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| Benefit-Cost Analysis Memorandum  Corridor K Improvements in Graham County  US 129, NC 143, NC 28 (A-0009)  2023 Rural Grant Application  Prepared for NCDOT |

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# Executive Summary

A benefit-cost analysis (BCA) was conducted for Corridor K Improvements in Graham County (hereafter called the Project) to support the North Carolina Department of Transportation’s (NCDOT’s) grant application for the USDOT 2023 Rural Surface Transportation Grant (RURAL) program. This analysis was conducted in accordance with the 2023 *Benefit-Cost Analysis Guidance for Discretionary Grant Programs* (Guidance).[[1]](#footnote-2) Capital outlays are scheduled to begin in 2023 and construction is scheduled for completion in 2028. All values are in 2021 dollars discounted at a 7 percent discount rate to 2021 and cover a 20-year operations period, 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.

Exhibit 1 **–** Impact Matrix

| **Current Status/Baseline** | **Change to Baseline** | **Benefit** | **Affected Population** | **Economic Benefit (NPV, $2021M)** | **Page Reference in BCA Memo** |
| --- | --- | --- | --- | --- | --- |
| The Project is the final phase of the Appalachian Regional Commission Corridor K between Andrews, NC and Stecoah, NC. This segment serves as an alternative route to the US 74 corridor through the Nantahala Gorge. Due to the topography of the roadway, there are very limited alternative routes in the area and any major accident along the stretch will reroute to US 74. This can cause multi-hour delays. The narrow roadway also causes longer than normal clearance times for vehicles involved in accidents and emergency service vehicles. | This corridor segment will provide an improved system of transportation for both routine travel and emergency travel in the event of a national crisis by reducing the slope of the roadway as well as widening the road for shoulder pull-offs. The proposed project will restore the good condition of infrastructure and result in travel time savings, delays and detours avoided, emissions savings, emergency response improvements, and improved recreational access. | **Safety Benefits** | | | |
| Reduced Roadway Fatalities and Crashes | All corridor users | $44.7 | 10 |
| Emergency Services | All regional users and non-users | $11.1 | 10 |
| Wildlife Safety | Wildlife and corridor drivers | Negligible | 11 |
|  | | | |
| **Economic Impacts, Freight Movement, and Job Creation** | |  |  |
| Auto Travel Time Savings | Corridor auto users | $63.9 | 11 |
| Truck Travel Time Savings | Corridor truck drivers | $4.2 | 11 |
| Truck Operating Savings | Corridor truck operators | $7.3 | 11 |
| Signal Coordination Time Savings | Users in Robbinsville | $3.6 | 11 |
| Maintenance Detour Delays Avoided | US 74 users | $14.3 | 11 |
| DMS/Trailblazers Detour Delays Avoided | All corridor and US 74 users | $81.9 | 11 |
| Agricultural Market Accessibility Benefit | Graham and Swain County farms | $35.6 | 12 |
|  | | | |
| **Climate Change, Resiliency, and the Environment** | | | |
| Emissions Savings | All regional users and non-users | $2.4 | 12 |
|  | | | |
| **Equity, Multimodal Options, and Quality of Life** | | | |
| Paratransit Travel Time Savings | Graham County transit users | $0.4 | 13 |
|  |  |  |  |
| **Innovation Areas: Technology, Project Delivery, and Financing** | |  |  |
| Resident and Visitor Recreation | Graham County bikers and hikers | $0.2 | 13 |
|  |  |  |  |
| **State of Good Repair** |  |  |  |
| Net Operating & Maintenance Cost Savings | NCDOT and NC taxpayers | $8.8 | 13 |
| Residual Value | NCDOT and NC taxpayers | $23.8 | 14 |

Exhibit 2 summarizes long term outcomes of the Project. Taken in total, the Project provides $302.2 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 1.23, a solid return on this critical investment for the region. The net benefits of the Project are $57.3 million using a 7 percent discount rate.

