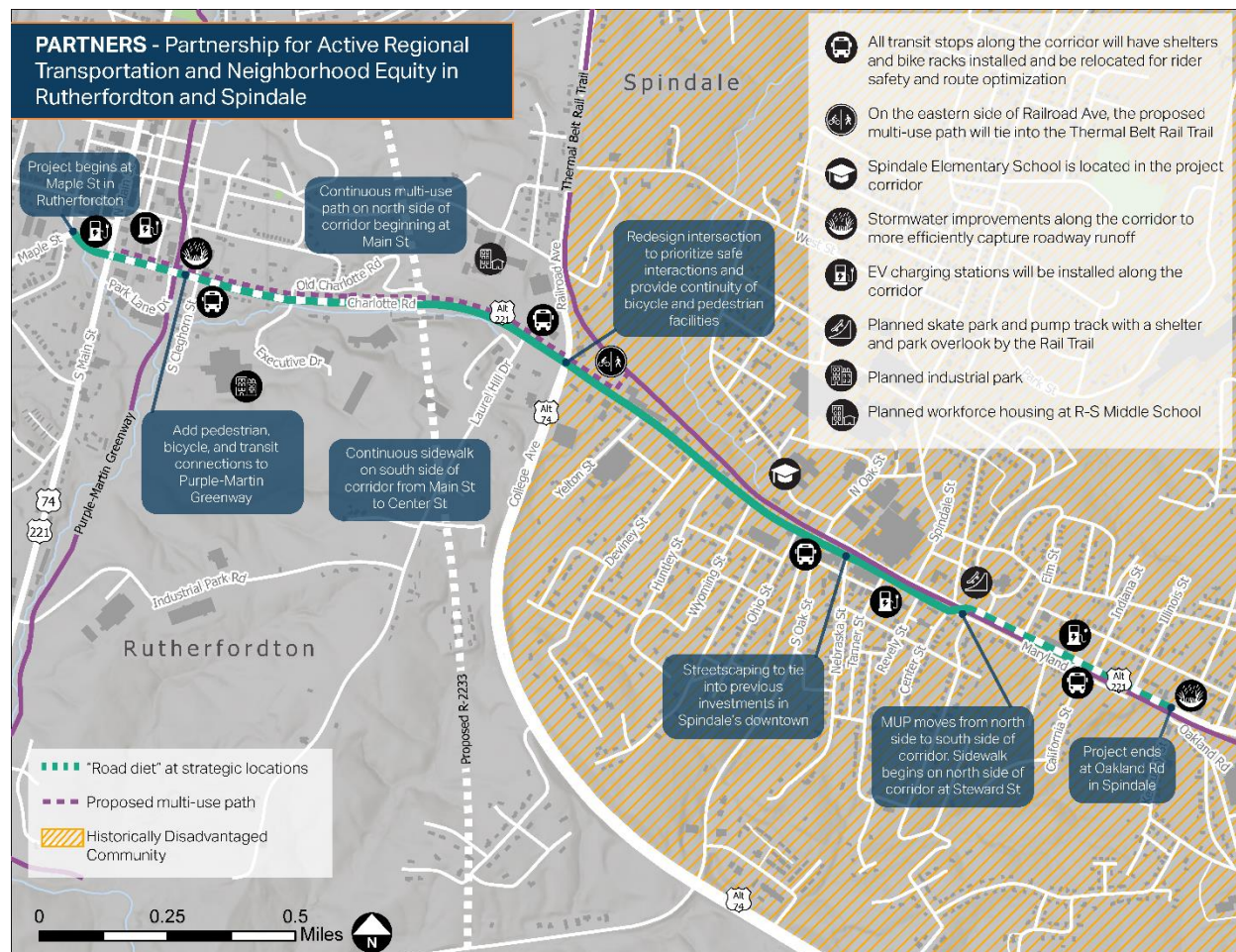
Spur economic development

- Include streetscape enhancements complementing the unique characteristics of the towns to promote rural main street revitalization and recreational tourism.
- Provide critical connections to planned developments in Rutherfordton and Spindale

Promote environmental sustainability

- Install stormwater improvements to reduce runoff, control erosion, and improve water quality.
- Install four electric vehicle (EV) charging stations along the corridor to support the adoption of electric vehicles

Exhibit 3 – Project Location and Elements



The Project addresses multiple criteria in the RAISE Grant program. These include: Safety, Environmental Sustainability, Quality of Life, Mobility and Community Connectivity, Economic Competitiveness and Opportunity, and State of Good Repair. In some cases, the expected Project outcomes apply to more than one of the benefit categories identified above.

