RAISE GRANT PROGRAM
Benefit-Cost Analysis Technical Memorandum

Prepared for

Connecting the Community
US 21/SC 802 Corridor Improvements Project
Beaufort County, South Carolina

Submitted by

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1.0 Executive Summary

Located on Lady's Island in Beaufort County, South Carolina, the "US 21 Business/US 21 (Sea Island Parkway), US 21 (Lady's Island Drive), and SC 802 (Sam's Point Road) Mainline Improvements" project (aka US 21/SC 802 Corridor Improvements) is a critical corridor improvement for this region with a primary intersection. These two corridors – 1) US 21 Business/US 21 (Sea Island Parkway) and 2) US 21 (Lady's Island Drive)/SC 802 (Sam's Point Road) - are urban minor arterials serving all traffic on Lady's Island as well as all traffic for St. Helena Island, Harbor Island, Hunting Island, Fripp Island, Capers Island, Dataw Island, and other outer sea islands. In addition, US 21 (Lady's Island Drive/Sea Island Parkway) is a hurricane evacuation route. These corridors provide the only access to the boundary islands making it the only available hurricane evacuation route.

Currently, the primary intersection for the US 21/SC 802 Corridor Improvements has a level of service (LOS) of F. The main intersection has begun to reach full capacity in the AM and PM peak hours with long queues expected to develop in the future, blocking access for side streets and driveways. The future traffic increases for US 21 will increase side street delays which already have issues making left turns onto US 21.

Inadequate capacity and design contribute to safety issues within the project area. Eight (8) years of traffic data were obtained between January 1, 2012, and December 31, 2019, had 1,021 crashes with four (4) fatalities and 326 serious injuries.

A Benefit-Cost Analysis (BCA) was conducted for the US 21/SC 802 Corridor Improvements Project for submission to the United States Department of Transportation (USDOT) as a requirement for the 2022 RAISE discretionary grant program. The analysis was conducted in accordance with the benefit-cost analysis methodology as recommended by USDOT. The BCA covers a 25-year analysis period with three (3) years of design, two (2) years of construction, and twenty (20)-years of benefits. Future construction and development costs are estimated at $29.3 million in discounted 2020 dollars for engineering, construction, and right-of-way land acquisition. Costs estimated to be spent on operations and maintenance (O&M) amount to $12.6 million in discounted 2020 dollars and the total construction, O&M, and development costs are $41.9 million in discounted 2020 dollars. For the purposes of this BCA, all costs and benefits were inflated or discounted to 2020 dollars using 7-percent discount rate.

Relevant data and calculations utilized to compile the benefits and costs of the project are shown in the BCA model that accompanies this grant application. Based on the analysis depicted and outlined in this document, the project is expected to generate $95.2 million in discounted benefits and $41.9 million in discounted costs, using a 7-percent real discount rate. Therefore, the Benefit/Cost ratio of 2.27 for the 7-percent discount rate was calculated as shown in **Table 1** below.

Summary of BCA Outcomes

Project Evaluation Metric	Savings (Millions 2020$)	
	Undiscounted	Present value Discounted 7%
Total Benefits	$283.7	$95.2
Total O&M Costs	$22.1	$12.6
Total Construction Costs*	$41.3	$29.3
Net Present Value	$220.3	$53.3
Benefit/Cost Ratio	4.48	2.27

*Includes Engineering, ROW acquisition and construction.

In addition to the monetized benefits, the project would generate benefits that are difficult to quantify or are captured wholly or partially within benefit factors discussed elsewhere. A brief description of those benefits is provided qualitatively below.

Agglomeration Economies Benefits/Mobility and Community Connectivity/Quality-of-Life

- The project improves transportation infrastructure that enhances the connections between communities, people, and businesses providing opportunities to reshape the economic geography of the region with the connection to St. Helena Island, having one of the highest poverty rates along the corridor and inclusive of one of the largest Gullah/Geechee communities, as well as the other outer sea islands.
- The project will bring safer cycling lanes and wider multiuse pathways to areas having poverty levels of over 20-percent[1] to promote pedestrian and bicycle travel.
- The project community connection will assist in creating more opportunities for households with higher poverty rates to enjoy positive benefit spillovers from the spatial concentration of economic activity located along the project improvement corridor that also serves as the hurricane evacuation route.
- The project has the potential to impact the size of the labor market and/or future concentrations of economic activities for the surrounding communities inclusive of areas with higher poverty rates.
- The pedestrian, bicycling, and lighting infrastructure improvements will increase safety and encourage all users to travel via non-motorized means while expanding many resource opportunities to the developments along the corridor to underserved communities with minority, lower income, and disabled populations.
- Improvements to pedestrian and bicycle facilities are a large component of the agglomeration, community connectivity, and quality of life benefits, however, these could not be monetized due to the lack of pedestrian/bicycle traffic data for the area needed to use the RAISE guidance tools requiring the number of facility users.

Environmental Sustainability

- The project improvements will decrease emissions due to the modal shift from autos to pedestrian and bicycle transportation. While this benefit isn't monetized as it requires the combination of the benefits from the smaller local "Access Roads" projects to provide a savings in vehicular miles traveled per the guidance.
- Stormwater management water quality will be enhanced through new water quality innovative methods.

Economic Competitiveness and Opportunity

- Vehicle operating costs will be a savings along the corridor project but cannot be monetized without the inclusion of the "Access Roads" projects to show a decrease in vehicle miles traveled (VMT).

State of Good Repair

- The project will bring major renewal to aging infrastructure, upgrading it to modern designs and capacity requirements.
- The project will reduce roadway maintenance costs by converting pavement sections to landscaped areas, and these costs are captured as savings to the O&M between the build and no build condition.

Health Benefits

- Corridor improvements will positively impact generations of all ages and diversities with the encouragement and accessibility to pedestrian and cycling infrastructure promoting exercise.

1 American Community Survey of the Bureau of the Census, 2014-2018 5-year Poverty Status in the Past 12 Months estimates data table. United States Census Bureau, 2019, https://data.census.gov/

Innovation

- The project will facilitate the use of innovative technologies such as additional conduit installation for future broadband service.
- The project will include internet Wi-fi access points integrated into the roadway lighting system.

Improvements to System Reliability

- Improvements in road capacity and reduction in traffic congestion typically improve the reliability of travel times as well as the reduction in the number of accidents and corresponding delays when lanes are blocked with disabled vehicles or during times of routine maintenance.

2.0 Introduction

This document provides detailed technical information on the economic analyses conducted in support of the US 21/SC 802 Corridor Improvements Project RAISE grant application. The remainder of this document is organized into the following sections:

- Section 3, Methodological Framework, introduces the conceptual framework used in the BCA.
- Section 4, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the project is expected to generate.
- Section 5, General Assumptions, discusses the general assumptions used in the estimation of project costs and benefits.
- Section 6, Demand Projections, shows the estimates of travel demand and traffic growth.
- Section 7, Benefits Measurement, Data, and Assumptions, presents specific data elements and assumptions pertaining to the long-term outcomes, along with associated benefit estimates.
- Section 8, Summary of Findings and BCA Outcomes, introduces estimates of the Project's Net Present Value (NPV), its Benefit/Cost Ratio (BCR) and other project evaluation metrics.
- Section 9, BCA Sensitivity Analysis, provides the results of the sensitivity analysis depicting tools in the BCA module spreadsheet to allow the user to enter variations in one of four parameter values to evaluate its impact on the BCA results.

Additional data tables are provided within the BCA model including annual estimates of benefits and costs to assist the USDOT in its review of the application[2].

3.0 Methodological Framework

The BCA conducted for this project includes the monetized benefits and costs measured using USDOT guidance, as well as the quantitative merits of the project. A BCA provides estimates of the benefits that are expected to accrue from a project over a specified period and compares them to the anticipated costs of the project. Costs include both the resources required to develop the project and the costs of maintaining the new or improved asset over time. Estimated benefits are based on the projected impacts of the project on both users and non-users of the facility, valued in monetary terms[3].