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

|  |  |
| --- | --- |
|  | Total Project |
| Analysis Period: (20 years) | 7% Discount Rate |
|  | 2028-2048 |
| Costs (2021$M) |  |
| Capital Cost | $244.9 |
| ***Total Costs*** | ***$244.9*** |
| **Safety Benefits** |  |
| Reduced Roadway Fatalities and Crashes | $44.7 |
| Emergency Services | $11.1 |
| Wildlife Safety | Negligible |
| *Subtotal* | *$55.8* |
| **Economic Impacts, Freight Movement, and Job Creation** | |
| Auto Travel Time Savings | $63.9 |
| Truck Travel Time Savings | $4.2 |
| Truck Operating Savings | $7.3 |
| Signal Coordination Time Savings | $3.6 |
| Maintenance Detour Delays Avoided | $14.3 |
| DMS/Trailblazers Detour Delays Avoided | $81.9 |
| Agricultural Market Accessibility Benefit | $35.6 |
| *Sub-Total* | *$210.8* |
| **Climate Change, Resiliency, and the Environment** |  |
| Emissions Savings | $2.4 |
| *Sub-Total* | *$2.4* |
| **Equity, Multimodal Options, and Quality of Life** |  |
| Paratransit Travel Time Savings | $0.4 |
| *Sub-Total* | *$0.4* |
| **Innovation Areas: Technology, Project Delivery, and Financing** |  |
| Resident and Visitor Recreation | $0.2 |
| *Sub-Total* | *$0.2* |
| **State of Good Repair** |  |
| Net Operating & Maintenance Cost Savings | $8.8 |
| Residual Value | $23.8 |
| *Sub-Total* | *$32.6* |
| ***Total Benefits*** | ***$302.2*** |
| **Results** |  |
| Net Present Value (2021 $M) | $57.3 |
| Benefit-Cost Ratio | 1.23 |

# Introduction

Safe, reliable, and affordable transportation is an urgent challenge faced by many across the nation. The Corridor K Improvements in Graham County Project will upgrade the existing roadway and complete the final segment of Appalachian Regional Commission Corridor K between Andrews, NC and Stecoah, NC[[2]](#footnote-3).

The Project is part of a multi-phased project aimed at addressing transportation challenges related to safety, mobility, and access along the corridor to create a safe and efficient facility for all users. Once complete, this corridor will provide for the national economic interests, enhance local economic development opportunities along and near the corridor, and provide an improved system of transportation for both routine travel and emergency travel in the event of a regional crisis. The proposed project will restore the good condition of infrastructure that supports commerce and economic growth; advance national or regional economic development in areas of need; and reduce barriers separating workers from employment centers by reducing transportation network gaps to connect peripheral regions to urban areas and job opportunities.

The Project will consist of a combination of infrastructure and technological improvements to address transportation challenges along the corridor, create a safe and efficient facility for all modes, and address multiple criteria in the RURAL Grant program. These include Safety Benefits; Economic Impacts, Freight Movement, and Job Creation; Climate Change, Resiliency, and the Environment; Equity, Multimodal Options, and Quality of Life; Innovation Areas: Technology, Project Delivery, and Financing; and State of Good Repair. In some cases, the expected Project outcomes apply to more than one of the benefit categories.

* ***Safety Benefits***: The Project improves safety in several ways:
* In instances where the corridor is realigned with a modified slope and added passing and climbing lanes, the improved geometry and right of way will reduce the potential for crashes. This will also reduce emergency response travel times, saving lives and property; and
* The wildlife and pedestrian bridge will separate wildlife from vehicular traffic, resulting in fewer conflicts and their associated damage.
* ***Economic Impacts, Freight Movement, and Job Creation***: Three types of economic competitiveness benefits are estimated as part of the BCA:
  + The intelligent transportation system (ITS) components will alert drivers of long delays due to incidents on US 74, allowing them the opportunity to reroute, and will provide signal coordination in Robbinsville, both of which will produce travel time savings for commuters;
  + The grade modification and climbing lanes along the corridor will reduce travel time and provide an ease of use for motorists, including commercial vehicles; and
  + The more efficient travel through the corridor results in time savings which will also marginally reduce transportation costs for farms within the region.
* ***Climate Change, Resiliency, and the Environment***: Project improvements that result in travel time savings for users also reduce motorized emissions through a reduction in idling.
* ***Equity, Multimodal Options, and Quality of Life***: Mobility benefits are realized through the Project by paratransit travel time savings.
* ***Innovation Areas: Technology, Project Delivery, and Financing***: The Project increases Quality of Life by enhancing the recreational benefit for trail users by connecting the Appalachian Trail with additional parking spaces.
* ***State of Good Repair***: State of Good Repair benefits include the residual value of the investment and annual operating and maintenance cost savings compared to the No Build.