- **Safety:** The Project improves safety in several ways:
 - First, in instances where the existing road is realigned and the roundabout constructed, the new features and approach will be modernized, reducing the potential for fatalities, injuries, and crashes.
 - Second, once the roadway is replaced and able to accommodate all types of vehicles, riders will divert from auto to transit, reducing vehicle miles traveled (VMT) and the chance of a crash.

- Third, the Project will include signal preemption for emergency response that will reduce the travel time for emergency services, saving lives and property.
- Finally, with improved bike paths and public facilities, non-motorized transportation will be separated from autos and therefore result in reduced bicycle and pedestrian conflicts.
- **Environmental Sustainability:** Project improvements that result in travel time savings and avoided VMT for users also reduce motorized emissions through modal diversion and a reduction in idling with the implementation of the traffic roundabout.
- **Quality of Life:** The Project benefits Quality of Life by resulting in reduced noise and congestion from modal diversion to transit. The analysis also accounts for the negative impacts to traffic from construction activities.
- **Mobility and Community Connectivity:** Three mobility benefits are realized through the Project:
 - First, bike and pedestrian health and recreation benefits result from the improved corridor and connections to the existing trails;
 - Second, transit users save travel time by diverting from walking; and finally
 - The improved transit shelters result in a transit amenities benefit for users.
- **Economic Competitiveness and Opportunity:** Three types of economic competitiveness benefits are estimated as part of the BCA. Travel time savings result from coordinated signals in Spindale, auto operating costs avoided from diversions to transit, and transit operating efficiencies from rerouting the service.
- **State of Good Repair:** State of Good Repair benefits include the residual value of the investment, avoided mill and fill refurbishment costs, and annual operating and maintenance costs to keep the facility in a state of good repair.

2. Analysis Framework

The parameters of the benefits analysis follow the protocols set by the Office of Management and Budget (OMB) Circular A-94 as well as the recommended benefit quantification methods by the USDOT and the Federal Emergency Management Agency (FEMA). Generally, standard factors and values accepted by Federal agencies were used for the benefits calculation except in cases where more Project-specific values or prices were available. In all such cases, modifications are noted and references are provided for data sources. The analysis follows a conservative estimation of the benefits. By adhering to a strict standard of what could be included in the benefits analysis, actual total benefits may be greater than depicted in the results.

The baseline assumes that the Project would not be built and current conditions and operations would continue in the project area. Under the baseline, the purpose of and need for the Project would not be met and would generally be limited to the operation and maintenance of existing infrastructure. The Project was compared to the baseline to identify benefits and costs.

A custom model was developed to estimate the future benefits for the Project. Benefits were estimated over a 20-year period of analysis beginning when construction ends and concluding after 20 full years of operations. Design for the project is scheduled for 2023 until mid-2025; right of way acquisition and utilities are scheduled for 2024 to mid-2025, and when construction is expected to begin. Construction from mid-2025 through mid-2027 results in the project opening in mid-2027. As such, partial years of benefits for 2027 and 2047 are applied in the analysis to get the full 20-years of benefits.

The benefits are expressed in constant 2020 dollars, which avoids forecasting future inflation and escalating future values for benefits and costs accordingly. The BCA Guidance deflator and gross domestic product chained price index from the OMB were used to adjust past cost estimates or price values into 2020 dollar terms.

The use of constant dollar values requires the use of a real discount rate for discounting to the present value. Projects expecting to use federal funding are required to use a 7 percent discount rate.

3. Analysis Assumptions

A list of assumptions for the Project is provided in the BCA workbook (see Inputs tab in the file BCA.xlsx) as well as in Exhibit 4.