While a BCA is just one of many tools that can be used in making decisions about infrastructure investments, the USDOT believes that it provides a useful benchmark from which to evaluate and compare potential transportation investments[4]. The specific methodology adopted for this application is based on the BCA guidance developed by USDOT and is consistent with

2 The BCA models do not accompany this report, they are provided separately as part of the application.
3 USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, March 2022.
4 Ibid

the RAISE program guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the build and no-build scenarios;
- Assessing benefits with respect to each of the merit criteria identified in the Notice of Funding Opportunity (NOFO);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using USDOT guidance for the valuation of travel time savings, safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by USDOT (7-percent); and
- Conducting a sensitivity analysis to assess the impacts of changes in key estimating assumptions.

4.0–Project Overview

4.1–Project Description, Current Conditions and Challenges

Project Description

The US 21/SC 802 Corridor Improvements Project limits, see **Figure 1**, are approximately 2.2 miles on US 21 Business/US 21 (Sea Island Parkway) from Woods Memorial Bridge to the causeway for the Chowan Creek bridge, and approximately 1.1 miles on US 21 (Lady's Island Drive)/SC 802 (Sam's Point Road) from Rue Du Bois to Miller Drive West.

Lady's Island and all outer sea islands access the mainland via the Woods Memorial Bridge, a 2-lane swing bridge, into downtown Historic City of Beaufort, utilizing US 21 Business (Sea Island Parkway), or via the J.E. McTeer Bridge, twin 2-lane fixed bridges, into the Town of Port Royal, utilizing US 21 (Lady's Island Drive). These are the only two bridge locations and corridors providing access to Lady's Island and the outer sea islands.

The project at the main intersection of these two corridors is beginning to reach full capacity and have a LOS of F according to the traffic study[5].

The corridor improvements include:

- US 21 Business (Sea Island Parkway) from Woods Memorial Bridge to near US 21/SC 802 intersection
  - Replace 5-ft sidewalks with 5-ft grass buffers and 10-ft multi-use pathways on both sides.
  - Replace 15-ft flush paved median with raised planted/concrete medians for access management.
  - Improve lighting and other streetscaping components.
- US 21 (Sea Island Parkway) from US 21/SC 802 intersection to near the Chowan Creek causeway
  - Provide an additional eastbound travel lane for approximately 2,800 LF Near Airport Circle.
  - Replace 5-ft sidewalks with 5-ft grass buffers and 10-ft multi-use pathways on both sides to Dow Road and replace 5-ft sidewalk with 5-ft buffer and 10-ft multi-use pathway on one side from Dow Road to end of project limits.
  - Replace 15-ft flush paved median with raised planted/concrete medians for access management.
  - Improve lighting and other streetscaping components.

5 Stantec, *Lady's Island Corridor Study.* Beaufort County Penny, 2017, https://beaufortcountypenny.com/wp-content/uploads/pdfs/2017-lady-sislandcorridorstudy-stantecreport.pdf

- US 21 (Lady's Island Drive) from US 21/SC 802 intersection to Rue Du Bois
  - Replace 5-ft sidewalks with 5-ft grass buffer and 10-ft multi-use pathways on both sides.
  - Replace 15-ft flush paved median with raised planted/concrete medians for access management.
  - Improve lighting and other streetscaping components.
- SC 802 (Sam's Point Road) from the US 21/SC 802 intersection to Miller Drive West
  - Replace 5-ft sidewalks with 5-ft grass buffer and 10-ft multi-use pathways on both sides.
  - Replace 15-ft flush median with raised planted/concrete medians for access management.
  - Add bike lanes/shared lanes, future evaluation underway to determine the best design.
  - Improve lighting and other streetscaping components.
- US 21 Business/US 21/SC 802 Intersection (primary intersection)
  - Add dedicated right turn lane on US 21 (Sea Island Parkway) westbound.
  - Add dual left turn lanes from US 21 Business onto SC 802 and US 21 (Sea Island Parkway) onto US 21 (Lady's Island Drive).
  - Design the intersection signal and medians for the new pedestrian and bicycle facilities to improve the "walkability" across the intersection.
  - Improve lighting and other streetscaping components.

Figure 1 Project Limits

Current Conditions

US 21 Business/US 21 (Sea Island Parkway) is currently a three-lane roadway at the Wood's Memorial Bridge which widens out to a five-lane roadway near Youmans Drive. At the marsh, the roadway narrows to four lanes and at airport circle narrows down to a three-lane road. The 2.2-mile section of US 21 Business has a speed limit of 40 miles per hour (mph) from Wood's Memorial Bridge to near Lost Island Road, 50 mph from near Taylor Drive to a location near Hudson Drive, and 55 mph from near Hudson Drive to the study limit at Chowan Creek Bridge. The roadway currently has a 5-foot sidewalk and dedicated bike lane on both sides of the existing road.

US 21 (Lady's Island Drive) is currently a five-lane roadway within the study limits. The 0.6-mile section of US 21 has a speed limit of 45 miles per hour (mph) from the intersection at US 21 Business to just north of Hazel Farm Road. From Hazel Farm Road

to the southern study limit, the speed limit is 55 mph. The roadway currently has a 5-foot sidewalk and dedicated bike lane on both sides of the existing road.

SC 802 (Sam's Point Road) is currently a five-lane roadway within the study limits. The 0.5-mile section of US 21 has a speed limit of 45 miles per hour (mph). The roadway currently has a 5-foot sidewalk on both sides of the existing road.

Challenges

Table 2 Challenges

Challenge	Description	Solution
Hurricane Evacuation Corridor	US 21 (Sea Island Parkway/Lady's Island Drive) is the official route for Lady's Island and the outer sea islands	Close coordination between County, SCDOT, and Contractor should an event occur during construction to maintain the route
Safety	Two Way Left Turn Lane (TWLTL) allowing for multiple movements; multiple driveways for shopping centers	- Access management to include concrete/raised planted medians to define areas for left turns/U-turns to minimize conflicting movements and converting driveways/roads to right-in/right-out
		- Shared driveways, where possible
		- Coordinated signals
		- Extend US 21 eastbound outside through lane at Airport Circle
Corridor Capacity	Existing 3-lane and 5-lane roadways with 4.5-ft bike lanes on three segments and 5-ft sidewalks	- Construct Lady's Island Access Roads to enhance street connectivity
Intersection Capacity	Primary intersection of US 21 Bus. /US 21/SC 802 (aka Sam's Point intersection) w/ approx. 50,000 VPD	- Add right turn lane on SC 802
		- Add right turn lane on US 21 westbound
		- Add dual left turn lanes for eastbound US 21 Bus. and westbound US 21
		- Construct Lady's Island Access Roads to enhance street connectivity
Bicycle and Pedestrian Enhancements	Existing 4.5-ft bike lanes on US 21 Bus and US 21, 5-ft sidewalks adjacent to curb & gutter	- Retain existing 4.5-ft bike lanes as "road" cyclists use them
		- Add shared-lane or 4-ft bike lanes on SC 802
		- Remove existing sidewalks, provide 5-ft grassed shoulder and 10-ft sidewalk/pathway for pedestrians and "recreational" cyclists

4.2–Base Case and Alternatives

The Base Case for the project corridor project is the No Build scenario. The No Build scenario reflects the continuation of current conditions. The corridor will continue at relatively high volumes and poor service levels with congestion continuing to exceed the corridor capacity.

The project Alternative is the build scenario inclusive of the previously mentioned corridor improvements with raised concrete and landscaped medians, 10-ft multi-use pathways along both sides, added grass buffers between pathways, improved overall lighting, intersection improvements with new traffic lights, improved crosswalks, and dual turn lanes at the primary corridor

intersection with access management. The improvements will increase service levels and reduce congestion relative to the overall corridor capacity in addition to the other project benefits outlined in this BCA document.