# 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. Construction for the Project is scheduled from 2023 through 2028 and results in the project opening in 2028. As such, benefits are applied for 2028 through 2048 in the analysis.

The benefits are expressed in constant 2021 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 2021-dollar terms.[[3]](#footnote-4)

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.

# Analysis Assumptions

A list of assumptions for the Project is provided in the BCA workbook (see Inputs tab in the file A-0009 Benefit Cost Analayis.xlsx) as well as in Exhibit 4.

Exhibit 4 **–** BCA Calculation Inputs

|  |  |  |
| --- | --- | --- |
| **Input** | **Value** | **Source** |
| **General** |  |  |
| Discount Rate | 7% | January 2023 BCA Guidance for Discretionary Grant Programs |
| SCC Discount Rate - CO2 | 3% | January 2023 BCA Guidance for Discretionary Grant Programs |
| Deflator | See "Deflator" Sheet | <https://www.whitehouse.gov/wp-content/uploads/2022/03/hist10z1_fy2023.xlsx> |
| Begin Construction year | 2023 | NCDOT |
| Complete Construction year | 2028 | NCDOT |
| Analysis Period | 20 |  |
| Dollar Year | 2021 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Discount year | 2021 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Benefit Year | 2028 | NCDOT |
| Factor for half year benefits | 0.5 | NCDOT |
| **Traffic Data Assumptions** |  |  |
| Percentage of Trucks | 6% | TSG Engineers; STIP Project No. A-0009C - Passing and Climbing Lane Documentation |
| Annualization Factor | 320 | Assumption |
| Annualization Factor for paratransit (demand response) | 288 | Graham County Transit |
| Annual Growth Rate (CAGR) | 3.2% | TSG Engineers; STIP Project No. A-0009C - Passing and Climbing Lane Documentation |
| Average Corridor Travel Time without Project (hr) | 0.25 | TSG Engineers; STIP Project No. A-0009C - Passing and Climbing Lane Documentation |
| Average Corridor Travel Time with Project (hr) | 0.13 | TSG Engineers; STIP Project No. A-0009C - Passing and Climbing Lane Documentation |
| Average Corridor Travel Time Savings (hr per veh) | 0.12 | TSG Engineers; STIP Project No. A-0009C - Passing and Climbing Lane Documentation |
| US 74 closure per vehicle per instance (hours) | 3.54 | TIMS Data |
| US 74 Maintenance detour (hours) | 0.3 | Google Maps |
| Net Maintenance time savings (hours) per vehicle | 0.5 | Assumption |
| US 74 closure or detours per year | 32.6 | TIMS Data |
| NC 143 Maintenance detour (annual frequency) | 13 | Graham County NC 143, 5-yr Maint. Costs, NCDOT |
| Average Passenger Vehicle Occupancy, all travel | 1.67 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Delay savings with coordinated signals (per trip) | 0.40 | Source: <https://connect.ncdot.gov/resources/safety/Teppl/TEPPL%20All%20Documents%20Library/Signal%20System%20Timing%20Philosophy%20Manual.pdf> |
| **State of Good Repair** |  |  |
| Highway and Streets Service Life | 45.00 | BEA Rate of Depreciation, Service Lives, Declining-Balance Rates, and Hulten-Wykoff Categories |
| **Economic Competitiveness** |  |  |
| Vehicle Maintenance Cost per Mile (Gas, Maintenance, Tires, Depreciation) (2021$/Mile) -- Light Duty Vehicles | $0.46 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Value of Time (2021$), all purposes | $18.80 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Value of Time, (2021$), truck driver per hour | $32.40 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Truck operating costs per hour (2021$) | $55.97 | Table 9 ATRI Operational Cost of Trucking 2023. Includes fuel, truck/trailer lease, repair, maintenance, driver benefits, tires, and insurance. Excludes driver time (valued in travel time savings); https://truckingresearch.org/wp-content/uploads/2023/06/ATRI-Operational-Cost-of-Trucking-06-2023.pdf |
| Value of Time (2021$), bus driver | $35.00 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Average paratransit bus passengers per month | 1,505 | Graham County Transit Director (email dated 1/23/23) |
| Average Annual paratransit bus passengers | 18,060 | Calculation |
| Average Trip Counts by month (NCDOT) | 24 | Graham County Transit Director (email dated 1/23/23) |
| **Safety** |  |  |
| PDO Damage values (2021$) | $4,800 | January 2023 BCA Guidance for Discretionary Grant Programs |
| O – No Injury (2021$) | $4,000 | January 2023 BCA Guidance for Discretionary Grant Programs |
| C – Possible Injury (2021$) | $78,500 | January 2023 BCA Guidance for Discretionary Grant Programs |
| B – Non-incapacitating (2021$) | $153,700 | January 2023 BCA Guidance for Discretionary Grant Programs |
| A – Incapacitating (2021$) | $564,300 | January 2023 BCA Guidance for Discretionary Grant Programs |
| K – Killed (2021$) | $11,800,000 | January 2023 BCA Guidance for Discretionary Grant Programs |
| U – Injured (Severity Unknown) (2021$) | $213,900 | January 2023 BCA Guidance for Discretionary Grant Programs |
| # Accidents Reported (Unknown if Injured) (2021$) | $162,600 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Injury crash (2021$) | $307,800 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Fatal crash (2021$) | $13,046,800 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Number of Annual Trail Trips in 2022 - Walking | 8,082 | Extrapolated data from Appalachian Trail Conservancy |
| Per Person per mile, pedestrian Improvement | 0.11 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Mortality Reduction Benefits Induced Active Transportation - Walking (2021$) | 7.2 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Mortality Reduction Benefits Induced Active Transportation - Cycling (2021$) | 6.42 | January 2023 BCA Guidance for Discretionary Grant Programs |
| Number of current parking spaces | 6 | NCDOT |
| Number of added parking spaces | 2 | NCDOT |
| Deer Hit near Wildlife Bridge - Year 2018 (annual) | 1 | NCDOT |
| **Environmental** |  |  |
| Light Vehicle Idle Emissions Rates (average 3.515,4.065) g/hr. NOx | 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. CO2 | 2,444 | Greenhouse Gas Emissions from a Typical Passenger Vehicle, EPA |
| Heavy Duty (Class VII) Idle Emissions Rates g/hr. NOx | 30.343 | Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks Emission Facts, EPA420-F-08-025, October 2008 |