Exhibit 4 – BCA Calculation Inputs

Inputs	Value	Source
General		
Discount Rate	7%	2022 USDOT BCA Guidance
Discount Rate, CO ₂	3%	2022 USDOT BCA Guidance
Discount Year	2020	2022 USDOT BCA Guidance
Dollar Year	2020	2022 USDOT BCA Guidance
Construction begin	2025	NCDOT
Construction end	2027	NCDOT
Construction duration (years)	2	Estimated
Year 1	2027	NCDOT
Year 20	2047	NCDOT
Analysis Duration (years)	20	2022 USDOT BCA Guidance
Factor for half year operations in first and last year	0.5	
Minutes to hours	60	
Annualization factor - autos	300	NCDOT
Annualization factor - transit operations	260	Foothills RPO
Conversion - g/metric ton	1,000,000	
100 million multiplier	100,000,000	
Costs		
O&M Costs Avoided in 2024 With Project (2022\$)	\$725,000	NCDOT
O&M Costs Avoided in 2024 With Project (2020\$) (mill and fill/roadway rehab)	\$700,958	Adjusted with deflator
O&M Annual costs as a percentage of construction	0.50%	NCDOT
O&M Annual costs (2020\$)	\$109,717	NCDOT
Share of costs less labor	80%	Estimated
Economic Competitiveness		
Value of time - personal (2020\$)	\$16.20	2022 USDOT BCA Guidance
Value of time - business (2020\$)	\$29.40	2022 USDOT BCA Guidance
Value of time - all purposes (2020\$)	\$17.80	2022 USDOT BCA Guidance
Occupancy rate - passenger vehicles	1.67	2022 USDOT BCA Guidance
Value of time - truck drivers (2020\$)	\$32.00	2022 USDOT BCA Guidance
Value of time - bus drivers (2020\$)	\$33.60	2022 USDOT BCA Guidance
Value of time - walking, cycling, waiting, standing (2020\$)	\$32.40	2022 USDOT BCA Guidance
Vehicle operating costs - light duty vehicles (2020\$)	\$0.45	2022 USDOT BCA Guidance
Noise cost per mile - all vehicles - all locations (2020\$)	\$0.003	2022 USDOT BCA Guidance
Congestion cost per mile - all vehicles - all locations (2020\$)	\$0.115	2022 USDOT BCA Guidance

Inputs	Value	Source
Time savings per auto - coordinated signals (sec) for Spindale traffic only	1	Estimated
Average trip length avoided by auto (miles)	0.86	2022 USDOT BCA Guidance
Average walking speed avoided (mph)	3.2	2022 USDOT BCA Guidance
Average walking trip (hours)	0.3	Estimated
Diverted from Auto (remainder walked)	20%	Foothills RPO
Diversion factor for safety	10%	2022 USDOT BCA Guidance
Safety		
O - No injury (2020\$)	\$3,900	2022 USDOT BCA Guidance
C - Possible Injury (2020\$)	\$77,200	2022 USDOT BCA Guidance
B - Non-incapacitating (2020\$)	\$151,100	2022 USDOT BCA Guidance
A - Incapacitating (2020\$)	\$554,800	2022 USDOT BCA Guidance
K- Killed (2020\$)	\$11,600,000	2022 USDOT BCA Guidance
U-Injury crash (Severity Unknown) (2020\$)	\$210,300	2022 USDOT BCA Guidance
# Accidents Reported (unknown if injured) (2020\$)	\$159,800	2022 USDOT BCA Guidance
PDO crash (2020\$)	\$4,600	2022 USDOT BCA Guidance
Injury Crash (2020\$)	\$302,600	2022 USDOT BCA Guidance
Fatal Crash (2020\$)	\$12,837,400	2022 USDOT BCA Guidance
North Carolina Auto Fatalities (per 100 M VMT) (2020)	1.17	NCDOT, https://connect.ncdot.gov/business/DMV/CrashFactsDocuments/2020%20Crash%20Facts.pdf
Auto Injured persons (per 100 M VMT) (2019)	84	BTS Motor Vehicle Safety Data Table 2-17, https://www.bts.gov/content/motor-vehicle-safety-data
Auto PDO Crash (per 100 M VMT) (2019)	207	
Share of emergency calls using corridor	80%	Foothills RPO
Estimated No Build response time (mins)	6	Foothills RPO
Estimated Build response time with signal coordination/preemption (mins)	5.5	Foothills RPO
Total Number of Bus Stops	28	Foothills RPO
Number of New Stop Shelters	4	Foothills RPO
Emissions		
CO2 kg/gallon diesel	10.2	EPA, https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf
Truck Emissions Rate g per hour NO _x (average of 8a and 8b trucks)	39.1	EPA, https://www3.epa.gov/otaq/consumer/420f08025.pdf , Class 8 trucks include long-haul semi-tractor trailer rigs ranging from 33,001 lbs to >60,000 lbs
Truck Emissions Rate g per hour PM _{2.5} (average of 8a and 8b trucks)	1.1	
Light Vehicle Idle Emissions Rates g/hr. NO _x	3.8	Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks Emission Facts, EPA420-F-08-025, October 2008
Light Vehicle Idle Emissions Rates g/hr. CO ₂	2,444	Greenhouse Gas Emissions from a Typical Passenger Vehicle, EPA
Ridership/Users		
Rutherford County Transit: weekly (2021-2022)		
Passengers	325	Foothills RPO
Total Miles	5,377	Foothills RPO
Local Trips	920	Foothills RPO
Miles per Trip	5.84	Foothills RPO
Trips per Passenger	2.8	Foothills RPO
Assumed average bus speed (mph)	30	Estimated
Average trip time (hrs)	0.2	Estimated
Increased Transit Trips from New Stops/Service Enhancements	10%	Foothills RPO
Induced walking trips from new bike/ped paths	10%	Foothills RPO