4.3–Types of Impacts

The US 21/SC 802 Corridor Improvements project is expected to generate the following impacts:

- Safety benefits due to less traffic congestion, access management with raised concrete/landscaped medians with defined areas for U-turns, sharing driveways and converting some access driveways to right in right out only movements, added coordinated signals at other intersections, adding 5-ft grass buffers between the roadway and multi-use paths, and converting 5-ft sidewalks to 10-ft multi-use paths on both sides of the roadway.
- Health benefits and community connection impacts resulting from the enhanced safety encouraging non-motorized travel and exercise.
- Travel time savings to existing traffic due to improved pavement surfaces, turn lanes, and access management with a reduction in the annual vehicle hours traveled (VHT).
- Improvement in the state of repair of roads along the corridor with the avoidance of future costs of resurfacing and repairs.
- Reduction in the number of accidents and the corresponding social accident costs and travel time delays.
- Reinforce the corridor's capacity as the primary connection and hurricane evacuation route for areas having low income and higher poverty levels.
- Facilitate and strengthen connections to lower income and minority areas with higher poverty levels offering safer means of pedestrian/bicycle travel, access to development, resources, and employment opportunities.

4.4–Project Cost and Schedule

The initial project investment development costs include right-of-way (ROW) acquisition, engineering and design, and construction costs. Total project capital investment costs are estimated at $41.3 million in constant dollars included in the project budget occurring between 2022 and ending in 2027. Operation and maintenance costs estimated at $22.1 million in constant dollars to total $63.4 million in constant dollars. As shown in **Table 3** below these values in raw constant dollars equate to a total of $41.9 million in 2020 dollars using a 7-percent discount rate.

Table 3 Summary of Costs, Millions of 2020 Dollars

Project Cost Summary			
Item Costs	**Constant Dollars**	**Discounted 7%**	**Discounted 3%**
Engineering & Design	$1.2	$1.0	$1.1
ROW	$10.1	$8.2	$9.2
Construction	$30.0	$20.1	$25.2
O&M	$22.1	$12.6	$16.7
Total	**$63.4**	**$41.9**	**$52.2**

4.5–Disruptions Due to Construction

Disruption to businesses and traffic along the Corridors are not quantified in the BCA. The project expedited schedule is anticipated to minimize disruptions, particularly by the local access road improvements. Local access road improvements are not included in the BCA and these disruptions are not quantified or monetized.

4.6–Effects on Selection Criteria

In the table below, the main benefit categories associated with the project are mapped into the primary selection criteria set forth by the USDOT in the Notice of Funding Opportunity for the Raise Grant Program.

Table 4 Benefit Categories and Expected Alignment with Project Requirements

Primary Selection Criteria	Benefit or Impact Categories	Description	Monetized	Qualitative
Safety	Reduction in number of traffic crashes, fatalities, and injuries	Reduction in property losses, injuries, and deaths due to improved intersections, added traffic lights and crosswalks, access management reducing direct access, raised medians, added green space and width between multi-use path and roadway. Travel improved for pedestrians, cyclists, and automobiles.	Yes	Yes
Environmental Sustainability	Emission costs savings	Decrease emissions for less reliance on fossil fuels with diversion from vehicles to pedestrians and bicycles		Yes
	Stormwater management/ water quality improvement	The project will improve stormwater management and use innovative water quality devices/facilities		Yes
Quality of Life	Accessibility Enhancements	Improved connectivity between residential areas across the corridor and to lower income high poverty areas creating more opportunities for jobs, resources, and other development facilities.		Yes
Improves Mobility and Community Connectivity	Facility and Vehicle Amenities, Pedestrian and Bicycle Facilities	Improvements to the 5-ft sidewalks converting them to 10-ft multi-use paths on both sides of the road with a grass buffer offers safety benefits that will enhance the agglomeration benefits connecting lower income poverty areas with development, jobs, and family resources that may not otherwise be available or encouraged without the improvements.		Yes
Economic Competitiveness and Opportunity	Travel time savings	Improved intersections with dedicated turn lanes, shared driveways, and access management to improve congestion and travel time hours.	Yes	Yes
	Vehicle Operating Costs	Improvements reduce congestion and promotes pedestrian travel. Reduced vehicle hours traveled for the project results to reduced operating costs.		Yes
State of Good Repair	O&M Savings	Cost savings on maintaining signals, lighting, pavement, sidewalks, and bike lanes.	Yes	Yes
Partnership and Collaboration	Mobility and Community Connectivity	The project will include public meetings to engage the affected communities. Specifically disadvantaged communities will have the opportunity to have collaborative yet diverse input during the project planning. The ROW acquisition plan will have minimal disruption to the communities and will maintain community cohesion.		Yes
		Project delivery will include teaming partnerships with both public and private entities including disadvantaged businesses. The project will have collaboration with local DOT agencies to ensure guidelines are met.		Yes

Primary Selection Criteria	Benefit or Impact Categories	Description	Monetized	Qualitative
Innovation	Innovative Technologies	Water quality innovative devices to enhance the local quality of surface waters. Technology will enhance the environmental permitting efforts to conserve time, space, and money throughout the project lifecycle.		Yes
		During project construction conduits will be installed under the roadway in several areas to accommodate future broadband/data infrastructure. Improved lighting will include internet Wi-Fi access points to enhance data connections for users of the corridor.		Yes

5.0–General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of project development and including 20 years of operations. The monetized benefits and costs are estimated in 2020 dollars with future dollars discounted in compliance with RAISE requirements using a 7-percent[6] real rate to year 2020. A 3-percent discount rate is provided in accordance with the RAISE guidance document.

This methodology makes several key assumptions and seeks to avoid overestimating the benefits and underestimating the costs. Specifically:

- Input prices are expressed in 2020 dollars.
- The first year of analysis begins in 2022, with the base year in 2020, and ends in 2047. It includes project development (2022-2025), construction (2025-2027), and 20 years of operations (2027-2047).
- Opening year demand and benefits are inputs to the BCA and assumed to be fully realized after construction is finished and project starts operations in 2027 (No ramp-up); and
- Unless specified otherwise, the results shown in this document correspond to the effects of the full Build Alternative as described in **Section 4.2** (Base Case and Alternatives)

The BCA produces several important measures to assess the cost effectiveness of a proposed infrastructure project. The benefit cost ratio (BCR) calculated by dividing the project's discounted societal benefits by its discounted project costs, measures the societal return on each dollar spent in project costs. A BCR or more than 1.0 indicates that for each dollar spent, more than one-dollar worth of benefits will be generated by the project. Another important measure is the net present value (NPV), calculated by subtracting the discounted project costs from the discounted societal benefits created by the project. This measure indicates the net social worth created by the project, after accounting for its costs.

However, the BCR and NPV only account for benefits that can be successfully quantified and monetized; some benefits generated by a project may be difficult to quantify or monetize and are therefore excluded from the measures described above. It is important that the BCR and NPV of a project be considered in conjunction with other qualitative criteria when judging a project's overall worth.

6 White House Office of Management and Budget, Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (October 29, 1992).

6.0–Demand Projections

Traffic demand projections illustrate the growth in roadway use in response to the availability of capacity and user demand and the social costs and benefits associated with the use of the facility. Projections of future traffic indicates whether project improvements will increase safety and decrease congestion with additional capacity and infrastructure features. The table below summarizes the vehicular demands related to the corridor improvements only. Note that VMTs are the same for the build and no build scenarios since the VMT savings comes from the combination of the project with the construction of the local access roads which is not included in this BCA.

Table 5 No Build and Build Demand Projections[7]

Variable	Project Opening Year (2027)		Final Year of Analysis (2047)	
	No Build	Build	No Build	Build
Annual VHTs	1,036,000	715,000	2,210,000	1,725,000
Annual VMTs	28,990,000	28,990,000	32,952,000	32,952,000

The demand projections were developed from the analysis completed as part of the 2021 Lady's Island Traffic Study[8]. This analysis utilized Synchro traffic simulation software to examine build and no-build operations during the peak AM and PM periods, see **Section 7.5** for more information about how this data was used in the BCA.