# Benefit Analysis

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

## Safety Benefits

A key goal of the Project is to reduce the likelihood of fatalities, injuries, and property damage that result from crashes given the current road hazards. Through roadway safety and modernization, safety of the corridor is improved and provides better access to the area and region. The Project would result in safety benefits by modernizing the corridor through grade modification and the addition of passing and climbing lanes. This will improve motorist and emergency service transit and access along the corridor. The Project will also include a dedicated bridge separating wildlife and pedestrians from auto traffic.

### *Reduced Roadway Fatalities and Crashes*

An important aspect of the Project is the implementation of roadway modernization. The proposed roadway will widen lanes with alternate climbing and passing lanes, widen and pave shoulders, and modify super elevations to improve flow.

NCDOT provided the crash history in the corridor across three segments over the past five years, which totaled 270 crashes. One incident in the crash history was a pedestrian. Crash modification factors (CMFs) were assigned by NCDOT by segment to reflect project conditions throughout the corridor. Given the independence of the elements, CMFs were compounded to create a combined CMF in areas where there were multiple project aspects in a particular segment[[4]](#footnote-5). NCDOT backup data and calculations are included in the BCA workbook. The Project is estimated to eliminate 19 crashes annually 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 $44.7 million, discounted at 7 percent.***

### *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 dynamic message boards, climbing lanes, and slope realignment, emergency response vehicles will be able to reach their destinations sooner.[[5]](#footnote-6)

The FEMA method for estimating the loss of emergency services (fire and ambulance) was used to estimate the benefits of the Project.[[6]](#footnote-7) The analysis assumes that the Project results in an improved emergency response time of 8 minutes per vehicle from the climbing lanes for portions[[7]](#footnote-8) [[8]](#footnote-9) of the populations of Graham, Swain, Cherokee, Jackson, and Macon Counties (17,084 population).[[9]](#footnote-10) With the grade and ITS adjustments, the faster response time will allow emergency service providers to reduce the number of deaths from cardiac arrest and property losses due to fire in the service area. ***The emergency access benefit totals $11.1 million discounted at 7 percent.***