Inputs	Value	Source
Annual growth	1%	Foothills RPO
Annual Transit Operating Cost Efficiency Savings (\$2022)	\$9,867	Foothills RPO
Annual Transit Operating Cost Efficiency Savings (\$2020)	\$9,540	Adjusted with deflator
Bus Shelter - Platform/Stop Seating	\$0.18	2022 USDOT BCA Guidance
Bus Shelter - Platform/Stop Weather Protection	\$0.24	2022 USDOT BCA Guidance
Bus Shelter - Step-Free Access to Station/Stop	\$0.30	2022 USDOT BCA Guidance
Bus Shelter - Timetables	\$0.22	2022 USDOT BCA Guidance
Truck percent	4%	NCDOT Annual Average Daily Traffic Mapping Application, average of corridor, https://ncdot.maps.arcgis.com/apps/webappviewer/index.html?id=964881960f0549de8c3583bf46ef5ed4
Expanded Sidewalk per foot added (width)	\$0.10	2022 USDOT BCA Guidance
Install marked crosswalk on roadway (>10k veh/day)	\$0.18	2022 USDOT BCA Guidance
Install signal for ped crossing on roadway (>13k veh/day)	\$0.46	2022 USDOT BCA Guidance
Platform/Stop Weather Protection (2020\$) per trip	\$0.24	2022 USDOT BCA Guidance
Thermal Belt Rail Trail (July 2020-June 2021) one-directional counts		
Bikes	78,565	Foothills RPO
Pedestrians	59,460	Foothills RPO
Total	138,025	Foothills RPO
Purple Martin Greenway (January 2021-December 2021)	21,421	Foothills RPO
Corridor AADT (2020)	8,650	NCDOT Annual Average Daily Traffic Mapping Application, average of corridor, https://ncdot.maps.arcgis.com/apps/webappviewer/index.html?id=964881960f0549de8c3583bf46ef5ed4
Corridor AADT (2022)	8,824	NCDOT
Auto annual growth rate (%)	1.0%	NCDOT
Walking (ages 20-74) value per induced trip (2020\$)	\$7.08	2022 USDOT BCA Guidance
Cycling (ages 20-64) value per induced trip (2020\$)	\$6.31	2022 USDOT BCA Guidance

4. Benefit Analysis

The method, analysis, and results for each Project benefit category are described in the following sections.

Safety

A key goal of the Project is to reduce the likelihood of injuries and property damage that result from crashes. Through roadway safety and modernization, modal diversion, and improving emergency service transit, it improves the safety of the corridor and provides better access to the area and region. The Project would result in safety benefits by modernizing the corridor with a road diet and roundabout,

separating cyclists and pedestrians from auto traffic to their own dedicated side path, and improving emergency vehicle access through signal coordination and preemption.