7.0–Benefits Measurement, Data, and Assumptions

This section describes the measurement approach used for each quantifiable benefit or impact category identified in **Table 4** and provides an overview of the associated methodology, assumptions, and estimates.

7.1–Safety

The project will improve the safety at multiple intersections across the corridor by the implementation of high-definition crosswalks, pedestrian refuge islands, and signal leading pedestrian intervals. The safety along the corridor is also enhanced with new street lighting, new grass buffered pedestrian walkways, multi-use paths on both sides of the roadway, roadway access management and raised medians. According to an analysis of crash data in seven states by the Federal Highway Administration (FHWA), raised medians reduce crashes by over 40 percent in urban areas[9].

As noted in the Raise Grant Application, the South Carolina Department of Public Safety documented 1,021 accidents over an 8-year span along the project improvement corridor. These accidents were made up of the following:

- (4) Fatal crashes
- (326) Injury crashes
- (691) PDO crashes.

A key safety benefit of any transportation infrastructure project is to reduce the likelihood of fatalities, injuries, and property damage from crashes by reducing the number and severity of such crashes. The documented crashes were primarily made up of

7 *2021 Lady's Island Traffic Study*, Stantec Consulting Services Inc.
8 *2021 Lady's Island Traffic Study*, Stantec Consulting Services Inc.
9 FHWA, *Benefits of Access Management* Brochure. Office of Operations, March 2020, https://ops.fhwa.dot.gov/access_mgmt/docs/benefits_am_trifold.htm

rear end and angled collisions at Sea Island Parkway & Lady's Island Drive. Through access management eliminating left hand turns, isolating U-turn movements, and providing raised medians, crash reductions can be quantified.

To estimate the crash reduction by the proposed improvements, the existing no build scenario projecting the local accident data gathered annually to the project service period is calculated first. The monetized values from Appendix A of the guidance were used to apply the rates shown in the table below[10]:

Table 6 Crash Monetized Values (2020$)

Crash Type	Cash Values	Unit
Injury	$302,600	$/veh
Fatal	$12,837,400	$/veh

The summary of the raw costs of the no build case are then discounted to 2020 dollars for comparison to the build case. The build case is developed using the crash modification factor (CMF) methodology to apply the appropriate crash reduction value associated with the respective infrastructure improvements (countermeasures) along the project corridor[11].

One of the most significant countermeasures for crash reductions, specifically for angled and rear end collisions, is the installation of raised medians with or without marked crosswalks at intersections. This countermeasure reduces the crash rates by 25.9-percent (CMF of 0.741 for CMF ID 9015). The CMF of 0.741 was applied to the annual projected crashes throughout the analysis period for the build scenario and then discounted to 2020 dollars. The difference in the no build scenario summarized discounted costs and the build scenario will be the crash reduction savings benefit for the corridor project. The Table 7 below summarizes this benefit.

Table 7 Project Corridor Crash Savings Summary

Scenario	Crash Costs (Millions 2020$)	
	Discounted 7%	Discounted 3%
No Build	$211.2	$331.7
Build	$175.5	$267.8
Savings Benefit (2027-2047) =	**$35.7**	**$63.9**

Pedestrian and bicycle safety is also a significant benefit in addition to vehicular crash reduction. However, the safety improvements to the pedestrian and bicycle infrastructure along the corridor are not monetized the same as vehicular safety due to the lack of relevant data requiring detailed existing and projected volume studies. Therefore, this safety benefit is qualitatively discussed in other benefit areas inclusive of the following sections:

- Quality-of-Life
- Facility and Vehicle Amenity Benefits
- Health Benefits

7.2–Environmental Sustainability

The project will create environmental benefits relating to water quality from new and updated stormwater improvements utilizing innovative technology to enhance the quality of surface waters. The water quality benefit is not monetized but discussed qualitatively. The project improvements will result in reductions in emission volumes which are typically derived based upon the reduction in VMT resulting from the project. While the project improvements along the corridor will receive the reduced emission

10 USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, March 2022.

11 http://www.cmfclearinghouse.org/

benefits, they are not monetized due to the corridor project alone not showing a decrease in VMT. The VMT reductions occur from the combination of another improvement project for the local access roads, therefore, this benefit is not monetized in this BCA. However, there will inherently be more pedestrians resulting from the project that will potentially replace some of the local vehicular travel, but this value is not quantified/monetized in this analysis due to the lack of relevant local data predicting this shift. Another qualitative benefit from the project is the enhanced support for fiscally responsible land use and transportation efficient design. The zoning along the corridor associated with Beaufort County's comprehensive plan considers the existing and future land uses by implementing the preservation of cultural, historic, and archaeological resources. The preservation through zoning is inclusive of protecting the rural landscape and way of life while incorporating efficient transportation infrastructure which directly benefits these areas through the corridor improvements enhanced safe connections to underserved, minority, and disadvantaged rural communities.

7.3–Quality-of-Life

The corridor improvements create quality-of-life / livability benefits associated with encouraging pedestrian and bicycle traffic by extending and improving pedestrian infrastructure to increase connectivity within the community. Community connectivity has been shown to induce foot and bicycle traffic for commuting and recreation. The improved pedestrian pathways and bicycle lanes have a direct positive impact to quality-of-life in addition to benefits discussed in other sections such as Health Benefits, and Facility and Vehicle Amenity Benefits. The quality-of-life will also be enhanced by complimenting the unique characteristics of the community by increasing the accessibility for all travelers specifically overburdened, disadvantaged lower income poverty areas with the expanded community connections that increase the safe accessibility to development, resources, and potential job opportunities. The community connection benefits to quality-of-life are also discussed qualitatively in Section 1 as Agglomeration Economies Benefits. The quality-of-life benefits are not monetized due to lack of data to quantify these benefits. Other quality-of-life benefits not monetized for this merit criteria include benefits discussed in other sections such as innovation with improved lighting along the corridor which is anticipated to include Wi-Fi access point connectivity and the addition of future utility expansion conduits for future broadband connectivity.

7.4–Mobility and Community Connectivity

The components of this benefit have been discussed in previous sections qualitatively with the project improvements encouraging non-motorized travel by extending and improving non-motorized infrastructure to increase connectivity to other communities for all users. Improving the safety of the non-motorized infrastructure to the outlying communities will link resources along the corridor. This focus on promoting the enhanced pedestrian and bicycle facilities will encourage individuals and communities to move around freely with or without motorized transportation to create neighborhoods where people can live, work and play. The pedestrian facilities will meet the Americans with Disabilities Act (ADA) requirements in addition to being accessible to people with disabilities inclusive of those who use wheelchairs. The project will have ADA accessible ramps at intersections and have grade profiles conducive to all applicable ADA guidelines.

In addition to connecting communities for all users including those with disabilities, the corridor improvements will provide expanded transportation connections for vehicular and non-vehicular users to underserved, overburdened lower income, and minority communities for potential job and business opportunities by providing safer mobile infrastructure. Additional information supporting the need for safer community connectivity can be found in the previous benefit sections on Safety, Quality-of-Life and in other sections below.

7.5–Economic Competitiveness and Opportunity

The project corridor improvements will contribute to enhancing the economic competitiveness of the County through improvements in the mobility of people and goods within and across the study area, including improvements to efficiency and connectivity to revitalize underserved, overburdened, and disadvantaged communities. The improvements to the system connectivity enhances opportunities for underserved, overburdened, and disadvantaged communities with increased access to jobs, location of efficient affordable housing, and facilitating tourism opportunities. In this analysis, one monetary measure of mobility is presented for travel-time savings as it relates to the project VHT for the build and no build scenario. Benefits for out-of-pocket transportation operating costs are not monetized due to the corridor project improvements under the RAISE Grant application not resulting in a reduction in VMT. VMT reductions will occur with the combination of this project with the local "Access Roads" individual projects. Since the individual "Access Roads" projects are required to achieve the VMT reductions, the vehicle operating cost benefits have been excluded from this BCA.