### *Wildlife Safety*

The Project improves wildlife safety by providing a dedicated passageway for wildlife as well as wildlife crossing indicators. Historical data has confirmed wildlife encounters with motorists. Using the North Carolina Department of Transportation Animal Crash Data, annual incident data was estimated during the period of analysis for incidents within the Project area. The Colorado Department of Transportation (CDOT) has developed wildlife value estimates and a crash reduction factor of 0.87 to quantity impacts to wildlife located within the Project area. Using the annual wildlife incident data and the CDOT crash reduction factor, wildlife safety events were estimated as a benefit to the Project.[[10]](#footnote-11) ***The wildlife savings associated with the wildlife bridge, however, is negligible.***

## Economic Impacts, Freight Movement, and Job Creation

### *Travel Time Savings*

The travel time savings for the Project result from improved mobility through passing and climbing lanes and through grade modification. Patriot Transportation Engineering, PLLC documented in their Passing Lane/ Climbing Lane technical memorandum that climbing and passing lanes improve mobility along the corridor allowing vehicles to efficiently pass slower moving vehicles.[[11]](#footnote-12) These improvements save vehicles an average of 8 minutes per trip.

In addition to the grade modification and implementation of climbing and passing lanes, time saving is also realized through the signal coordination for lights in Graham County that are not already coordinated with the corridor. Users will save an average of 24 seconds per trip through the corridor using signal coordination. For both time saving opportunities, the analysis considers an annual growth rate of 3.2% throughout the period of analysis based on historical AADT values. Truck and auto value inputs are based on Guidance, as presented in Exhibit 4. ***The travel time savings for the Project total $68.1 million, discounted at 7 percent.***

### *Truck Operating Cost Savings*

The Project results in efficiency for truck operators, resulting in operating cost savings. The annual operating cost saving is provided by the American Transportation Research Institute Operational Cost of Trucking 2022[[12]](#footnote-13) and is estimated at $59.85 per hour. This estimate excludes the value of truck driver time, which is included in the Travel Time Savings benefit. ***The total truck operating cost savings is $7.3 million, discounted at 7 percent.***

### *Dynamic Message Signs (DMS) and Trailblazer Detour Delays Avoided*

The Project results in avoided travel time for auto and truck drivers travelling along the corridor with the implementation of ITS through DMS and trailblazers. These systems will alert users en route to US 74 ahead of current landslides, accidents, and/or unforeseen maintenance delays. DMS and trailblazers reduce travel time by notifying commuters in advance, prior to them initiating their journey along the impacted segment of US 74. On average, DMS and trailblazer detours save the traveler 3.5 hours, as estimated by the average maintenance times in the Traffic Incident Management System (TIMS) data provided by NCDOT[[13]](#footnote-14). Auto and truck trips diverted reduce the wait time for maintenance and landslide delays, saving vehicle hours travelled (VHT). The frequency of these incidents along US 74 was calculated to be 33 incidents per year using TIMS data provided by NCDOT. Operating cost and time savings were used to estimate the detour avoidance benefit for the Project based on those recommended by Guidance and presented in Exhibit 4. ***Detour cost savings resulting from DMS/trailblazers and maintenance delays total $81.9 million, discounted at 7 percent.***

### *Agricultural Market Accessibility*

The project increases accessibility for farmers and the agricultural industry located within the region. As of 2017, there were over one thousand farms in Graham, Swain, Cherokee, Jackson, and Macon Counties.[[14]](#footnote-15) With the Project improvements, farms in the region are supported and marginal transportation costs are saved through ease of accessibility. Additionally, tourists can also access the farms and nearby National parks more reliably. This improved accessibility along the corridor reduces delays, shipping costs, and ultimately prices to the end users[[15]](#footnote-16). The annual value of improvement was calculated using the estimated impacted expenses by county, the proportion of expenses related to travel, including indirect labor expenses, and the proportion of affected farmers. It was estimated that 60 percent of the total farms would be impacted. Assuming most of these farmers service the local community, transportation-related expenses were reduced by 8 percent with the Project elements. ***The total agricultural market accessibility benefit totals $35.6 million, discounted at 7 percent.***

## Climate Change, Resiliency, and the Environment

The Project would result in environmental benefits by saving travel time from the slope and passing lane improvements and reduced idling from the implementation of the DMS and trailblazers.