Roadway Safety and Modernization

An important aspect of the Project is the implementation of a road diet along the corridor which modernizes the roadway and separates the bicyclists and pedestrians with their own dedicated path and constructs the roundabout at the College Ave/Railroad Ave and Charlotte Road intersection.

NCDOT provided the crash history in the corridor and intersection across seven segments over the past five years, which totaled 101 crashes. One incident in the crash history was a pedestrian. The crash reduction factors (CRFs) were provided by NCDOT by segment and crash type. NCDOT backup data and calculations are included in the Safety Analysis.pdf in the Supplemental Materials.² The Project is estimated to eliminate 95 crashes over the 20-year analysis period; fatal, injury, and PDO crashes are valued using damages costs from the Guidance, as shown in Exhibit 4. ***In total, the Project results in roadway safety and modernization savings of \$11.9 million, discounted at 7 percent.***

One of the safety considerations in the Project is to increase access of non-motorized transportation for its citizens. By linking the Purple Martin Greenway and Thermal Belt Rail Trails, it eliminates the detour for cyclers and pedestrians who traverse both trails. Including a separate passageway along the corridor reduces the number of pedestrian-motor and cycling-motor incidents. Additionally, diverting pedestrian and cycling to a specified pathway would allow for more efficient transit with cars as well as with emergency services. ***This benefit was not quantified as part of the BCA.***

Safety from Modal Diversion

The Project improves transit amenities, circulation, and provides better pedestrian accommodations; as a result, an increase in transit ridership is expected. Rutherford County Transit, the operator of the service in Rutherfordton and Spindale, estimated an increased ridership of 10 percent, and assumed 20 percent diverted from auto while the remainder would have walked. This results in approximately 5,000 new transit trips annually. Based on the Guidance, the average trip length of 0.86 miles and occupancy of 1.67 were used to estimate over 500 VMT annually.

North Carolina crash rates for fatalities,³ and Bureau of Transportation Statistics crash rates for injured persons, and property damage only (PDO)⁴ and the values of the crashes were applied as found in Exhibit 4. Guidance states that only 10% of safety costs are external; as a result, safety benefits of modal diversion were factored down to only consider the external damages. ***While there are safety benefits from modal diversion, monetizing the benefits according to Guidance results in only a small increase in benefits.***

Emergency Services

Emergency services provide vital services to communities, such as fire response and emergency medical care. The ability for emergency services to respond quickly is essential to reducing damages and decreasing injuries and fatalities. With the addition of an Intelligent Transportation System (ITS) signal preemption systems, emergency response vehicles will be able to reach their destination sooner. This will include sensing and pre-sequencing signal lights to coordinate traffic lights in the corridor.^{5 6}

² Supplemental Materials: <https://connect.ncdot.gov/resources/RAISE2022-IMD/Pages/default.aspx>

³ <https://connect.ncdot.gov/business/DMV/CrashFactsDocuments/2020%20Crash%20Facts.pdf>

⁴ Source: BTS Motor Vehicle Safety Data Table 2-17, <https://www.bts.gov/content/motor-vehicle-safety-data>

⁵ Intelligent Transportation System. Online. NCDOT. <https://www.ncdot.gov/initiatives-policies/Transportation/safety-mobility/its/Pages/default.aspx?msclkid=fe32a008aee111ecb3e031f8d79a80ed>

⁶ Signal Systems. Online. NCDOT. <https://www.ncdot.gov/initiatives-policies/Transportation/safety-mobility/its/Pages/signal-systems.aspx>

The FEMA method for estimating the loss of emergency services (fire and ambulance) was used to estimate the benefits of the Project.⁷ The analysis assumes that the Project results in an improved emergency response time of 30 seconds for the population of Rutherfordton and Spindale (8,190 total). Based on conversations with Foothills RPO and the emergency services provider, the corridor is used for approximately 80% of the emergency calls. With the signal preemption, the net results are positive safety benefits for the Project due to the faster response time. **The emergency access benefit totals \$5.7 million discounted at 7 percent.**

Environmental Sustainability

The Project would result in environmental benefits by saving travel time in the long-term with the roundabout and avoiding VMT through modal diversion from auto to transit.