Table 8 below depicts the no build and build scenarios with the project annual VHT values taken from the project traffic study. The applicable range for the VHT savings begins when the project service life begins in 2027 and ends after the project life cycle in 2047. The operational analysis was completed as part of the 2021 Lady's Island Traffic Study[12]. This analysis utilized Synchro traffic simulation software to examine build and no-build operations during the peak AM and PM periods.

The peak-hour traffic simulation models were used to determine the VHT for a build and no-build scenario. The peak hours for the purpose of this scenario are considered the top three (3) AM and PM peak hours; six total for the day. The Peak Hour VHT's calculated should be considered a conservative estimate of the VMT hours saved as they are derived from only the peak hours of the day. Outside of these six peak hours, traffic conditions have not been modeled and it is assumed that the difference in VHT between build and no-build alternatives is less significant.

Table 8 US 21/SC 802 Corridor Improvements Average VHT

Year		Daily VHT (veh-hours-traveled)		DIFFERENCE IN VHT (veh-hours-traveled)	Travel Time Savings (Undiscounted)	Travel Time Savings (Discounted 7% 2020$)	Travel Time Savings (Discounted 3% 2020$)
Year	Year ID	Base-No Build	Alternative-Build				
2020	Base Year	467,000	-	0	$0.00	$0.00	$0.00
2024	-3	898,000	-	0	$0.00	$0.00	$0.00
2025	-2	944,000	-	0	$0.00	$0.00	$0.00
2026	-1	990,000	-	0	$0.00	$0.00	$0.00
2027	0	1,036,000	715,000	321,000	$5,713,800	$3,558,267	$4,645,842
2028	1	1,082,000	761,000	321,000	$5,713,800	$3,325,484	$4,510,526
2029	2	1,128,000	807,000	321,000	$5,713,800	$3,107,929	$4,379,152
2030	3	1,174,000	853,000	321,000	$5,713,800	$2,904,606	$4,251,604
2031	4	1,220,000	899,000	321,000	$5,713,800	$2,714,585	$4,127,771
2032	5	1,266,000	945,000	321,000	$5,713,800	$2,536,996	$4,007,544
2033	6	1,312,000	991,000	321,000	$5,713,800	$2,371,024	$3,890,820
2034	7	1,358,000	1,037,000	321,000	$5,713,800	$2,215,910	$3,777,495
2035	8	1,404,000	1,083,000	321,000	$5,713,800	$2,070,944	$3,667,471
2036	9	1,450,000	1,129,000	321,000	$5,713,800	$1,935,462	$3,560,651

12 *2021 Lady's Island Traffic* Study, Stantec Consulting Services Inc.

Table 8 US 21/SC 802 Corridor Improvements Average VHT (continued)

Year		Daily VHT (veh-hours-traveled)		DIFFERENCE IN VHT (veh-hours-traveled)	Travel Time Savings (Undiscounted)	Travel Time Savings (Discounted 7% 2020$)	Travel Time Savings (Discounted 3% 2020$)
Year	Year ID	Base-No Build	Alternative-Build				
2037	10	1,496,000	1,175,000	321,000	$5,713,800	$1,808,843	$3,456,943
2038	11	1,542,000	1,221,000	321,000	$5,713,800	$1,690,507	$3,356,255
2039	12	1,588,000	1,267,000	321,000	$5,713,800	$1,579,913	$3,258,500
2040	13	1,634,000	1,313,000	321,000	$5,713,800	$1,476,554	$3,163,593
2041	14	1,680,000	1,359,000	321,000	$5,713,800	$1,379,957	$3,071,449
2042	15	1,980,000	1,495,000	485,000	$8,633,000	$1,948,582	$4,505,498
2043	16	2,026,000	1,541,000	485,000	$8,633,000	$1,821,104	$4,374,270
2044	17	2,072,000	1,587,000	485,000	$8,633,000	$1,701,967	$4,246,864
2045	18	2,118,000	1,633,000	485,000	$8,633,000	$1,590,623	$4,123,169
2046	19	2,164,000	1,679,000	485,000	$8,633,000	$1,486,564	$4,003,077
2047	20	2,210,000	1,725,000	485,000	$8,633,000	$1,389,312	$3,886,482
				Total	$137,505,000	$44,615,133	$82,264,976

The Table 9 below summarizes the results of the Travel Time Savings as shown in the BCA analysis.

Table 9 Vehicle Travel Time Savings

Benefit	Travel Time Savings (Millions 2020$)	
	Discounted 7%	Discounted 3%
Savings Benefit (2022-2047) =	$44.6	$82.3

7.6–Facility and Vehicle Amenity Benefits[13]

The improvements to pedestrian and bicycle facilities provide amenities that can improve the quality or comfort of journeys made by active transportation users. As discussed in other benefit sections, this is also related to quality-of-life and health benefits. The facility benefits from the corridor project includes replacing 5-ft sidewalks with 10-ft multi-use paths on both sides, the addition of bike lanes/shared lanes on SC 802, and the replacement of crosswalks with high-definition (HD) crosswalks and the installation of new HD marked crosswalks with crossing signals at intersections.

Beaufort County published a bicycle and pedestrian plan in 2021 to help prepare for future growth supporting improved bicycle and pedestrian access throughout the county. The publication is the result of regional collaborative efforts of a Bicycle/Pedestrian Task Force made up of members from Beaufort County and the local municipalities. The publication's initiatives included public surveying, mapping, and input collection from each participating municipality. The survey was inclusive of nearly 2,000 members of the public responding with 60-percent indicating that bicycle and pedestrian facilities are an important factor in deciding where to live and work. Yet, nearly half of them commented that though they had an interest in cycling or walking, they don't due to facility safety and wayfinding concerns. These survey responses reported "wanting walking or biking to be their primary mode of transportation". The data gathered clearly establishes a need and desire for more interconnecting and safer bicycle and pedestrian infrastructure in Beaufort County. The reported needs and desires for this facility type supports and confirms that a portion of the corridor population would likely use bicycle and/or pedestrian facilities if they were safer, therefore, the

13 USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, March 2022.

new infrastructure proposed was partially driven by safety and connections to other communities. The proposed project corridor was identified as being ranked number 3 of the top areas in Beaufort County reported as needing safe bicycle and pedestrian improvements[14].

In 2021, South Carolina was ranked as the 7th most dangerous state in the United States for pedestrians according to the report "Dangerous by Design" published by The National Complete Streets Coalition and Smart Growth America. This depicts a decline in pedestrian and bicycling safety of the state's already poor rating in the 2019 report, when the state was ranked 10th. South Carolina's repeated ranking on the top ten list helps illustrate the profound lack of pedestrian infrastructure in the state.

Between 2009 and 2017, South Carolina experienced over 9,000 crashes involving pedestrians and 1,112 pedestrian fatalities, and these accidents did not affect the population equally. Although the state's populations was approximately 27-percent African American at the time, 47-percent of those involved in pedestrian crashes were African American[15]. These statistics reinforce the need for safer bicycle and pedestrian infrastructure providing access to minority communities as proposed in the corridor improvement project.

Pedestrian Facilities

There are 5-ft sidewalks currently located on both sides of the roadways, however, they are proposed to be removed and replaced with a 5-foot planting strip and 10-ft multi-use paths on both sides to Dow Road and then a 10-ft multiuse path on one side and a new 5-ft sidewalk on the other side to the end of the project near Chowan Creek. The key pedestrian facility attributes for sidewalks and multi-use paths are the width as it affects the comfort, convenience, and the safety of the facility. The monetization for the improved pedestrian facilities is capped at average length of a walking trip of 0.86 miles[16]. Therefore, only 0.86 miles of sidewalk could be monetized from the 5.7 miles of 10-ft multi-use path addition with adequate pedestrian trip estimates. However, due to the lack of local pedestrian volume availability or detailed pedestrian studies along the corridor, a projected value for the number of people walking along the corridor could not be estimated. The monetization factors from the Raise Grant 2022 Guide from Appendix A Table A-8 require estimates of the number of person-miles walked. Therefore, this benefit is described qualitatively only. Leaving this benefit out will result in a conservative BCA having this benefit excluded. If the estimation of the person-miles walked along the corridor were available, the benefit would be $0.10 per foot of pathway width added for each person mile walked along the project for the maximum of 0.86 miles. Table 10 below presents the Unit Value Benefit of the proposed pathway improvements.