### *Emissions Savings from Reduced Idling*

Travel time savings for the Project result from improved mobility through the corridor by improving the slope with road modifications as well as passing and climbing lanes, saving vehicles an average of 8 minutes per trip in the corridor; the travel time savings for the slope and climbing lane modifications provided by TSGS Engineers in their Climbing and Passing Lane Documentation[[16]](#footnote-17). In addition, it is assumed that the ITS signal coordination for Robbinsville signals that are not already coordinated with the corridor will save each user approximately 24 seconds per trip.[[17]](#footnote-18) Finally, the avoidance of long delays due to incidents on US 74 through the use of DMS and trailblazers will save users 3.5 hours for each of the 33 average annual incidents. This travel time savings reduces emissions and the associated impacts to the community.

Emissions rates are based on grams per hour for autos and trucks, as found in Exhibit 4, and were valued for NOx, PM2.5, and CO2 using economic damages per metric ton as found in Guidance. The value of CO2 avoided was discounted at 3 percent. ***The emissions savings from reduced idling total $2.4 million, discounted at 7 percent and 3 percent for CO*2*.***

## Equity, Multimodal Options, and Quality of Life

The Project allows for improved regional mobility and network connectivity, resulting in better access to the region for commuters, residents, and tourists through improved paratransit. This improved mobility enhances paratransit service times for users.

### *Travel Time Savings for Paratransit Users*

The Project is estimated to reduce the travel time for the existing paratransit system users. The paratransit system is a demand response service that operates over 13,000 trips in the corridor annually. There are a total of 9 vehicles that operate weekly along the corridor. The travel time savings from the slope modification and road widening will provide better access to those using the demand-response system. Corridor travel time improvements were estimated at an 8-minute improvement with annual transit savings estimated based on Guidance. ***In total, the value of time saved for transit users from travel time savings is $0.4 million, discounted at 7 percent.***

## Innovation Areas, Technology, Project Delivery and Financing

The Appalachian Trail is an attraction for residents and tourists travelling to and through Graham and Swain Counties. With the addition of the connected trail, pedestrians and wildlife can continue along the Appalachian Trail fluidly and with less risk of motor incidents. Parking accessibility was an inhibitor and the addition of two parking spaces will also encourage new tourists to the area for recreational activity.

### *Pedestrian Facility Improvements*

The Project allows for greater access to the Appalachian Trail with a dedicated and widened bridge to allow for pedestrian and wildlife to cross the roadway. This pedestrian bridge allows users to continue along the trail, enhancing their recreational benefit and inducing recreational walking benefits. Guidance provides a benefit of $0.11 for the widening of the trail. ***The*** ***pedestrian improvement benefit is negligible.***

### *Pedestrian Health and Recreation*

The Project integrates pedestrian safety as well as mobility and accessibility into the regional transportation system. The Appalachian Trail is frequented by visitors daily. The corridor is currently limited by its current parking availability. The Project encourages visitors to utilize the trail by adding 33 percent more parking spaces. With greater multimodal access to the region’s natural resources, it is anticipated that an increase in walking would occur. This shift provides health and recreation benefits for those additional pedestrians that would utilize the Project components. Guidance provides a benefit of $7.2 per induced walking trips for users aged 20-74. This analysis applies a 33% increase in walking due to the Project parking improvements. Baseline trail counts were provided by the Appalachian National Scenic Trail Conservancy. In total, approximately 128,500 walking trips are estimated over the analysis period. ***The benefit of walking for health and recreation totals $0.2 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 at the end of the analysis period and avoided recurring operating and maintenance costs of the existing roadway.

### *Roadway Operating and Maintenance Costs Avoided*

Given the condition of the existing roadway, NCDOT has scheduled a series of activities along the corridor beginning in 2025 under the No Build. This includes a full asset renewal update consisting of re-pavement, pipe and headwall replacement, guardrail replacement and upgrade, and bridge replacement. The total cost for the full rehabilitation project in 2025 is estimated at $10.3 million. Additionally, subsequent activities are expected with re-pavement occurring every 15 years and the guardrail replacement and upgrade occurring every 20 years. ***The roadway O&M costs avoided total $8.8 million, discounted at 7 percent.***

### *Residual Value*

Construction of the new roadway results in residual value because the Project elements have 40 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 are for infrastructure. The remaining value of the roadway and right of way at the end of the analysis period 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 $23.8 million.***

# Cost Analysis

The Project has two cost components: the initial capital costs and annual 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 2021 dollars.