Emissions Savings from Modal Diversion

With the improvements at bus stops and more visibility of the transit system, it is expected that residents would shift their transportation preferences from auto or walking to riding public transportation. The modal shift from auto to bus produces a reduction in VMT and the avoided VMT decreases the amount of annual nitrogen oxides (NO_x), particulate matter (PM_{2.5}), and carbon dioxide (CO₂) in the atmosphere. Auto and truck emissions rates (g/mile) are estimated based on the California Air Resources Board (CARB) Onroad Emissions Rates model, which was run in order to estimate the long-term change in emissions rates. CARB projected annual emission rates were used to estimate emission rates for 2021-2050.⁸ California has some of the nation's strictest emissions standards; as a result, the rates used in this analysis are conservative.

The tons of reduced emissions were monetized using the recommended values as shown in Exhibit 4. The value of CO₂ avoided was discounted at 3 percent. **While there are emissions benefits from modal diversion and signal coordination, benefits according to Guidance results in only a small increase in benefits.**

Emissions Savings from Reduced Idling and Signal Coordination

The increase in auto and truck travel time will result in a temporary increase in emissions during the construction period, but the reduction in travel time after the project opens results in overall emissions savings for the long-term. The two are netted in this analysis.

The travel time savings for the Project result from improved mobility through the roundabout, saving vehicles an average of 7 to 9 seconds over the analysis period; the travel time savings for the roundabout were provided by NCDOT travel demand modeling.⁹ In addition, it is assumed that the signal coordination for lights in Spindale that are not already coordinated with the corridor, will save each user 1 second per trip.

Emissions rates based on grams per hour for autos and trucks, as found in Exhibit 4, were valued for NO_x, PM_{2.5}, and CO₂ using economic damages per metric ton as found in Guidance. **The emissions savings from reduced idling total \$0.06 million, discounted at 7 percent.**

⁷ Presented in the USDOT's Benefit-Cost Analysis Guidance for Discretionary Grant Programs (December 2018) and described in FEMA's Benefit-Cost Analysis Re-Engineering (BCAR), Development of Standard Economic Values Version 6.0, December 2011

⁸ Raw Data and Results for LDV WTW emissions. Online. California Air Resources Board. November 2020. https://ww2.arb.ca.gov/sites/default/files/2020-11/LDV_MSS_supporting_materials_ISAS_Nov2020.xlsx

⁹ Source: RAB Travel Time Savings - US 221A (Charlotte Rd) at US 74A (College Ave); see Supplemental Materials <https://connect.ncdot.gov/resources/RAISE2022-IMD/Pages/default.aspx>

Quality of Life

Safer and better roads improve the daily life for those living and working in or around Rutherfordton and Spindale. Diverting autos to transit results in noise and congestion savings, but also considers construction delays.

Noise and Congestion Avoided

The VMT avoided by diverting auto users to transit results in noise and congestion savings, as valued by USDOT at \$0.118 per mile in total. **While there are noise and congestion benefits, monetizing the benefits according to Guidance results in only a small increase in benefits.**

Construction Delay

During construction, users will experience delays in the corridor due to reduced speeds. The analysis assumes the corridor traffic will be affected during construction (2025-2027) and average speeds will decrease by 15 miles per hour for approximately half of the traffic. **Delays from construction result in auto and truck hours lost, totaling -\$2.4 million, discounted at 7 percent.**

Mobility and Community Connectivity

The Project allows for improved regional mobility and network connectivity, resulting in better access to the region for commuters, residents, and tourists by all modes. This improved mobility provides bike and pedestrian health and recreation benefits, saves users time, and allows for users to benefit from the new transit amenities included in the Project.