Table 10 Pedestrian Unit Value Monetization Table[17]

Pathway Length (miles)	Added Width (ft.)	Value per Person-Mile (per added foot of width walked)	Length Allowed (miles)	Unit Value (per person-mile)
5.70	5.00	$0.10	0.86	$0.43

Bicycle Facilities

Dedicated bicycle facilities currently exist along US 21 and US 21 Business corridors with an existing population of "Dedicated Cyclists", however, the 10-ft multi-use paths will accommodate additional "Recreational Cyclists" that likely would not use the dedicated bike lanes. To monetize improvements to bicycle facilities, the added length of new bike lanes was evaluated. However,

14 *Beaufort County CONNECTS, Bicycle and Pedestrian Plan 2021*. https://www.beaufortcountysc.gov/planning/documents/BCC2021_Final_9.2021-1.pdf
15 Ibid.
16 2017 National Household Travel Survey
17 USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, March 2022.

due to the lack of local cyclist volume availability or detailed cyclist studies along the corridor, a projected value for the number of people cycling along the corridor could not be estimated. The monetization factors from the Raise Grant 2022 Guide from Appendix A Table A-9 require the number of cyclists per miles cycled. Therefore, this benefit is described qualitatively only. Leaving this benefit out will result in a conservative BCA. If the estimation of the number of cyclists and number of miles cycled along the corridor were available, the benefit would be $1.69 per cyclist per mile along the project. The maximum estimated bike lane length value per cyclist on a proposed project facility is 2.38 miles[18]. Dedicated bike lanes/shared lanes are proposed for SC 802 on both sides with a total of 0.88 miles of bike lanes. Table 11 below presents the Unit Value Benefit of the proposed cycling improvements.

Table 11 Cycling Unit Value Monetization Table[19]

Dedicated Bike Lane Length (miles)	Value (per cyclist per-cycling mile)	Max Length Allowed (miles)	Unit Value (per cyclist)
0.88	$1.69	2.38	$1.49

Crosswalks

The installation of marked crosswalks and crossing signals provide pedestrians with an increased sense of safety when crossing a roadway facility, as well as potential travel time savings for pedestrians where such a crossing was previously not possible due to traffic volumes and crossing distances. Additionally, the existing driveways along the corridor do not all have a crosswalk, or they have been worn away. The corridor improvements will provide new/improved crosswalks for all driveways having access to the corridor. While pedestrian time savings and added crosswalk improvement benefits are not monetized for the new crosswalk installations, the benefit can be seen qualitatively with benefits also related to quality-of-life.

7.7–Health Benefits

South Carolina ranks number 12 in the nation for the rate of adult obesity. Not surprisingly then, obesity is also a problem in Beaufort County. Morbidity data collected for the County in 2013 indicated that 21-percent of the adult population was obese. By 2019, that number had increased to 23-percent where nearly one in four adults is obese. Excessive weight has been identified as a causal factor in the development of heart disease, diabetes, hypertension, and stroke. Obesity is even more common in children. A 2018-2019 study at a Beaufort County middle school shows 34-percent, 44-percent and 43-percent of 3rd, 5th, and 8th graders respectively are overweight or obese[20].

The corridor project improvement to the pedestrian and cycling facilities will help facilitate and promote walking and biking as a mode of exercise to improve community health. Promoting safer pedestrian and cycling facilities through the corridor improvements will have health benefits for children, adults, and seniors.

The health benefits associated with walking and cycling are monetized based the number of induced trips with standard values provided based on maximum benefit lengths and average speeds as shown in the Table 12 below.

18 2017 National Household Travel Survey
19 Ibid.
20 *Beaufort County CONNECTS, Bicycle and Pedestrian Plan 2021*. https://www.beaufortcountysc.gov/planning/documents/BCC2021_Final_9.2021-1.pdf

Table 12 Mortality Reduction Benefits of Induced Active Transportation Values[21]

Mode	Age Range	Recommended Value per Induced Trip (2020$)	Length Allowed (miles)	Speed (mph)
Walking	20-74	$7.08	0.86	3.20
Cycling	20-64	$6.31	2.38	9.80

The dollar values in the table above are units that would be used to calculate a monetized health benefit from the reduction of mortality by multiplying the recommended value by the number of induced trips. This value cannot be monetized for reasons previously mentioned regarding the lack of local pedestrian and cycling traffic data demands.

7.8–State of Good Repair

The state of good repair (SOGR) condition benefits assessed in this analysis include maintenance and repair savings, and the deferral of replacement cost savings. The corridor improvements project proposes to eliminate sections of pavement by converting two-way left turn lanes into raised planted or concrete medians and adding vegetated buffers separating multi-use pathways from the roadway. Benefits of projects that replace, repair, or improve existing transportation assets to bring them to a SOGR are typically captured by benefits and cost factors in other areas, such as long-term maintenance and repair costs of the assets, enhanced safety, and improved service or facility reliability and quality.

The corridor improvements project evaluates the SOGR as a reduction of long-term maintenance and repairs. The costs section of the BCA includes the O&M costs for the build condition only. As a result, the difference between the build and no build conditions represents the O&M savings which is the benefit presented as the SOGR. The project will maintain assets which is a state of good repair while addressing projected system safety vulnerabilities for underserved, overburdened disadvantaged communities with the added and improved pathway connections.

The O&M costs were developed based on the assumption that the existing and proposed traffic demands are made up of 4-percent trucks and 96-percent of cars with a constant lane mile length of 6.6 miles (3.3 each direction). The maintenance costs in dollars per vehicle miles were calculated using the traffic VMT values from the project traffic study, which remain constant between the build and no build condition, and the calculated average pavement costs for cars and trucks in urban areas. These high-level values represent pavement costs for a mile of travel by the different vehicle types to pavement deterioration and the repair costs. These values were taken from an addendum to the 1997 Federal Highway Cost Allocation Study[22]. The Federal Highway study has cost per mile values for pavement, congestion, crashes, air pollution, and noise. However, for this BCA only the pavement cost per mile values were used. These values were inflated from 2000 dollars to 2020 dollars using cost price index (CPI) inflation values and then discounted throughout the improvement's life cycle.

21 USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, March 2022, (Table A-12)

22 *1997 Federal Highway Cost Allocation Study, Final Report Addendum 2000*, Table 13. https://www.fhwa.dot.gov/policy/hcas/addendum.cfm

Table 13 Estimated Marginal External Pavement Costs

Vehicle Class	Urban Highways (Average) in 2000$/mile	CPI 2000	CPI 2016	Inf. Factor 2020$ from 2016	Urban Highways (Average) in 2020$/mile
Passenger Cars	0.001	172.19	240.01	1.07	0.0015
Trucks	0.182	172.19	240.01	1.07	0.2707
				Average	**0.01226**

The average cost in 2020 dollars per mile traveled is shown in the Table 13 above. Table 14 below depicts the build and no build O&M costs. The summary of the build costs below is input as the O&M costs in the BCA. Table 15 presents the cost difference between the build and no build O&M costs which accounts for the SOGR benefit. The O&M and SOGR was evaluated such that the cost and benefit are not double counted.