**Exhibit 5 – Undiscounted Capital Costs—in 2021 Dollars**

|  |  |
| --- | --- |
| **Year** | **Cost** |
| 2022 | $6,056,412 |
| 2023 | $54,508,518 |
| 2024 | $60,076,945 |
| 2025 | $65,512,807 |
| 2026 | $65,512,807 |
| 2027 | $46,606,528 |
| 2028 | $5,435,862 |
| Total | **$324,622,000** |

Source: NCDOT

The capital costs are applied over the individual project construction periods, beginning in 2022 and ending in 202. Capital costs were estimated in 2022 dollars and converted to 2021 dollars using the deflator provided in Guidance, resulting in a total cost of $324.6 million (2022 dollars) and $303.7 million (2021 dollars). ***The total capital costs for the Project discounted at 7 percent are $244.9 million.***

## *Annual Operating and Maintenance Costs*

The Project requires annual and periodic O&M expenditures to maintain the roadway, bridge, signals, and pavement. O&M estimates for the Build scenario were provided by NCDOT and is estimated at $48,000 in the No Build and $77,000 in the Build, resulting in a net increase in O&M for the pavement. Periodic renewal costs avoided are described in the Roadway Operating and Maintenance Costs Avoided section. ***The Build O&M cost over the period of analysis is $1.3 million, discounted at 7 percent. (This is included in the Benefits total as a disbenefit to the Project.)***

# BCA Results

The analysis results in a total Project Benefit-Cost Ratio (BCR) of 1.23 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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| |  |  | | --- | --- | |  | Total Project | | Analysis Period: (20 years) | 7% Discount Rate | |  | 2028-2048 | | Costs (2021$M) |  | | Capital Cost | $244.9 | | ***Total Costs*** | ***$244.9*** | | **Safety Benefits** |  | | Reduced Roadway Fatalities and Crashes | $44.7 | | Emergency Services | $11.1 | | Wildlife Safety | Negligible | | *Subtotal* | *$55.8* | | **Economic Impacts, Freight Movement, and Job Creation** | | | Auto Travel Time Savings | $63.9 | | Truck Travel Time Savings | $4.2 | | Truck Operating Savings | $7.3 | | Signal Coordination Time Savings | $3.6 | | Maintenance Detour Delays Avoided | $14.3 | | DMS/Trailblazers Detour Delays Avoided | $81.9 | | Agricultural Market Accessibility Benefit | $35.6 | | *Sub-Total* | *$210.0* | | **Climate Change, Resiliency, and the Environment** |  | | Emissions Savings | $2.4 | | *Sub-Total* | *$2.4* | | **Equity, Multimodal Options, and Quality of Life** |  | | Paratransit Travel Time Savings | $0.4 | | *Sub-Total* | *$0.4* | | **Innovation Areas: Technology, Project Delivery, and Financing** |  | | Resident and Visitor Recreation | $0.2 | | *Sub-Total* | *$0.2* | | **State of Good Repair** |  | | Net Operating & Maintenance Cost Savings | $8.8 | | Residual Value | $23.8 | | *Sub-Total* | *$32.6* | | ***Total Benefits*** | ***$302.2*** | | **Results** |  | | Net Present Value (2021 $M) | $57.3 | | Benefit-Cost Ratio | 1.23 | |  |
|  |  |

1. List of Supporting Documents

AECOM, “A-0009 Benefit Cost Analysis.xlsx” excel workbook

NCDOT, “Carter responses on proposed improvements A-0009 grant”. Excel Workbook

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Wild Animal Benefit-to-Cost Spreadsheet. Colorado Department of Transportation. Online. https://codot.gov/programs/research/pdfs/2022/wildlife-prioritization/eswps-bca-instructions

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2. 2023 Benefit Cost Analysis Guidance. USDOT. Retrieved Online. <https://www.transportation.gov/sites/dot.gov/files/> 2023-01/Benefit%20Cost%20Analysis%20Guidance%202023%20Update.pdf [↑](#footnote-ref-3)
3. Table 10.1 – Gross Domestic Product and Deflators Used in the Historical Tables: 1940-2027. Online. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.whitehouse.gov%2Fwp-content%2Fuploads%2F2022%2F03%2Fhist10z1\_fy2023.xlsx&wdOrigin=BROWSELINK [↑](#footnote-ref-4)
4. NCDOT, “Carter responses on proposed improvements A-0009 grant”. Excel Workbook [↑](#footnote-ref-5)
5. Signal Systems. Online. NCDOT. <https://www.ncdot.gov/initiatives-policies/Transportation/safety-mobility/its/Pages/signal-systems.aspx> [↑](#footnote-ref-6)
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