Bike and Pedestrian Health and Recreation

The Project integrates bicycle and pedestrian safety as well as mobility and accessibility into the regional transportation system. With greater multimodal access to the towns, it is anticipated that an increase in walking and cycling would occur. This shift provides health and recreation benefits for those additional pedestrians and cyclists that would utilize the Project components. Guidance provides a benefit of \$7.08 per induced walking trips and \$6.31 per induced cycling trip for users aged 20-74. This analysis assumes a 10% increase in biking and walking due to the Project; baseline trail counts were provided by the Foothills RPO. In total, approximately 138,200 walking trips and 182,600 biking trips are estimated over the analysis period. **The benefit of walking and cycling for health and recreation totals \$0.7 million, discounted at 7 percent.**

Time Savings for Transit Users from Modal Diversion

The Project is estimated to result in an increase in transit ridership of 10%, and of those riders 80% are expected to divert from walking. The travel time savings for diverting from walking to transit is estimated based on Guidance. The average walking trip is estimated to take 0.3 hours and transit is estimated to take 0.2 hours, resulting in a travel time savings of 0.1 hours per trip. **In total, the value of time saved for transit users from modal diversion is \$0.07 million, discounted at 7 percent.**

Transit Amenities

The Project supports transit by providing amenities to the bus stop and reconfiguring the current routes. Amenities that are included in the Project include: bus stop shelters with canopies, bicycle racks at the stop shelters, shelter platform seating, and step-free access to each stop. Each of these added amenities enhance the transit system and provide benefits to the project. A 10% growth rate for ridership was estimated given these enhancements, and 14% of users will benefit from the amenities based on the share of bus stops improved (4) compared to the total number of stops (28). USDOT values the amenities

as found in Exhibit 4 at \$0.94 per trip. **The transit amenity benefit totals \$0.05 million, discounted at 7 percent.**

Economic Competitiveness and Opportunity

Travel Time Savings

The travel time savings for the Project result from improved mobility through the roundabout, saving vehicles an average of 7 to 9 seconds over the analysis period; the travel time savings for the roundabout were provided by NCDOT travel demand modeling.¹⁰ In addition, it is assumed that the signal coordination for lights in Spindale that are not already coordinated with the corridor, will save each user 1 second per trip. The analysis considers the increased corridor traffic due to the bypass opening in 2026.¹¹ Truck and auto value of time is based on Guidance, as presented in Exhibit 4. **The travel time savings for the Project totals \$5.6 million, discounted at 7 percent.**

Auto Operating Costs Avoided

The auto trips diverted to transit saves auto VMT. Auto operating cost savings was estimated using a cost savings of \$0.45 per reduced auto VMT as recommended by Guidance and presented in Exhibit 4. **Auto travel cost savings is negligible, discounted at 7 percent.**

Transit Operating Cost Efficiency Savings

The Project results in efficiencies for the transit route, resulting in operating cost savings. The annual operating cost savings was provided by Rutherford County Transit and is estimated at \$9,867. **The total transit operating cost efficiency savings is \$0.07 million, discounted at 7 percent.**

State of Good Repair

Two state of good repair benefits result from the Project: the remaining value of the Project is captured by the residual value, and a scheduled corridor refurbishment activity's cost would be avoided.

Residual Value

Construction of the new corridor and pathway results in residual value because the Project elements have 30 useful years remaining after the end of the analysis period. The full value of the right of way acquired for the Project was also included in the residual analysis. It was assumed that 80 percent of the capital costs for construction, stormwater, and utilities are for infrastructure. The remaining value of the roadway, stormwater, and utilities and right of way acquired was summed and discounted from the last year of the 20-year analysis period. **The value of the remaining useful life for the Project discounted at 7 percent is \$1.7 million.**

Corridor Operating and Maintenance Costs Avoided

NCDOT has scheduled a refurbishment to mill and fill the corridor in 2024 for a cost of \$750,000 under the No Build; with the Project, the road will be repaved and this cost will not be incurred. **Therefore, this cost avoided totals \$0.5 million, discounted at 7 percent.**

¹⁰ Source: RAB Travel Time Savings - US 221A (Charlotte Rd) at US 74A (College Ave); see Supplemental Materials <https://connect.ncdot.gov/resources/RAISE2022-IMD/Pages/default.aspx>

¹¹ NCDOT, Rutherfordton Bypass Traffic Forecast – Oct 2013.pdf; see Supplemental Materials <https://connect.ncdot.gov/resources/RAISE2022-IMD/Pages/default.aspx>

5. Cost Analysis

The Project has two cost components: the initial capital costs and ongoing operating and maintenance (O&M) costs.