Table 14 Annual O&M Costs (Millions of 2020$)

		VMT (annual)	Raw	Discounted at 7 %	Discounted at 3 %	Raw	Discounted at 7 %	Discounted at 3 %
		(Veh-miles)	**Build O&M**			**No Build O&M**		
Year	Year ID	Build/No Build	Annual O&M Costs (Millions of 2020$)			Annual O&M Costs (Millions of 2020$)		
2020	Base Year	19,900,000	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6
2022	-5	19,900,000	$3.2	$2.8	$3.0	$3.2	$2.8	$3.0
2023	-4	19,900,000	$1.6	$1.3	$1.5	$1.6	$1.3	$1.5
2024	-3	19,900,000	$1.6	$1.2	$1.4	$1.6	$1.2	$1.4
2025	-2	19,900,000	$1.6	$1.1	$1.4	$1.6	$1.1	$1.4
2026	-1	28,780,000	$2.3	$1.6	$2.0	$2.3	$1.6	$2.0
2027	0	28,990,000	$0.0	$0.0	$0.0	$2.3	$1.5	$1.9
2028	1	29,171,000	$0.0	$0.0	$0.0	$2.4	$1.4	$1.9
2029	2	29,352,000	$0.0	$0.0	$0.0	$2.4	$1.3	$1.8
2030	3	29,533,000	$0.0	$0.0	$0.0	$2.4	$1.2	$1.8
2031	4	29,714,000	$2.4	$1.1	$1.7	$2.4	$1.1	$1.7
2032	5	29,895,000	$0.0	$0.0	$0.0	$2.4	$1.1	$1.7
2033	6	30,076,000	$0.0	$0.0	$0.0	$2.4	$1.0	$1.7
2034	7	30,257,000	$0.0	$0.0	$0.0	$2.4	$0.9	$1.6
2035	8	30,438,000	$0.0	$0.0	$0.0	$2.5	$0.9	$1.6
2036	9	30,619,000	$0.0	$0.0	$0.0	$2.5	$0.8	$1.5
2037	10	30,800,000	$2.5	$0.8	$1.5	$2.5	$0.8	$1.5
2038	11	30,981,000	$0.0	$0.0	$0.0	$2.5	$0.7	$1.5
2039	12	31,162,000	$0.0	$0.0	$0.0	$2.5	$0.7	$1.4
2040	13	31,343,000	$0.0	$0.0	$0.0	$2.5	$0.7	$1.4
2041	14	31,524,000	$0.0	$0.0	$0.0	$2.6	$0.6	$1.4

		VMT (annual)	Raw	Discounted at 7 %	Discounted at 3 %	Raw	Discounted at 7 %	Discounted at 3 %
		(Veh-miles)	**Build O&M**			**No Build O&M**		
Year	Year ID	Build/No Build	Annual O&M Costs (Millions of 2020$)			Annual O&M Costs (Millions of 2020$)		
2042	15	31,705,000	$2.6	$0.6	$1.3	$2.6	$0.6	$1.3
2043	16	31,886,000	$0.0	$0.0	$0.0	$2.6	$0.5	$1.3
2044	17	32,067,000	$0.0	$0.0	$0.0	$2.6	$0.5	$1.3
2045	18	32,248,000	$0.0	$0.0	$0.0	$2.6	$0.5	$1.2
2046	19	32,600,000	$0.0	$0.0	$0.0	$2.6	$0.5	$1.2
2047	20	32,781,000	$2.7	$0.4	$1.2	$2.7	$0.4	$1.2
Total			**$22.1**	**$12.6**	**$16.7**	**$64.4**	**$27.4**	**$42.9**

The absolute value of the table below contains the values represented in the BCA benefits for SOGR with the BCA results figures. It should be noted that the savings benefit starts in 2027 when the corridor improvements begin its service life and ends in 2047. The O&M values remain constant without a difference until 2027.

Table 15 SOGR O&M Savings Benefit (Millions of 2020$)

Undiscounted	Discounted at 7 %	Discounted at 3 %
-$42.2	-$14.8	-$26.2

7.9–Innovation

As previously discussed, innovative technologies will be incorporated into the corridor improvements project for water quality at stormwater discharges, added conduit for future broadband and other underground utilities, and the installation of Wi-Fi access points integrated into the improved corridor lighting. The benefits from these innovative technologies cannot be monetized, however, the benefits are obvious for environmental sustainability and quality-of-life driven by resilience and enhanced economic outcomes for all users inclusive of underserved and disadvantaged communities.

An innovative technique offering qualified benefits would include building the corridor improvements project in conjunction with other projects of similar type and design. These can be under a single project or have accelerated timelines that align such that the projects can be complete or partially completed in a manner that maximizes the improvement benefit that facilitate improved project delivery. For example, the "Access Roads" projects include several smaller projects along the corridor quadrants with similar improvements and connections to the corridor improvement intersections offering relief in VMT and providing alternate routes from the main corridor during high congestion or during construction. The corridor improvements project will have these additional benefits when combined with the "Access Roads" improvements. The anticipated accelerated construction schedule of the "Access Roads" is expected to provide relief from potential work zone disruptions for the corridor project. Likewise, with the "Access Roads", many benefits not monetized in this BCA will be enjoyed throughout the corridor, adjacent development, and connecting communities. The benefits would be relative to a reduction in VMT which would result in quantifiable benefits for lower emission reductions and operating cost savings among others. These benefits were excluded from the BCA to isolate the corridor improvements independently from the other local projects.

8.0–Summary of findings and BCA Outcomes

The tables below summarize the BCA findings. Annual costs and benefits are estimated over the lifecycle of the project (from 2022 to 2047) with construction ending the second quarter of 2027. Benefits accrue during the operation of the Project (over the years 2027-2047).

The figures below present the overall outcomes of the benefit-cost analysis with project performance metrics for the both the 3-percent and 7-percent discount rates.

Benefit-Cost Assessment @ 7% Discount Rate for US 21/SC 802 Corridor Improvements Project

Benefit-Cost Analysis Summary @ 7% Discount Rate	
NET PRESENT VALUE = (B) - (C) =	$53,250,616
BENEFIT-COST RATIO = (B) / (C) =	2.27

Project Costs

Cost Categories	Undiscounted	In 2020$ Discounted at 7%
Capital Costs	$41,288,412	$29,309,564
O&M Costs	$22,103,665	$12,602,410
Total Costs (C)=	$63,392,076	$41,911,974

Project Benefits

Benefit Category	Savings	Undiscounted	In 2020$ Discounted at 7%
A. State of Good Repair (SOGR)	Avoided Maintenance Costs	$42,247,791	$14,807,089
B. Economic Competitiveness	Travel Time Savings	$137,505,000	$44,615,133
	Vehicle Operating Cost Saving		
C. Quality of Life	Health Benefits from Walking Trips		
	Avoided Auto Trips from Walking Trips		
C. Sustainability	Avoided Social Cost of Carbon Emissions		
	Avoided Non-Carbon Emission Costs		
D. Safety	Raised Medians (Avoided Collisions)	$103,951,540	$35,740,368
Total Benefits (B) =		$283,704,331	$95,162,591

Figure 2 BCA Summary Results 7% Discounted

Benefit-Cost Assessment @ 3% Discount Rate for US 21/SC 802 Corridor Improvements Project

Benefit-Cost Analysis Summary @ 7% Discount Rate	
NET PRESENT VALUE = (B) - (C) =	$120,202,243
BENEFIT-COST RATIO = (B) / (C) =	3.30

Project Costs

Cost Categories	Undiscounted	In 2020$ Discounted at 3%
Capital Costs	$41,288,412	$35,505,117
O&M Costs	$22,103,665	$16,666,430
Total Costs (C)=	$63,392,076	$52,171,548

Project Benefits

Benefit Category	Savings	Undiscounted	In 2020$ Discounted at 3%
A. State of Good Repair (SOGR)	Avoided Maintenance Costs	$42,247,791	$26,204,160
B. Economic Competitiveness	Travel Time Savings	$137,505,000	$82,264,976
	Vehicle Operating Cost Saving		
C. Quality of Life	Health Benefits from Walking Trips		
	Avoided Auto Trips from Walking Trips		
C. Sustainability	Avoided Social Cost of Carbon Emissions		
	Avoided Non-Carbon Emission Costs		
D. Safety	Raised Medians (Avoided Collisions)	$103,951,540	$63,904,655
Total Benefits (B) =		$283,704,331	$172,373,790

Figure 3 BCA Summary Results 3% Discounted

As shown in the **Figure 2** summary, the total benefits from the project improvements within the analysis period are calculated to be $95.2 million in 7-percent discounted 2020 dollars. The total capital costs, including engineering, construction, and right-of-way acquisition, are calculated to be $41.9 million in 7-percent discounted 2020 dollars. The difference of the discounted benefits and costs equal a net present value of $53.3 million in 7-percent discounted 2020 dollars, resulting in a benefit-cost ration (BCR) of 2.27. The corresponding values at the 3-percent discount rate are shown in **Figure 3**.