Capital Costs

The capital costs for the Project include the costs for right of way, utilities, design, and construction. Exhibit 5 shows the capital costs in 2020 dollars.

Exhibit 5 – Undiscounted Capital Costs—in 2020 Dollars

Category	Cost
Design	\$1,063,523
ROW	\$966,839
Utilities	\$1,933,678
Construction	\$17,499,788
Stormwater	\$241,710
Transit	\$107,319
ITS/EV	\$130,523
Total	\$21,943,381

Source: NCDOT

The capital costs are applied over the individual project construction periods, beginning with design and engineering in summer 2023 and ending construction in summer 2027. Capital costs were estimated in 2022 dollars and converted to 2020 dollars using the deflator provided in Guidance, resulting in a total cost of \$21.9 million. ***The total capital costs for the Project discounted at 7 percent are \$14.9 million.***

Annual Operating and Maintenance Costs

The Project requires annual and periodic O&M expenditures to maintain the new corridor, trail, signals, and pavement. In the Build, the annual O&M is estimated to be 0.5% of the capital costs. ***The net O&M cost over the analysis period and discounting at 7 percent is \$0.8 million. This cost is deducted from the benefits in the BCA.***

6. BCA Results

The analysis results in a total Project Benefit-Cost Ratio (BCR) of 1.56 when discounted at a rate of 7 percent. Exhibit 6 displays a summary of the BCA results for the total Project.

Exhibit 6 – BCA Results for the Project

	\$2020 Millions
	Discounted to 2020 at 7%
Costs	20-Year Analysis
Capital Costs	\$14.9
Total Costs	\$14.9
Safety	
Roadway Safety and Modernization	\$11.9
Safety from Modal Diversion	\$0.00001
Emergency Services	\$5.7
Environmental Sustainability	
Emissions Savings from Modal Diversion	\$0.0005
Emissions Savings from Reduced Idling and Signal Coordination	\$0.06
Quality of Life	
Noise & Congestion Avoided	\$0.0005
Construction Delay	-\$2.4
Mobility and Community Connectivity	
Bike and Pedestrian Health & Recreation	\$0.68
Time Savings for Transit Users from Modal Diversion	\$0.07
Transit Amenities	\$0.05
Economic Competitiveness and Opportunity	
Travel Time Savings	\$5.6
Auto Operating Costs Avoided	\$0.002
Transit Operating Cost Efficiency Savings	\$0.07
State of Good Repair	
Residual	\$1.7
Corridor O&M Costs Avoided	\$0.5
O&M Costs	-\$0.8
Total Benefits	\$23.3
Benefit-Cost Ratio	1.56
Net Benefits	\$8.3

Appendix A List of Supporting Documents

AECOM, "BCA.xls" excel workbook

FEMA Benefit-Cost Analysis Re-Engineering (BCAR), Development of Standard Economic Values Version 6.0, December 2011. Online. <https://www.mass.gov/doc/fema-benefit-cost-analysis-re-engineering-bcar-version-45-may-2009/download>

FHWA Highway Cost Allocation Study, 2000 Addendum, Table 13, <https://www.fhwa.dot.gov/policy/hcas/addendum.cfm>

Intelligent Transportation System. Online. NCDOT. <https://www.ncdot.gov/initiatives-policies/Transportation/safety-mobility/its/Pages/default.aspx?msckid=fe32a008aee111ecb3e031f8d79a80ed>

NCDOT, Safety Analysis, SafetyAnalysis.pdf

NCDOT, RAB Travel Time Savings - US 221A (Charlotte Rd) at US 74A (College Ave).pdf

NCDOT, Rutherfordton Bypass Traffic Forecast – Oct 2013.pdf

Raw Data and Results for LDV WTW emissions. Online. California Air Resources Board. November 2020. https://ww2.arb.ca.gov/sites/default/files/2020-11/LDV_MSS_supporting_materials_ISAS_Nov2020.xlsx

Signal Systems. Online. NCDOT. <https://www.ncdot.gov/initiatives-policies/Transportation/safety-mobility/its/Pages/signal-systems.aspx>

USDOT Benefit Cost Analysis Guidance 2022, <https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20%28Revised%29.pdf>