9.0–BCA Sensitivity Analysis

The BCA outcomes presented in previous sections rely on many assumptions and long-term projections, both of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have a potential to impact on the BCA outcomes: the "critical variables."

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the results would vary with reasonable variations from value for the variable; and
- Assess the stability of the BCA and evaluate whether the conclusions reached under the developed set of input values are significantly altered by reasonable departures from those values.

The sensitivity analysis was conducted with respect to the components of the corridor project's capital cost estimate (engineering, right-of-way acquisition, and construction), and the monetized values associated with crash fatalities. These parameters were identified due to the potential to impact the BCA and due to the variable uncertainties. The BCA module summary from the BCA Excel spreadsheet associated with the corridor project was developed to allow a simple sensitivity analysis by the alteration of one of the "critical" variables with multiple valuations. The variables identified for the sensitivity includes cost components and a benefit associated with the monetized value for the reduction of crash fatalities. The figure below depicts the first three sensitivity steps associated with the project BCA.

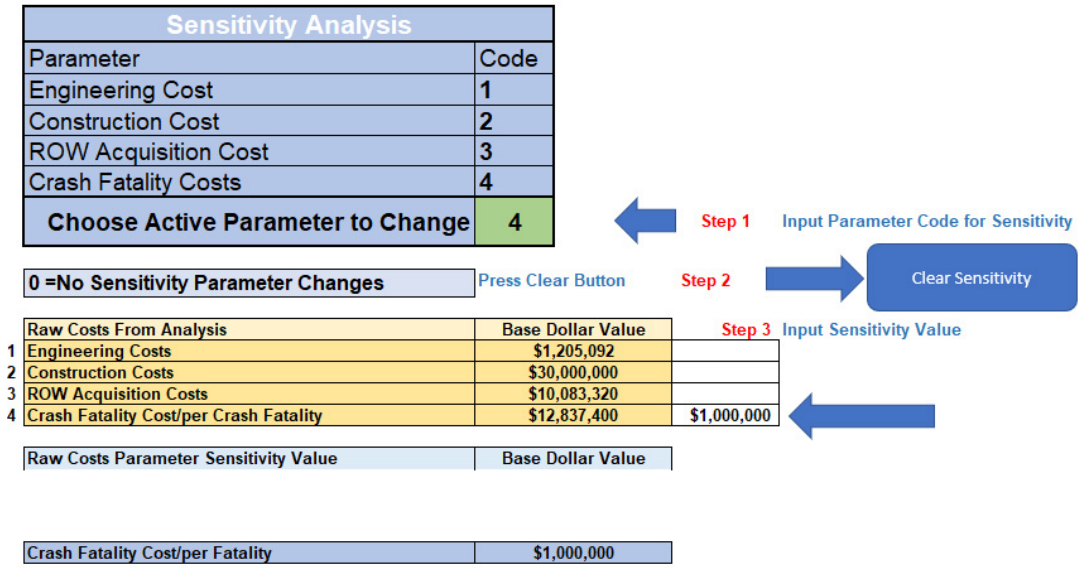

Figure 4 BCA Sensitivity Steps

Figure 4 was taken from the BCA results tab where the sensitivity calculations are conducted. The first step requires choosing the "Code" associated with one of the four parameters the reviewer wants to evaluate. Once the code is chosen as highlighted in green, the second step is to clear the sensitivity values previously conducted (this is required each time a parameter is chosen). Once the sensitivity has been cleared, then step three is to enter the alternate value of the chosen parameter in the adjacent cell, (only enter one parameter value matching the code chosen from step one). **Figure 4** depicts evaluating a sensitivity analysis on the Crash Fatality Costs identified as Code "4" with the alternate value of $1,000,000. The crash fatality costs are also known as the Value of Statistical Life (VSL). This value corresponds to the net value of the fatality crash reduction benefits. Directly next to the information shown above in the spreadsheet "Benefit-Cost Analysis" tab is a duplicated BCA results table that populates based on the alternate parameter value input by the user. The final step in the sensitivity evaluation is to review the results as shown in the figure below for the 7-percent discount rate. The spreadsheet also contains a duplicated "Benefit-Cost Analysis" tab with modifications to present the summary values at a 3-percent discount rate as suggested in the BCA Guide[23]. The overall evaluation of the BCA results is based on the 7-percent discount rate for all parameters unless noted otherwise.

Benefit-Cost Assessment Sensitivity

Step 4 Review Results

Benefit-Cost Analysis Summary @ 7% Discount Rate	
NET PRESENT VALUE = (B) - (C) =	$42,182,506
BENEFIT-COST RATIO = (B) / (C) =	2.01

Project Costs

Cost Categories	Undiscounted	In 2020$ Discounted at 7%
Capital Costs	$41,288,412	$29,309,564
O&M Costs	$22,103,665	$12,602,410
Total Costs (C)=	$63,392,076	$41,911,974

Project Benefits

Benefit Category	Savings	Undiscounted	In 2020$ Discounted at 7%
A. State of Good Repair (SOGR)	Avoided Maintenance Costs	$42,247,791	$14,807,089
B. Economic Competitiveness	Travel Time Savings	$137,505,000	$44,615,133
	Vehicle Operating Cost Saving		
C. Quality of Life	Health Benefits from Walking Trips		
	Avoided Auto Trips from Walking Trips		
C. Sustainability	Avoided Social Cost of Carbon Emissions		
	Avoided Non-Carbon Emission Costs		
D. Safety	Raised Medians (Avoided Collisions)	$71,759,731	$24,672,258
Total Benefits (B) =		$251,512,522	$84,094,480

BCR Sensitivity Change based on modification to Paramter Code	0.26
NPV Sensitivity Change based on modification to Paramter Code	$11,068,110

Figure 5 BCA Sensitivity Results with 7-Percent Discount Rate

As shown in **Figure 5** above and compared to **Figure 2**, reducing the monetized value for fatal crashes from $12.8 to $1 million base dollars reduces the Benefit Cost Ratio (BCR) by 0.26 and the NPV by $11.1 Million 2020 dollars for the 7-percent discount rate. Through several separate parameter sensitivity operations such as doubling the construction costs and reducing the fatality

23 USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, March 2022.

monetized cost / VSL by 92-percent the BCA results for the 7-percent discount rate remains robust with a BCR greater than 1 and a positive NPV. See other sensitivity scenarios in **Table 16** below.

Table 16 Quantitative Assessment of Sensitivity, 7-Percent Summary

Parameters	Change in Parameter Value	New NPV	% Change in NPV	New BCR
Engineering Cost	20% Increase	$53,048,963	-0.4%	2.26
	100% Increase	$52,242,352	-1.9%	2.22
Construction Cost	20% Increase	$49,225,427	-7.6%	2.07
	100% Increase	$33,124,668	-37.8%	1.53
ROW Acquisition Cost	20% Increase	$51,615,546	-3.1%	2.19
	100% Increase	$45,075,266	-15.4%	1.90
Crash Fatality Value	92.2 % Reduction	$42,182,506	-20.8%	2.01
	20% Increase	$55,651,241	4.5%	2.33
	100% Increase	$65,253,739	22.5%	2.56

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